Accuracy and Air Temperature Dependency of Commercial Low-cost NDIR CO$_2$ Sensors: An Experimental Investigation

An experimental campaign investigated the dependency of air temperature on the CO$_2$ concentration accuracy for commercial low-cost NDIR CO$_2$ sensors from the manufacturers Netatmo and IC-Meter. The test was conducted under different temperatures and CO$_2$ concentrations based on steady state conditions. Highly accurate instruments were employed to obtain reference temperatures and CO$_2$ concentrations. The IC-Meter modules were vaguely influenced by temperature, resulting in no significant difference compared to the reference concentration values. However, the Netatmo station modules were found to be positively temperature dependent.

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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Technical University of Denmark
Authors: Petersen, J. (Ekstern), Kristensen, J. (Ekstern), Elarga, H. (Intern), Andersen, R. (Intern), Midtstraum, A. (Ekstern)
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Accurate assessment of exposure using tracer gas measurements
Room airflow interaction, particularly in the breathing zone, is important to assess exposure to indoor air pollution. A breathing thermal manikin was used to simulate a room occupant with the convective boundary layer (CBL) generated
around the body and the respiratory flow. Local airflow against the face of the manikin was applied to increase the complexity of the airflow interaction. CO2 was released at the armpits and N2O at the groin to simulate the respective bio-effluents generated at these two body sites. The tracer gas concentration at the mouth/nose of the manikin was measured with gas analyzers with short and long response times, respectively. The tracer gas concentration was characterized by the mean, standard deviation and 95th percentile values. The results revealed that the measurement time needed to determine, with sufficient accuracy, these parameters decreased substantially with a decrease in the response time of the gas analyzer. When only CBL was present, shorter measurement time was needed for the accurate concentration measurement of the tracer gas released close to the breathing zone. For more complex flow, as a result of CBL interaction with the exhalation flow, the needed measurement time was longer. It has been concluded that the accurate exposure assessment requires that the concentration measurements are performed only during the inhalation period. Therefore, gas analysers with low response time and sampling time that is considerably shorter than the inhalation period have to be used.

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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Technical University of Denmark, Silesian University of Technology
Authors: Kierat, W. (Ekstern), Bivolarova, M. (Intern), Zavrl, E. (Ekstern), Popiolek, Z. (Intern), Melikov, A. (Intern)
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- Web of Science (2015): Indexed yes
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- ISI indexed (2011): ISI indexed yes
- Web of Science (2011): Indexed yes
- BFI (2010): BFI-level 1
- Scopus rating (2010): SJR 1.235 SNIP 2.001
- Web of Science (2010): Indexed yes
- BFI (2009): BFI-level 1
- Scopus rating (2009): SJR 1.028 SNIP 1.865
- Web of Science (2009): Indexed yes
This paper reviews past studies of airborne transmission between occupants in indoor environments, focusing on the spread of expiratory droplet nuclei from mouth/nose to mouth/nose for non-specific diseases. Special attention is paid to summarizing what is known about the influential factors, the inappropriate simplifications of the thermofluid boundary conditions of thermal manikins, the challenges facing the available experimental techniques, and the limitations of available evaluation methods. Secondary issues are highlighted and some new ways to improve our understanding of airborne transmission indoors are provided. The characteristics of airborne spread of expiratory droplet nuclei between occupants, which are influenced correlatively by both environmental and personal factors, were widely revealed under steady-state conditions. Owing to the different boundary conditions used, some inconsistent findings on specific influential factors have been published. The available instrumentation was too slow to provide accurate concentration profiles for time-dependent evaluations of events with obvious time characteristics, while CFD studies were mainly performed in the framework of inherently steady Reynolds-averaged Navier-Stokes modelling. Future research needs in three areas are identified: the importance of the direction of indoor airflow patterns, the dynamics of airborne transmission, and the application of CFD simulations. This article is protected by copyright. All rights reserved.

**General information**

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Authors: Ai, Z. (Intern), Melikov, A. K. (Intern)  
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Scopus rating (2013): CiteScore 3.63
An experimental evaluation on air purification performance of Clean-Air Heat Pump (CAHP) air cleaner

The escalation of energy consumption in buildings and heightened concerns about acceptable indoor air quality stimulate interest in the usage of air cleaner as an adjunct for indoor environmental conditioning. A regenerative desiccant wheel integrated into a ventilation system termed Clean-Air Heat Pump (CAHP) can improve the air quality during the process of dehumidification without using additional energy. An experimental study in a field lab was performed to investigate the air cleaning performance of CAHP. Photoacoustic gas analyzer-INNOVA was used to characterize chemical removal of indoor air pollutants by the CAHP. The results revealed that all the detected VOCs were removed effectively by the CAHP with an average single pass efficiency of 82.7% when the regeneration temperature for desiccant wheel was 60 °C. The mass balance between adsorption and desorption of the desiccant wheel was 96.8%, which indicated that the most of gaseous pollutants were not accumulated in the CAHP. The regeneration temperature for the wheel could affect the air purification performance of CAHP. At 70 °C of regeneration temperature, the air-cleaning efficiency reached 96.7%. Up to 70% of the outdoor air ventilation can be saved with the operation of CAHP. The clean air deliver rate (CADR) was over threefold of the outdoor air supply rate when CAHP was in operation.

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Web of Science (2017): Indexed yes
An experimental study of the effect of different starting room temperatures on occupant comfort in Danish summer weather

As office workers will usually have a slightly elevated metabolic rate when arriving at work, they may prefer a room temperature below the comfort range for sedentary activity in the morning. This possibility was studied in an experiment with 25 young people, male and female, exposed to four different conditions. Each condition consisted of two sessions,
the simulated commute (activity equivalent to walking to work) and the office session. Each office session had a different starting room temperature, namely 18.5 °C, 20 °C, 21.5 °C or 23 °C, followed by an increasing temperature "ramp" of 1.5K every 30 min. During the last 30 min the temperature remained constant. Physical measurements were continuously recorded and subjective evaluation questionnaires were completed every 30 min. It was observed that, upon arrival at the office-lab, a room temperature of 20 °C provided a thermal environment with neutral thermal sensation (0.23), low thermal dissatisfaction (8.6%) and a high level of thermal comfort for the whole body (3.3). It was concluded that, in the cooling season, to improve the thermal sensation of occupants, a lower temperature than is suggested by the existing standards should be maintained in the early office hours, and that this will lead to a lower maximum room temperature during the day, which would result in less demand for cooling during the summer period.

**General information**

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**Organisations:** Department of Civil Engineering, Section for Indoor Climate and Building Physics  
**Authors:** Bourdakis, E. (Intern), Simone, A. (Intern), Olesen, B. W. (Intern)  
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Web of Science (2015): Indexed yes  
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Scopus rating (2014): SJR 1.938 SNIP 2.797 CiteScore 4.14  
Web of Science (2014): Indexed yes  
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BFI (2011): BFI-level 1  
Scopus rating (2011): SJR 1.144 SNIP 2.255 CiteScore 2.76  
ISI indexed (2011): ISI indexed yes  
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Scopus rating (2010): SJR 1.235 SNIP 2.001  
Web of Science (2010): Indexed yes  
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Scopus rating (2009): SJR 1.028 SNIP 1.865  
Web of Science (2009): Indexed yes  
BFI (2008): BFI-level 1  
Scopus rating (2008): SJR 0.924 SNIP 1.38  
Web of Science (2008): Indexed yes  
Scopus rating (2007): SJR 0.788 SNIP 1.778
A Simulation Study on the Performance of Radiant Ceilings Combined with Free-Hanging Horizontal Sound Absorbers

Radiant heating and cooling systems, and Thermally Active Building Systems (TABS) in particular, have several advantages such as benefiting from the low temperature heating and high temperature cooling principle, coupling with renewable energy sources, peak shifting and peak load reductions.

When using TABS, most building simulation models assume an uncovered ceiling; however, this might not be the case in practice, due to the use of free-hanging horizontal (or vertical) sound absorbers for the control of room acoustic conditions. The use of sound absorbers will decrease the performance of radiant ceiling cooling systems. Therefore, the quantification of the effects during the design phase is important for predicting the resulting thermal indoor environment and for system dimensioning.

In this study, a two-person office room equipped with TABS was simulated using a commercially available simulation software with a recently developed plug-in that allows simulating the effects of horizontal sound absorbers on the performance of TABS and on the thermal indoor environment. The change in thermal indoor environment and in performance of TABS were quantified, and the simulation results were compared to measurement results. The measurement results show that with horizontal sound absorbers, the cooling performance of TABS decreases by 11%, 23% and 36% for ceiling coverage ratios of 43%, 60% and 80%, respectively. The developed simulation model was able to predict closely the cooling performance reduction of TABS, the ceiling surface temperature, and the thermal indoor environment in most cases. While the model can be improved in certain aspects (prediction of mean radiant temperature and cooling capacity coefficient), the accurate prediction of the surface temperature of the TABS makes the model useful for further studies, which may use differently constructed radiant surface heating and cooling systems.

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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Technical University of Denmark
Authors: Kazancı, O. B. (Intern), Domínguez, L. M. (Ekstern), Rage, N. (Ekstern), Olesen, B. W. (Intern)
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Can a Clean-Air Heat Pump (CAHP) maintain air purification capability when using polluted air for regeneration?
Clean Air Heat Pump (CAHP) was one type of rotary desiccant cooling system which combined a silica gel rotor with a heat pump to achieve air cleaning, dehumidifying and cooling in buildings. Using exhaust air from the conditioned room for regeneration of the silica gel rotor might have an advantage on reducing the regeneration air temperature and further improving the energy performance of the CAHP. However, the exhaust air carried a lot of indoor air pollutants. Whether
using exhaust air for the regeneration of the silica gel rotor had an impact on the air cleaning performance of the CAHP was experimentally studied. The results showed that using the air contained acetone or toluene for regeneration reduced the pollutants removal capability of CAHP with a reduction of approx. 10% in air cleaning efficiency. The energy performance of the CAHP when using exhaust air for regeneration was also evaluated compared with the CAHP with outdoor air for regeneration by means of numerical simulation. The simulated results showed that the energy saving of the CAHP was obvious when using exhaust air for regeneration, regardless of the degradation of indoor air quality. If the same indoor air quality level as that when using outdoor air for regeneration was expected to be maintained, increasing the intake of outdoor air was one possible way but would increase the energy consumption. The increased energy counteracted the reduced energy of using exhaust air for regeneration, and consequently the energy of CAHP was not saved.

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Scopus rating (2015): SJR 2.093 SNIP 2.49 CiteScore 4.37  
Web of Science (2015): Indexed yes  
BFI (2014): BFI-level 1  
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ISI indexed (2013): ISI indexed yes  
Web of Science (2013): Indexed yes  
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Web of Science (2012): Indexed yes  
BFI (2011): BFI-level 1  
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ISI indexed (2011): ISI indexed yes  
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BFI (2010): BFI-level 1  
Scopus rating (2010): SJR 1.235 SNIP 2.001  
Web of Science (2010): Indexed yes  
BFI (2009): BFI-level 1  
Scopus rating (2009): SJR 1.028 SNIP 1.865  
Web of Science (2009): Indexed yes  
BFI (2008): BFI-level 1  
Scopus rating (2008): SJR 0.924 SNIP 1.38  
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Clustering-based analysis for residential district heating data

The wide use of smart meters enables collection of a large amount of fine-granular time series, which can be used to improve the understanding of consumption behavior and used for consumption optimization. This paper presents a clustering-based knowledge discovery in databases method to analyze residential heating consumption data and evaluate information included in national building databases. The proposed method uses the K-means algorithm to segment consumption groups based on consumption intensity and representative patterns and ranks the groups according to daily consumption. This paper also examines the correlation between energy intensity and the characteristics of buildings and occupants, load profiles of households, consumption behavior changes over time, and consumption variability. The results show that the majority of the customers can be represented by fairly constant load profiles. Calendar context has an impact not only on the patterns but also on the consumption intensity and user behaviors. The variability studies show that consumption patterns are serially correlated, the customers with high energy consumption have lower variability, and the consumption is more stable over time. These findings will be valuable for district heating utilities and energy planners to optimize their operations, design demand-side management strategies, and develop targeting energy-efficiency programs or policies.

General information
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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Department of Management Engineering, Systems Analysis, Section for Building Energy
Authors: Gianniou, P. (Intern), Liu, X. (Intern), Heller, A. (Intern), Nielsen, P. S. (Intern), Rode, C. (Intern)
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Scopus rating (2015): SJR 2.09 SNIP 2.092 CiteScore 5.24
Comparison of indoor air distribution and thermal environment for different combinations of radiant heating systems with mechanical ventilation systems

A hybrid system with a radiant heating system and a mechanical ventilation system, which is regarded as an advanced heating, ventilation and air-conditioning (HVAC) system, has been applied in many modern buildings worldwide. To date, almost no studies focused on comparative analysis of the indoor air distribution and the thermal environment for all combinations of radiant heating systems with mechanical ventilation systems. Therefore, in this article, the indoor air distribution and the thermal environment were comparatively analyzed in a room with floor heating (FH) or ceiling heating (CH) and mixing ventilation (MV) or displacement ventilation (DV) when the supply air temperature ranged from 15.0°C to 19.0°C. The results showed that the temperature effectiveness values were 1.05–1.16 and 0.95–1.02 for MV + FH and MV + CH, respectively, and they were 0.78–0.91 and 0.51–0.67 for DV + FH and DV + CH, respectively. The Predicted Mean Vote values were from 0.24 to 0.45 and from 0.11 to 0.43 for MV + FH and MV + CH, respectively, and from 0.01 to 0.23 and from -0.41 to 0.10 for DV + FH and DV + CH, respectively. Hence, MV + FH had the largest temperature effectiveness and Predicted Mean Vote, and DV + CH had the smallest values. In addition, the vertical air temperature
differences for MV+ FH and MV+CH were all within the comfort zone according to ISO 7730, but exceeded the comfort zone for DV + FH and DV +CH when the supply air temperature was less than 17°C and 19°C, respectively. The air distribution effectiveness values for MV+ FH and MV+CH were close to the recommended value for MV in the ASHRAE Standard 62.1, and those for DV + FH and DV +CH were slightly less than the recommended value for displacement ventilation. The results in this article are relevant and useful in the process of selection and design of a hybrid system with a radiant heating system and a mechanical ventilation system in practice.

General information
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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Harbin Institute of Technology, Xi'an Jiaotong University
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Scopus rating (2014): SJR 0.596 SNIP 0.985 CiteScore 0.99
  Web of Science (2014): Indexed yes
  BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.696 SNIP 0.913 CiteScore 1.18
  BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1 SNIP 0.964 CiteScore 1.11
  BFI (2011): BFI-level 2
Scopus rating (2011): SJR 0.442 SNIP 0.934 CiteScore 0.82
  Web of Science (2011): Indexed yes
  BFI (2010): BFI-level 2
Scopus rating (2010): SJR 0.806 SNIP 0.691
  BFI (2009): BFI-level 2
Scopus rating (2009): SJR 0.633 SNIP 0.669
  BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.639 SNIP 0.624
  Scopus rating (2007): SJR 0.371 SNIP 0.709
Scopus rating (2006): SJR 0.186 SNIP 0.37
  Scopus rating (2005): SJR 0.393 SNIP 1.191
Scopus rating (2004): SJR 0.308 SNIP 0.811
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Scopus rating (2002): SJR 0.156 SNIP 0.649
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Development of a field measurement methodology for studying the thermal indoor environment in hybrid GEOTABS buildings

GEOTABS buildings combine an energy efficient heating and cooling system (Thermally Active Building Systems, TABS) with a renewable energy resource (ground, GEO) to heat and cool buildings in an energy efficient and sustainable way. Within the scope of a new EU project (HORIZON 2020-10 project EE-04-2016), hybrid GEOTABS buildings are studied in details in terms of optimal system design and dimensioning methodology, control, and in other terms. Model Predictive Control (MPC) algorithms will be developed by project partners and the developed algorithms will be implemented in demonstration buildings. The three demonstration buildings were an office building in Luxembourg, an elderly care home in Belgium, and an elementary school in Czech Republic. All of these buildings are equipped with hybrid GEOTABS systems; however, they vary in size and function, which requires a unique measurement methodology for studying them. These buildings already have advanced Building Management Systems (BMS); however, a more detailed measurement plan was needed for the purposes of the project to document the current performance of these systems regarding thermal indoor environment and energy performance, and to be able to document the improvements after the implementation of the MPC. This study provides the details of the developed field measurement methodology for each of these buildings to study the indoor environmental quality (IEQ) in details. The developed measurement methodology can be applied to other buildings of these types and to buildings with similar heating and cooling systems.

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Evaluation of computational and physical parameters influencing CFD simulations of pollutant dispersion in building arrays

Many CFD studies have investigated the influence of computational parameters on the predicted concentration distribution of pollutants around isolated buildings, but such studies for building arrays are still lacking. This study systematically evaluated the influence of four computational and two physical parameters on pollutant dispersion in building arrays, including turbulence models, grid resolution, discretization of time step size Δt, length of sampling period, aspect ratio of the arrays, and release rate of tracer gas. Throughout these evaluations, a set of published wind tunnel experimental data was used to validate the CFD models. For concentration simulations, the Large Eddy Simulation (LES) model gave the most accurate results but still had limitations in areas near the source, whereas the Detached Eddy Simulation (DES) and the Reynolds Averaged Navier-Stokes (RANS) k-ε models underperformed in some areas. The results of the LES and DES simulations varied with changes in Δt and sampling length until Δt was less than 0.24 and the sampling length was higher than 2400 Δt for LES and 1200 Δt for DES. A larger aspect ratio did not necessarily result in a higher concentration field than a smaller ratio. An increase in the tracer gas release rate did not change the general dispersion characteristics, but it still affected the concentration distribution in the areas near the source and resulted in a larger polluted area. The findings of this study are intended to contribute to improvements in the quality of CFD simulations of pollutant dispersion in building arrays.

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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Hong Kong Polytechnic University, Sun Yat-Sen University
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BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.028 SNIP 1.865
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.924 SNIP 1.38
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.788 SNIP 1.778
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.03 SNIP 1.63
Scopus rating (2005): SJR 0.955 SNIP 1.225
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 0.548 SNIP 1.266
Scopus rating (2003): SJR 0.948 SNIP 0.921
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.998 SNIP 1.39
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.777 SNIP 1.098
Scopus rating (2000): SJR 0.526 SNIP 1.14
Experimental study on an innovative enthalpy recovery technology based on indirect flash evaporative cooling

An indirect flash evaporative cooling enthalpy recovery technology used for building ventilation was proposed based on counter flow plate heat exchanger combing with ultrasonic atomizer. The technology is aimed at enhancing enthalpy recover efficiency and preventing contaminant transfer of heat recovery unit. The principle of the technology is to oversaturate indoor exhaust air by ultrasonic atomizing humidification. The evaporation of ultrafine mists cools down indoor exhaust air to its wet-bulb temperature and makes not only sensible heat transfer but also moisture condensed in outdoor supply air to realize total heat recovery. Compared with conventional indirect evaporative cooling, the application of ultrasonic atomizing enhances cooling effect through increasing water mists evaporation area and decreasing heat transfer resistance between exhaust air and supply air. No mass permeation, carrying-over or sorption occurs in this heat exchange process which guarantees no contaminant transfer from exhaust air to supply air. A prototype unit of the proposed technology was developed and tested in climate chambers. Temperatures and humidity ratios at inlets and outlets of the heat recovery unit were measured to investigate and analyze its energy recover efficiencies. The results showed that in hot and humid climate, up to 71% of total heat recover efficiency could be achieved by the prototype unit, and more than 50% of the enthalpy recovered was contributed by moisture condensation in the outdoor supply air.
Fifty years of Fanger's equation: Is there anything to discover yet?
This short communication to the Editor is completely devoted to a recent paper published by Broday et al. (2017) in which a comparative analysis of methods for determining the clothing surface temperature is reported. Contrarily to what our colleagues have found, we will demonstrate that the algorithms reported in ISO 7730 and ASHRAE 55 Standards from more than 30 years are reliable and consistent with other home-made codes based on different numerical techniques.

General information
State: Published
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Scopus rating (2015): SJR 0.631 SNIP 1.32 CiteScore 1.4
Flow characteristics in occupied zone – An experimental study with symmetrically located thermal plumes and low-momentum diffuse ceiling air distribution

Airflow interaction between thermal plumes and vertical air distribution may cause significant effects on airflow characteristics such as velocity and temperature fields, turbulence intensity and fluctuation frequency. The flow interaction creates a random flow motion, vortical structures and turbulent mixing that can further yield a draught discomfort in an occupied zone. The main objective was to investigate large-scale airflow patterns and fluctuations as a result of interaction of buoyancy flows and diffuse ceiling flow. Experiments were performed in a test room of 5.5 m (length) x 3.8 m (width) x 3.2 m (height) with symmetrical set-up of cylindrical heat sources that gave a thermal load of 40–80 W/floor-m². The ventilation air was supplied through a diffuse ceiling with 0.5% degree of perforation. The observations indicate that the mean air speed and the airflow fluctuation increase with thermal load. Furthermore, the results show that a range of length scales increases with thermal load and with mean air speed. The results indicate that it can be difficult to fulfill the standard air velocity criteria for highly occupied spaces, where the maximum allowable mean air velocity is relatively low, i.e. 0.15–0.20 m/s. This is because the buoyancy flows from heat sources accelerate locally the flow field.

General information

State: Published
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Full scale laboratory experiment on the cooling capacity of a radiant floor system

Direct solar radiation on a cooled radiant floor increases its cooling capacity. There is limited measured evidence of this phenomenon reported in the literature. We performed experiments for different chilled water supply temperature. The cooling capacity of the chilled radiant floor was measured to increase from 32 up to 110 W/m² under direct solar radiation. The surface temperature region exposed to solar radiation reached a peak temperature of 26°C while the unexposed areas were between 20 and 21°C. Increasing the chilled water supply temperature from 12 to 18°C caused a decrease in cooling capacity from ∼110 to ∼95 W/m². Higher air speeds along the floor created by ceiling fans increased the radiant slab cooling capacity by ∼12 % (from 32 to 36 W/m²) when the operative temperature was 24°C and, up to ∼19 % (∼40 W/m²) when it is increased to 26°C. The presence of thin carpet tiles reduced the radiant floor cooling capacity for ∼5 % compared to an exposed floor slab.
Implementation of Energy Strategies in Communities (Annex 63) Volume 3: Application of Strategic Measures

This report describes, for different scales (city, district and project level) and for 29 conceptualised case studies, how implementation champions can apply the strategic measures from Volume 2. Implementation champions are hereby understood as stakeholders in the city who take the initiative to lead and facilitate implementation processes.

General information
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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Section for Building Energy, Kuben Management, Beratungs- und Service-Gesellschaft Umwelt mbH, Deutscher Verband für Wohnungswesen, Städtebau und Raumordnung e.V, European Institute for Energy Research, Energie-Consulting AG, Fraunhofer Gesellschaft, Integrale Planung GmbH, Institute for Resource Efficiency and Energy Strategies - IREES GmbH, Sustainable Energy Authority of Ireland, SINTEF, Aalborg University, Natural Resources Canada, Norwegian University of Science and Technology, Osaka University, RWTH Aachen University, Salzburg Institute for Regional Planning and Housing, University of Minnesota, Hogeschool Zuyd
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Indoor Chemistry

This review aims to encapsulate the importance, ubiquity, and complexity of indoor chemistry. We discuss the many sources of indoor air pollutants and summarize their chemical reactions in the air and on surfaces. We also summarize some of the known impacts of human occupants, who act as sources and sinks of indoor chemicals, and whose activities (e.g., cooking, cleaning, smoking) can lead to extremely high pollutant concentrations. As we begin to use increasingly sensitive and selective instrumentation indoors, we are learning more about chemistry in this relatively understudied environment.
Interior insulation—Characterisation of the historic, solid masonry building segment and analysis of the heat saving potential by 1d, 2d, and 3d simulation

When considering interior insulation of historic, multi-storey buildings with solid masonry walls, it is important to focus on two important factors: How big is the building segment to which it can be applied, and what is the significance of how the multi-dimensional geometry of these facade walls is considered in the assessment of the heat saving potential. The findings show that a large proportion of Danish multi-storey dwellings with solid masonry walls, high energy consumption, and uniform characteristics were found to originate from the period 1851–1930. This segment accounts for 25% of all multi-storey apartments in Denmark. It was investigated which relative reduction of the average thermal transmittance could be obtained by interior insulation when simulated in different dimensions, degrees of insulation, and thickness. The analysis showed that partial insulation of the spandrels below windows on the 2nd/3rd highest storeys accounted for up to 40% of the average thermal transmittance reduction achievable by fully insulating inside walls, while covering 17% of the space needed in the full insulation strategy. Furthermore, the analysis showed an underestimation of average thermal transmittance by 2-dimensional compared to 3-dimensional simulation by up to 57%, indicating that 3-dimensional analysis is needed to obtain realistic results.
Multi-storey, Segment, Saving potential, Historical, Internal insulation, Simulation, Multi-dimensional

DOIs:
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Interior insulation – Experimental investigation of hygrothermal conditions and damage evaluation of solid masonry façades in a listed building

Exterior walls in historic multi-storey buildings compared to walls in modern buildings have low thermal resistance, resulting in high energy loss and cold surfaces/floors in cold climates. When restrictions regarding alteration of the exterior appearance exist, interior insulation might be the only possibility to increase occupant comfort. This paper describes an investigation of the hygrothermal influence when applying 100 mm of diffusion open interior insulation to a historic multi-storey solid masonry spandrel. The dormitory room with the insulated spandrel had a normal indoor climate with a maximum observed monthly average humidity by volume excess of 3.2 g/m³ during the experiment. Relative humidity and temperature were monitored manually using wooden dowels over 2 years and 8 months in two solid masonry spandrels: one insulated wall and one untreated wall. The investigation showed that installing insulation on a solid masonry spandrel induced hygrothermal changes: Uniformly distributed higher relative humidity and lower temperature throughout the masonry, compared to an un-insulated wall. The relative humidity of the un-insulated masonry wall was in the range 50% on the inside to 60% on the outside, while the insulated wall showed uniformly distributed values around 80%. The risk of moisture-induced damage was evaluated based on mathematical models for mould and decay of wood, visual inspection for frost and mould, and on-site measurements for presence of mould spores. The damage evaluation showed no risk of damage from the changed hygrothermal conditions when applying interior insulation to a solid masonry spandrel.

General information
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Laboratory Approaches to Studying Occupants

Laboratories offer the possibility to study occupant behavior in a very detailed manner. A wide range of indoor environmental scenarios can be simulated under precisely controlled conditions, and human subjects can be selected based on pre-defined criteria. The degree of control over experiments is high and a large number of physical, physiological, and psychological quantities can be monitored. This chapter gives an overview of various types of test facilities in the world and their main features in terms of experimental opportunities. It then presents typical technical equipment and sensor technologies used in laboratory environments. Finally, questions on appropriate laboratory design and experimental set-ups are discussed. One conclusion is that, in spite of many advantages, there are limits to investigating occupant behavior in a laboratory’s “artificial” environment, in part due to the fact that subjects always feel observed to some extent. However, valuable results can be achieved if the specific opportunities of laboratories are utilized both by appropriate design and precise experiments during operation.

General information
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Modelling of pedestrian level wind environment on a high-quality mesh: A case study for the HKPolyU campus

Quality and efficiency of computational fluid dynamics (CFD) simulation of pedestrian level wind environment in a complex urban area are often compromised by many influencing factors, particularly mesh quality. This paper first proposes a systematic and efficient mesh generation method and then performs detailed sensitivity analysis of some important computational parameters. The geometrically complex Hong Kong Polytechnic University (HKPolyU) campus is taken as a case study. Based on the high-quality mesh system, the influences of three important computational parameters, namely, turbulence model, near-wall mesh density and computational domain size, on the CFD predicted results of pedestrian level wind environment are quantitatively evaluated. Validation of CFD models is conducted against wind tunnel experimental data, where a good agreement is achieved. It is found that the proposed mesh generation method can effectively provide a high-quality and high-resolution structural grid for CFD simulation of wind environment in a complex urban area.

General information
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Scopus rating (2012): SJR 1.829 SNIP 2.012 CiteScore 3.69
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Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.68 SNIP 2.096 CiteScore 3.52
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
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Scopus rating (2010): SJR 1.684 SNIP 2.221
Web of Science (2010): Indexed yes
Occupancy and Occupants' Actions

Occupants' presence and actions within the built environment are crucial aspects related to understanding variations in energy use. Within this chapter, first, a nomenclature for the field of research dealing with occupants in buildings is defined. This nomenclature distinguishes between occupants' presence and behavior, states and actions, adaptive triggers, non-adaptive triggers, and contextual factors. Second, an extensive list of occupant behaviors is provided and categorizations of occupants' actions are introduced. The list includes most of the possible phenomena that researchers may wish to study, measure, and ultimately model. The categories are physiological, individual, environmental, and spatial adjustments. Third, a list of adaptive and non-adaptive triggers together with contextual factors that could influence occupant behavior is presented. Individual elements are further grouped into physical environmental, physiological, psychological, and social aspects. Finally, a comprehensive table of studies related to occupant behavior and the corresponding significant and non-significant predictors, based on an extensive literature review, is shown. This table highlights areas of research where numerous studies have been conducted, as well as areas where hardly any research has been published. The conclusion highlights the importance of publishing future occupant monitoring campaigns with sufficient detail to inform future researchers and save redundant effort. Such detail is especially necessary in relation to the methodology, including, for example, a clear description of the type of variables monitored, and in relation to the results, where both the influencing factors that were found to be significant and insignificant should be documented.

General information
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Source: FindIt
Profiling Occupant Behaviour in Danish Dwellings using Time Use Survey Data - Part I: Data Description and Activity Profiling

Occupant behaviour has been shown to be one of the key driving factors of uncertainty in prediction of energy consumption in buildings. Building occupants affect building energy use directly and indirectly by interacting with building energy systems such as adjusting temperature set-points, switching lights on/off, using electrical devices and opening/closing windows. Furthermore, building inhabitants' daily activity profiles clearly shape the timing of energy demand in households. Modelling energy-related human activities throughout the day, therefore, is crucial to defining more realistic occupant profiles for prediction of energy use to reduce the gap between predicted and real building energy consumptions.

To generate accurate occupant profiles for the residential sector in Denmark, the Danish time use surveys are considered an essential data source. The latest Danish diary-based time use survey was conducted in 2008/09 among 17,707 individuals from 4,679 households. Individuals’ daily activities were logged in 10-minute time increments throughout 24 h, starting and ending at 4am, during both weekdays and weekends. The dataset was clustered in 10 activities that were considered suitable for modelling occupancy profiles and behavioural patterns related to energy use. The latter were analysed for different categories such as variation during different days of the week and seasons of the year.

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Profiling Occupant Behaviour in Danish Dwellings using Time Use Survey Data - Part II: Time-related Factors and Occupancy

Occupant behaviour has been shown to be one of the key driving factors of uncertainty in prediction of energy consumption in buildings. Building occupants affect building energy use directly and indirectly by interacting with building energy systems such as adjusting temperature set-points, switching lights on/off, using electrical devices and opening/closing windows. Furthermore, building inhabitants’ daily activity profiles clearly shape the timing of energy demand in households. Modelling energy-related human activities throughout the day, therefore, is crucial to defining more realistic occupant profiles for prediction of energy use to reduce the gap between predicted and real building energy consumptions.

In this study, we exploit diary-based Danish Time Use Surveys for understanding and modelling occupant behaviour in the residential sector in Denmark. This paper is a continuation of “Profiling occupant behaviour in Danish Dwellings using Time Use Survey Data: Part I” that focuses on time-related and time-specific aspects of occupants’ activity profiles. Each activity was analysed in terms of daily time duration and starting/ending times. In detail, a Kaplan-Meier Survival analysis is performed in order to create an estimator of the survival function of the various activities. Finally, this study provides representative occupancy profiles in Danish households during weekdays and weekends.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Politecnico di Torino, Pennsylvania State University
Authors: Barthelmes, V. (Ekstern), Li, R. (Intern), Andersen, R. (Intern), Bahnfleth, W. (Ekstern), Corgnati, S. (Ekstern), Rode, C. (Intern)
Pages: 103-108
Publication date: 2018
Quantifying demand flexibility of power-to-heat and thermal energy storage in the control of building heating systems

In the future due to continued integration of renewable energy sources, demand-side flexibility would be required for managing power grids. Building energy systems will serve as one possible source of energy flexibility. The degree of flexibility provided by building energy systems is highly restricted by power-to-heat conversion such as heat pumps and thermal energy storage possibilities of a building. To quantify building demand flexibility, it is essential to capture the dynamic response of the building energy system with thermal energy storage. To identify the maximum flexibility a building’s energy system can provide, optimal control is required. In this paper, optimal control serves to determine in detail demand flexibility of an office building equipped with heat pump, electric heater, and thermal energy storage tanks. The demand flexibility is quantified using different performance indicators that sufficiently characterize flexibility in terms of size (energy), time (power) and costs. To fully describe power flexibility, the paper introduces the instantaneous power flexibility as power flexibility indicator. The instantaneous power flexibility shows the potential power flexibility of TES and power-to-heat in any case of charging, discharging or idle mode. A simulation case study is performed showing that a water tank, a phase change material tank, and a thermochemical material tank integrated with building heating system can be designed to provide flexibility with optimal control.
Sensory evaluation and chemical analysis of exhaled and dermally emitted bioeffluents

Conditions in which exhaled and dermally emitted bioeffluents could be sampled separately or together (whole-body emission) were created. Five lightly dressed males exhaled the air through a mask to another, identical chamber or without a mask to the chamber in which they were sitting; the outdoor air supply rate was the same in both chambers. The carbon dioxide concentration in the chamber with exhaled air was 2000 ppm. Chamber temperatures were 23°C or 28°C, and ozone was present or absent in the supply airflow. When dermally emitted bioeffluents were present, the perceived air quality (PAQ) was less acceptable, and the odor intensity was higher than when only exhaled bioeffluents were present. The presence or absence of exhaled bioeffluents in the unoccupied chamber made no significant difference to sensory assessments. At 28°C and with ozone present, the odor intensity increased and the PAQ was less acceptable in the chambers with whole-body bioeffluents. The concentrations of nonanal, decanal, geranylacetone, and 6-MHO were higher when dermally emitted bioeffluents were present; they increased further when ozone was present. The concentration of squalene then decreased and increased again at 28°C. Dermally emitted bioeffluents seem to play a major role in the sensory nuisance experienced when occupied volumes are inadequately ventilated.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Waseda University
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Publication information
Simulation Study of Active Ceilings with Phase Change Material in Office Buildings for Different National Building Regulations

The aim of this study was to examine the performance of phase change material (PCM) in active ceilings for an office room under different Danish building regulations for both heating and cooling purposes. A model of a two-person office room was simulated with the only heating and cooling source being radiant ceiling panels containing PCM. The target was to reduce energy use for the simulation models and still meet the recommended criteria of Category II for the European Standard EN 15251:2007 namely, 23°C – 26°C (73.4°F – 78.8°F) during summer and between 20°C – 24°C (68.0°F – 73.4°F) during winter. The office model was simulated for a whole year and analyzed for three Danish building regulations BR10 (2010), BR15 (2015) and BR20 (2020). The results show that the indoor environment was within the desired Category II, according to EN 15251 for the whole occupancy period. The predicted percentage of dissatisfied (PPD) was below the desired 10% for Class II of EN15251 during 95% of the occupied hours in a year for BR10, 94% for BR15 and 100% for BR20. The use of PCM model decreased energy use by 45% for BR10, 35% for BR15, while it increased by 17% for BR20. The results indicate that active ceilings with integrated PCM could help maintain a satisfactory thermal indoor environment while reducing the energy use. This demonstrated a great potential for PCM to be used to achieve strict energy frame requirements for future low energy buildings.
Simulation Study of Performance of Active Ceilings with Phase Change Material in Office Buildings under Extreme Climate Conditions

This study examined the performance of Phase Change Material (PCM) in active ceiling panels under extreme climate conditions. The purpose was to reduce the annual energy use and still maintain an indoor climate corresponding to Category II in the European Standard, EN15251. Dynamic yearly simulations were run with a building simulation software for eight climates. The chosen climates were Dubai – UAE, Istanbul – Turkey, Lima – Peru, Moscow – Russia, Nuuk – Greenland, Salvador – Brazil, Tokyo – Japan and Tromsø – Norway. Two models of a two-person office were made for each climate; one model with active ceiling with PCM and an all-air ventilation model without PCM to compare the models and investigate the effects of using PCM in active ceilings. The results results show that the PCM models lowered the peak room temperature during the cooling season. None of the PCM models had temperatures outside the desired ranges, and in general provided a more comfortable thermal indoor climate than the all-air system. The PPD level was lower for the PCM models in all of the tested climates, except for the hot climates Dubai and Salvador. The largest differences in energy use were found in the cold climates, namely Moscow, Nuuk and Tromsø. The PCM model of Nuuk used 42% less energy annually than the all-air system, while the PCM models of Tromsø and Moscow had 39% and 30% lower annual energy use, respectively. The PCM models of Istanbul and Dubai showed an energy use 24% and 13% lower compared to the all-air models. The subtropical climates Tokyo and Salvador had an 7% and 2% lower energy use, respectively. Lima was the only climate where the PCM model had a negative effect on the energy use with -20%. The implementation of PCM showed to have the largest benefit in terms of energy use under cold climate conditions; however, all climates, except for Lima, showed that active ceilings with PCM could be implemented with positive effects by lowering the peak room temperatures and the energy use in buildings.
scope, and inclusion of local communities. As a synopsis, the main technical, physical, organizational and socioeconomic challenges for local energy policy implementation were illustrated. Internal organization, lacking municipal capacities, combined with the complexity of communities leads to procedural deficits in strategy production. The resulting neglect of socioeconomics and other community peculiarities by technology-driven strategies impede strategy implementation. As a consequence, a community-oriented taxonomy of implementation challenges is introduced. This approach might help to improve the scope of SEPs, ensure a local anchoring of energy strategies, and raise awareness for challenges already present during strategy production to facilitate strategy implementation.

The effects of cement-based and cement-ash-based mortar slabs on indoor air quality
The effects of emissions from cement-based and cement-ash-based mortar slabs were studied. In the latter, 30% of the cement content had been replaced by sewage sludge ash. They were tested singly and together with either carpet or linoleum. The air exhausted from the chambers was assessed by means of odour intensity and chemical characterization of emissions. Odour intensity increased with the increased exposed area of the slabs. It did not differ significantly between cement-based or cement-ash-based mortar and neither did the chemical composition of the exhaust air. A significant sink effect was observed when linoleum was added to any of the two slabs examined. The sink effect increased as the exposed area of the slabs was increased. The odour intensity of the mixture of the slab and linoleum was lower than the intensity of odour produced by any of the two materials when tested singly. A plausible explanation for this effect was that the mortar slabs adsorbed the organic acids that were emitted at a high rate from linoleum, mortar being strong base. The same sink effect was also observed when the mortar slabs were exposed together with carpet but it was much smaller because the carpet emitted smaller quantities of acids. The total concentration of organic compounds measured was not appreciably different when the slabs were tested alone or together with linoleum or carpet. Considerable differences in the concentration of organic compounds were however observed when the total concentration of each functional group was calculated and compared.
The Influence of a Radiant Panel System with Integrated Phase Change Material on Energy Use and Thermal Indoor Environment

This study examined the effect on energy use and thermal comfort when combining microencapsulated phase change material (PCM) with radiant ceiling panels in a two-person office. The performance of the system was studied during the cooling season in the climates of Copenhagen, Denmark, and Rome, Italy, using a basic cooling strategy and a night cooling strategy. Negligible effect was observed in both Copenhagen and Rome with PCM integration using the basic cooling strategy with a constant cooling set point of 26°C (78.8°F). This caused nearly constant temperatures in the office, preventing full utilization of the PCM potential as charge and discharge of the PCM was averted. Application of night cooling strategy created more optimum temperature conditions for PCM activation with cooling of the office during night down to 23°C (73.4°F), enabling discharge of the PCM. This decreased the peak cooling power by 15% and increased the occupied hours in Category I of the European standard EN 16798-1 (EN 2016) by 8% in Copenhagen. Clearer effects were observed in Rome, decreasing the peak cooling power by 17% and increasing the occupied hours in Category I by 18%. These enhancements were achieved due to reduced operative temperature fluctuations caused by the construction thermal mass increase when integrating PCM. The study was based on both measured and theoretical properties of the ceiling panels, and greater enhancements of thermal indoor conditions were obtained using the theoretical panel specifications.

General information
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Thermal environment, IAQ and sleep
Is sleep becoming so much scarcer than ever before because people do not realize the importance of sleep for health and well-being? All over the world, digital communications now mean that contact with work continues after hours and during weekends and that "friends" are no longer just the people we meet regularly, but the many more we contact regularly. These new contacts compete strongly for our time with online entertainment and news, our leisure activities and our immediate families, and there are still only 24 hours in each day.

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State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Shanghai Jiao Tong University
Authors: Wargocki, P. (Intern), Lan, L. (Ekstern), Lian, Z. (Ekstern), Wyon, D. P. (Intern)
Pages: 60-63
Publication date: 2018
Main Research Area: Technical/natural sciences

Publication information
Journal: A S H R A E Journal
Utilizing thermal building mass for storage in district heating systems: Combined building level simulations and system level optimization

Higher shares of intermittent renewable energy in energy systems have raised the issue of the need for different energy storage solutions. The utilization of existing thermal building mass for storage is a cost-efficient solution. In order to investigate its potential, a detailed building simulation model was coupled with a linear optimization model of the energy system. Different building archetypes were modelled in detail, and their potential preheating and subsequent heat supply cut-off periods were assessed. Energy system optimization focused on the impact of thermal mass for storage on the energy supply of district heating. Results showed that longer preheating time increased the possible duration of cut-off events. System optimization showed that the thermal mass for storage was used as intra-day storage. Flexible load accounted for 5.5%–7.7% of the total district heating demand. Furthermore, thermal mass for storage enabled more solar thermal heating energy to be effectively utilized in the system. One of the sensitivity analyses showed that the large-scale pit thermal energy storage and thermal mass for storage are complimentary. The cut-off duration potential, which did not compromise thermal comfort, was longer in the newer, better insulated buildings, reaching 6h among different building archetypes.

General information

State: Published
Organisations: Department of Energy Conversion and Storage, Department of Civil Engineering, Section for Indoor Climate and Building Physics, Department of Management Engineering, Systems Analysis, Centre for IT-Intelligent Energy Systems in Cities
Authors: Dominkovic, D. F. (Intern), Gianniou, P. (Intern), Münster, M. (Intern), Heller, A. (Intern), Rode, C. (Intern)
Pages: 949-966
Publication date: 2018
Main Research Area: Technical/natural sciences

Publication information

Journal: Energy
Volume: 153
ISSN (Print): 0360-5442
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.17 SJR 1.999 SNIP 1.798
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.276 SNIP 2.046 CiteScore 5.03
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.647 SNIP 2.63 CiteScore 5.7
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.54 SNIP 2.593 CiteScore 5.02
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.998 SNIP 2.25 CiteScore 4.25
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.609 SNIP 2.043 CiteScore 4
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.814 SNIP 2.725
Wind-induced single-sided natural ventilation in buildings near a long street canyon: CFD evaluation of street configuration and envelope design

Wind-induced single-sided natural ventilation in buildings was widely investigated based on isolated buildings. However, owing to the presence of surrounding buildings, the wind flow pattern around a building in an urban area becomes very different from that around an isolated building. Considering an urban context, this study investigates the wind-induced single-sided natural ventilation in buildings near a long street canyon under a perpendicular wind direction using CFD method. Four aspect ratios (AR) of the street canyon, from 1.0, 2.0, 4.0 to 6.0, are investigated to examine the influence of street configuration, while eight envelope features are compared to explore the possibility of envelope design in improving natural ventilation performance of urban buildings. Ventilation rate of rooms in buildings is particularly analyzed. AR influences ventilation rate and its distribution among rooms along height of buildings. The percentage decrease of ventilation rate of buildings reaches 67% when AR of a street canyon is increased from 1.0 to 6.0. Envelope design provides a possibility to enhance the adaptability of buildings to dense urban environments. A good envelope design, such as a horizontal feature at the middle of an opening, can break effectively the along-facade flow and thus create a large pressure difference to drive ventilation. The findings of this study are intended to increase the understanding of natural ventilation performance in urban buildings and thus provide information for urban planning and building design.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Hong Kong Polytechnic University
Authors: Ai, Z. (Intern), Mak, C. (Ekstern)
Number of pages: 11
Pages: 96-106
Publication date: 2018
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Wind Engineering and Industrial Aerodynamics
Volume: 172
ISSN (Print): 0167-6105
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
Window and door opening behavior, carbon dioxide concentration, temperature, and energy use during the heating season in classrooms with different ventilation retrofits—ASHRAE RP1624
The aim of the present study was to extend the knowledge on the suitability and performance of different ventilation retrofit solutions for school buildings located in a temperate climate. A unique approach was used, where four similar and adjacent classrooms in the same school unit located north of Copenhagen, Denmark, were retrofitted either with a decentralized, balanced supply and exhaust mechanical ventilation unit with heat recovery; automatically operable windows with an exhaust fan; automatically operable windows with alternating counter-flow heat recovery through slots in the outside wall; or a visual feedback display unit showing the current classroom carbon dioxide concentration, thus advising when the windows should be opened. For comparison, one classroom retained the original approach for achieving ventilation by manual opening of windows. One year after retrofitting the classrooms carbon dioxide concentrations, temperatures, energy use, and window and door opening behavior were recorded during a four week period in the heating season in January. The measured carbon dioxide concentrations were significantly lower in the classrooms with the mechanical ventilation system and the system with automatic window opening and an exhaust fan as compared with the classrooms with automatic window opening and heat recovery, with visual carbon dioxide feedback and where windows were opened manually. The automatically controlled windows were open for 71% of the occupied time including breaks with an exhaust fan and for 49% with heat recovery. The façade windows were open up to 17% of the occupied time including breaks in the classrooms with manual window opening (with or without visual feedback). The classroom temperature was generally within the recommended thermal comfort range. The present results indicate that in temperate climates the mechanical ventilation system and both systems with automatic window opening are the recommended systems for classrooms in temperate climates. Providing simply visual feedback on the current carbon dioxide concentration, as a motivation for window opening, did not do so.

General information
State: Accepted/In press
Organisations: Section for Indoor Climate and Building Physics, Department of Civil Engineering, Danish Technological Institute
Authors: Heebøll, A. (Ekstern), Wargocki, P. (Intern), Toftum, J. (Intern)
Pages: 1-12
Publication date: 2018
Main Research Area: Technical/natural sciences

Publication information
Journal: Science and Technology for the Built Environment
ISSN (Print): 2374-4731
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.01
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.514 SNIP 0.731
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.561 SNIP 0.891
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.544 SNIP 1.104
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.498 SNIP 0.742
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.93 SNIP 0.956
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
This paper pays tribute to Povl Ole Fanger, the late professor at the Technical University of Denmark. His scientific studies, focused on the main parameters affecting indoor environmental quality, have inspired (and still inspire) professional design engineers and academic researchers on human thermal comfort and indoor air quality over the last five decades. In addition, he strongly contributed to the creation of a "European School" that addressed engineering issues and was well integrated with the American School, which was characterised (at that time) by a physiological approach. Ten years after his death, this paper is a memorial of his research in the field of thermal comfort and some aspects of indoor air quality. Only the original papers of this Danish scientist will be discussed. The analysis of each single topic of his research and of its impact on past and present research would require more space than would be available in a review article. The authors are confident that the research described in this paper will serve as a beacon for researchers working on thermal comfort now and in the future.

**General information**

State: Published  
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Universita di Salerno, University of Naples Federico II  
Authors: d'Ambrosio Alfano, F. R. (Ekstern), Olesen, B. W. (Intern), Palella, B. I. (Ekstern)  
Pages: 243-249  
Publication date: 1 Oct 2017  
Main Research Area: Technical/natural sciences

**Publication information**

Journal: Energy and Buildings  
Volume: 152  
ISSN (Print): 0378-7788  
Ratings:  
BFI (2018): BFI-level 2  
Web of Science (2018): Indexed yes  
BFI (2017): BFI-level 2  
Web of Science (2017): Indexed yes  
BFI (2016): BFI-level 2  
Scopus rating (2016): CiteScore 4.64 SJR 2.093 SNIP 1.965  
Web of Science (2016): Indexed yes
A comparison between tracer gas and aerosol particles distribution indoors: The impact of ventilation rate, interaction of airflows, and presence of objects

The study investigated the separate and combined effects of ventilation rate, free convection flow produced by a thermal manikin, and the presence of objects on the distribution of tracer gas and particles in indoor air. The concentration of aerosol particles and tracer gas was measured in a test room with mixing ventilation. Three layouts were arranged: an empty room, an office room with an occupant sitting in front of a table, and a single-bed hospital room. The room occupant...
was simulated by a thermal manikin. Monodisperse particles of three sizes (0.07, 0.7, and 3.5 μm) and nitrous oxide tracer gas were generated simultaneously at the same location in the room. The particles and gas concentrations were measured in the bulk room air, in the breathing zone of the manikin, and in the exhaust air. Within the breathing zone of the sitting occupant, the tracer gas emerged as reliable predictor for the exposure to all different-sized test particles. A change in the ventilation rate did not affect the difference in concentration distribution between tracer gas and larger particle sizes. Increasing the room surface area did not influence the similarity in the dispersion of the aerosol particles and the tracer gas.

**General information**

State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Institute of Chemical Process Fundamentals of the CAS
Authors: Bivolarova, M. P. (Intern), Ondráček, J. (Ekstern), Melikov, A. K. (Intern), Ždímal, V. (Ekstern)
Number of pages: 12
Pages: 1201-1212
Publication date: 2017
Main Research Area: Technical/natural sciences

**Publication information**

Journal: Indoor Air
Volume: 27
Issue number: 6
ISSN (Print): 0905-6947
Ratings:

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Advanced airflow distribution methods for reducing exposure of indoor pollution

The adverse effect of various indoor pollutants on occupants’ health have been recognized. In public spaces flu viruses may spread from person to person by airflow generated by various traditional ventilation methods, like natural ventilation and mixing ventilation (MV). Personalized ventilation (PV) supplies clean air close to the occupant and directly into the breathing zone. Studies show that it improves the inhaled air quality and reduces the risk of airborne cross-infection in comparison with total volume (TV) ventilation. However, it is still challenging for PV and other advanced air distribution methods to reduce the exposure to gaseous and particulate pollutants under disturbed conditions and to ensure thermal comfort at the same time. The objective of this study is to analyse the performance of different advanced airflow distribution methods for protection of occupants from exposure to indoor pollutants.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Aalborg University
Authors: Cao, G. (Ekstern), Nielsen, P. V. (Ekstern), Melikov, A. K. (Intern), Kosonen, R. (Ekstern)
Number of pages: 6
Publication date: 2017
Event: Paper presented at 38th AIVC Conference, Nottingham, United Kingdom.
Main Research Area: Technical/natural sciences
Publication: Research - peer-review › Paper – Annual report year: 2018

Are building users prepared for energy flexible buildings—A large-scale survey in the Netherlands

Building energy flexibility might play a crucial role in demand side management for integrating intermittent renewables into smart grids. The potential of building energy flexibility depends not only on the physical characteristics of a building but also on occupant behaviour in the building. Building users will have to adopt smart technologies and to change their daily energy use behaviours or routines, if energy flexibility is to be achieved. The willingness of users to make changes will determine how much demand flexibility can be achieved in buildings and whether energy flexible buildings can be realized. This will have a considerable impact on the transition to smart grids. This study is thus to assess the perception of smart grids and energy flexible buildings by building users, and their readiness for them on a large scale. We attempted to identify the key characteristics of the ideal user of flexible buildings. A questionnaire was designed and administered as an online survey in the Netherlands. The questionnaire consisted of questions about the sociodemographic characteristics of the current users, house type, household composition, current energy use behaviour, willingness to use smart technologies, and willingness to change energy use behaviour. The survey was completed by 835 respondents, of which 785 (94%) were considered to have provided a genuine response. Our analysis showed that the concept of smart grids is an unfamiliar one, as more than 60% of the respondents had never heard of smart grids. However, unfamiliarity with smart grids increased with age, and half of the respondents aged 20–29 years old were aware of the concept. Monetary incentives were identified as the biggest motivating factor for adoption of smart grid technologies. It was also found that people would be most in favour of acquiring smart dishwashers (65% of the respondents) and refrigerator/freezers (60%). Statistical analysis shows that people who are willing to use smart technologies are also willing to change their behaviour, and can thus be categorised as potentially flexible building users. Given certain assumptions, 11% of the respondents were found to be potentially flexible building users. To encourage people to be prepared for energy flexible buildings, awareness of smart grids will have to be increased, and the adoption of smart technologies may have to be promoted by providing incentives such as financial rewards.

General information
State: Published
A Science Cloud for Smart Cities Research
Cities are densely populated and heavily equipped areas with a high level of service provision. Smart cities can use these conditions to achieve the goals of a smart society for their citizens. To facilitate such developments, the necessary IT-infrastructure has to be in place for supporting, amongst many other things, the whole lifecycle of big data management and analytics for research activities. At the Centre for IT-Intelligent Smart Energy for Cities, we have therefore been developing a flexible infrastructure, based on open sourcetechnologies. This paper presents this solution and its application in a city and building research.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Energy, Department of Management Engineering, Systems Analysis, Section for Indoor Climate and Building Physics, Centre for IT-Intelligent Energy Systems in Cities
Authors: Heller, A. (Intern), Liu, X. (Intern), Gianniou, P. (Intern)
Pages: 679-684
Publication date: 2017
Conference: CISBAT 2017, Lausanne, Switzerland, 06/09/2017 - 06/09/2017
Main Research Area: Technical/natural sciences

Publication information
Journal: Energy Procedia
Volume: 122
ISSN (Print): 1876-6102
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.16 SJR 0.467 SNIP 0.586
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.365 SNIP 0.561 CiteScore 0.92
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.433 SNIP 0.81 CiteScore 1.09
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.425 SNIP 0.785 CiteScore 1.02
ISI indexed (2013): ISI indexed no
Web of Science (2013): Indexed yes
Scopus rating (2012): SJR 0.425 SNIP 0.563 CiteScore 1.08
ISI indexed (2012): ISI indexed no
Web of Science (2012): Indexed yes
Scopus rating (2011): SJR 0.918 SNIP 1.505 CiteScore 2.42
ISI indexed (2011): ISI indexed no
Scopus rating (2010): SJR 0.433 SNIP 0.957
Assessing dermal exposure to nicotine - an interdisciplinary approach.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Fraunhofer Wilhelm-Klauditz-Institut (WKI), Institute for Prevention and Occupational Medicine of the German Social Accident Insurance, Missouri University of Science and Technology
Authors: Salthammer, T. (Ekstern), Bekö, G. (Intern), Clausen, G. (Intern), Koch, H. (Ekstern), Morrison, G. (Ekstern), Schripp, T. (Ekstern), Toftum, J. (Intern), Weschler, C. J. (Intern)
Publication date: 2017

Host publication information
Title of host publication: ISES 2017 Abstract Book
Article number: TH-PL-D2-649
Main Research Area: Technical/natural sciences
Conference: 27th Annual meeting of the International Society of Exposure Science, Research Triangle Park, United States, 15/10/2017 - 15/10/2017
A-indoor environment, B-VOCs, C-air, A-biomonitoring, A-exposure models
Electronic versions:
Untitled.pdf
Source: PublicationPreSubmission
Source-ID: 139560101
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2017

Challenges of Implementing Renewable Energy Policies at Community Scale: The Case of Strategic Energy Plans in Denmark
The implementation of national energy efficiency targets requires policies at the local scale. It is widely acknowledged that local communities play an important role to implement these policies: as arena where renewable energy technologies can be combined with socio-economic interests of local stakeholders. Although a vast amount of demo projects are well-documented, insufficient attention has been given to the average performing municipalities and their challenges in linking technical energy scenarios with their socio-economic realities in practice. This paper analyses the Strategic Energy Plans (SEP) of 17 Danish municipalities on their development, inclusion of local communities, affected stakeholders, and on their impact on the municipalities' working procedures.

The main technical, physical, organisational and socio-economic challenges for local energy policy implementation are illustrated by means of the SEPs. Findings indicate lacking capacity in municipalities; in both resources and technical knowledge. This explains partly the technology-focused strategies developed by private sector technocrats, leading to a negligence of socio-technical realities of the local communities, which in combination with lacking capacity makes it difficult for municipalities to implement these energy strategies. Conclusively, an implementation-oriented taxonomy of implementation challenges for communities to optimize the development and scope of SEPs is proposed. This approach might help improving local anchoring of energy strategies in communities, and raise awareness for external challenges to facilitate the strategy production and implementation process.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics
Authors: Petersen, J. (Intern)
Publication date: 2017

Host publication information
Title of host publication: Proceedings of the 13th International Conference on Researches in Science and Technology
Main Research Area: Technical/natural sciences
Conference: 13th International Conference on Researches in Science and Technology, Lisbon, Portugal, 25/05/2017 - 25/05/2017
Renewable Energies, Renewable Energy Policy, Municipal Energy Strategies, Implementation Challenges, Local Communities
Source: PublicationPreSubmission
Characterizing Aggregated Exposure to Primary Particulate Matter: Recommended Intake Fractions for Indoor and Outdoor Sources

Exposure to fine particulate matter (PM_{2.5}) from indoor and outdoor sources is a leading environmental contributor to global disease burden. In response, we established under the auspices of the UNEP/SETAC Life Cycle Initiative a coupled indoor-outdoor emission-to-exposure framework to provide a set of consistent primary PM_{2.5} aggregated exposure factors. We followed a matrix-based mass balance approach for quantifying exposure from indoor and ground-level urban and rural outdoor sources using an effective indoor-outdoor population intake fraction and a system of archetypes to represent different levels of spatial detail. Emission-to-exposure archetypes range from global indoor and outdoor averages, via archetypal urban and indoor settings, to 3646 real-world cities in 16 parameterized sub-continental regions. Population intake fractions from urban and rural outdoor sources are lowest in Northern regions and Oceania and highest in Southeast Asia with population-weighted means across 3646 cities and 16 sub-continental regions of, respectively, 39 ppm (95% confidence interval: 4.3–160 ppm) and 2 ppm (95% confidence interval: 0.2–6.3 ppm). Intake fractions from residential and occupational indoor sources range from 470 ppm to 62,000 ppm, mainly as function of air exchange rate and occupancy. Indoor exposure typically contributes 80–90% to overall exposure from outdoor sources. Our framework facilitates improvements in air pollution reduction strategies and life cycle impact assessments.

Computational fluid dynamics simulation of wind-driven inter-unit dispersion around multi-storey buildings: Upstream building effect

Previous studies on inter-unit dispersion around multi-storey buildings focused mostly on an isolated building. Considering that the presence of an upstream building(s) would significantly modify the airflow pattern around a downstream building, this study intends to investigate the influence of such changed airflow patterns on inter-unit dispersion characteristics around a multi-storey building due to wind effect. Computational fluid dynamics (CFD) method in the framework of Reynolds-averaged Navier-stokes modelling was employed to predict the coupled outdoor and indoor airflow field, and the tracer gas technique was used to simulate the dispersion of infectious agents between units. Based on the predicted
concentration field, a mass conservation based parameter, namely re-entry ratio, was used to evaluate quantitatively the inter-unit dispersion possibilities and thus assess risks along different routes. The presence of upstream building(s) could disrupt the strong impingement of approaching flows but brings a more complex and irregular airflow pattern around the downstream multi-storey buildings, leading to a more scattered distribution of re-entry ratio values among different units and uncertain dispersion routes. Generally, the tracer gas concentration in most units was lower than those in an isolated building, although very high concentrations were found in some specific areas.

**General information**
State: Accepted/In press
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Hong Kong Polytechnic University
Authors: Ai, Z. (Intern), Mak, C. (Ekstern), Dai, Y. (Ekstern)
Number of pages: 18
Publication date: 2017
Main Research Area: Technical/natural sciences

**Publication information**
Journal: Indoor and Built Environment
ISSN (Print): 1420-326X
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.97 SJR 0.55 SNIP 0.713
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.47 SNIP 0.612 CiteScore 0.82
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.595 SNIP 0.895 CiteScore 1.23
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 0.683 SNIP 1.102 CiteScore 1.71
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 0.541 SNIP 1.109 CiteScore 1.63
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 0.383 SNIP 0.85 CiteScore 1.59
ISI indexed (2011): ISI indexed yes
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BFI (2010): BFI-level 1
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Scopus rating (2009): SJR 0.463 SNIP 0.819
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Scopus rating (2008): SJR 0.363 SNIP 0.461
Scopus rating (2007): SJR 0.308 SNIP 0.52
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.341 SNIP 0.669
Scopus rating (2005): SJR 0.225 SNIP 0.372
Scopus rating (2004): SJR 0.269 SNIP 0.31
Scopus rating (2003): SJR 0.264 SNIP 0.292
Scopus rating (2002): SJR 0.279 SNIP 0.409
Conditions for mould growth on typical interior surfaces

Prediction of the risk for mould growth is an important parameter for the analysis and design of the hygrothermal performance of building constructions. However, in practice the mould growth does not always follow the predicted behavior described by the mould growth models. This is often explained by uncertainty in the real conditions of exposure. In this study, laboratory experiments were designed to determine mould growth at controlled transient climate compared to growth at constant climate. The experiment included three building materials with four different surface treatments. The samples were inoculated with 8 common indoor moulds. Even after 40 weeks no growth was observed on any sample. The paper describes different hypotheses for the missing growth, and how these have been tested.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Department of Biotechnology and Biomedicine, Fungal Degradation, Aalborg University
Authors: Møller, E. B. (Ekstern), Andersen, B. (Intern), Rode, C. (Intern), Peuhkuri, R. (Ekstern)
Pages: 171-176
Publication date: 2017
Conference: 11th Nordic Symposium on Building Physics, Trondheim, Norway, 11/06/2017 - 11/06/2017
Main Research Area: Technical/natural sciences
Control of Indoor Airflows for Reduction of Human Exposure to Aerosol Contaminants

Air distribution in indoor environments is a critical factor of occupants’ exposure to airborne contaminants. There is a wide range of gaseous and biological contaminants which deteriorate the indoor air quality and thus affect negatively occupants’ health and performance. Increasing attention is being paid to analysing indoor airflow patterns and on understanding indoor pollution transmission to the breathing zone of occupants. However, studies rarely take into account the complex airflow interaction in the breathing zone, which may lead to inaccurate exposure prediction. Therefore, there is still a need for improved understanding of the air movement in the vicinity of the occupants. Tracer gas measurements are often used to study exposure to both indoor generated gases and airborne particles (aerosols). The tracer gas, however, cannot be used as a common substitute for aerosols of all sizes due to the different physical forces acting on them. Determining to what extent tracer gas can be used as substitute for aerosols when assessing occupants’ exposure to indoor aerosols is needed and can be used for appropriate ventilation systems design. A properly developed ventilation method achieves the maximum efficiency with the minimum airflow rate, avoiding excessive installation and maintenance costs and more importantly, excessive energy use can be avoided. It is well-known that the most efficient method to prevent the risk of exposure is to control the contaminants directly or close to their source. A person, particularly his/her body, may be the primary source of unpleasant and even contagious contaminants in spaces. Dilution of the contaminated room air by supply of clean air, known as ventilation by dilution, is a recognised method for improving indoor air quality. The current method for ventilating an entire room based on total volume air distribution principles is often not efficient in providing high quality environment and satisfying every occupant. Hence, local exhaust ventilation applied in the vicinity of the occupants, i.e. close to the pollution source can offer a better solution.

The main objectives of the present thesis are: 1) to study the effect of typical airflow interactions around the human body (convective boundary layer, respiratory flow, and flow of local ventilation flow) on transport mechanisms of airborne contaminants and the resulting occupants’ exposure; 2) to verify the use of tracer gas as a measure of exposure to indoor aerosols; 3) to develop and study local exhaust ventilation methods for exposure reduction to body-emitted contaminants in indoor environments.

The most important findings of the research performed in this thesis are summarized in the following:

In ventilated rooms with low air mixing, the interaction of the exhaled flow with the convective boundary layer (CBL) around a seated person increases the exposure to own body released pollution, especially when the pollution is generated close to the breathing zone. Breathing does not affect exposure to gaseous pollutants emitted from the lower part of the body. Local airflow from personalised ventilation directed against the face with mean air speed of 0.4 m/s can reduce substantially the exposure regardless of the pollution source location. However, when the personalised airflow is combined with local source control, i.e. local exhaust of pollution, the exposure may increase depending on the airflow interaction at the breathing zone and the source location. Exposure assessment based on tracer gas concentration measurement can be incorrect if the measuring instrument has long response time and the complex airflow interaction in the breathing zone is not correctly simulated.

Results showed that in the breathing zone of a seated occupant, the tracer gas emerged as a reliable predictor for the exposure to aerosols with aerodynamic diameter 0.07, 0.7, and 3.5 μm in a room with mixing air distribution. An increase of the air change rate did not affect the comparable normalized concentration distribution of the tracer gas and the larger particles, namely 0.7μm and 3.5 μm. However, the ventilation rate was important for comparing the behaviour of the ultrafine particles (0.07 μm) and the tracer gas in the breathing zone. A moderate change of the room surface area did not influence the resemblance in the dispersion of the aerosols and the tracer gas. The results also showed that tracer gas can be used to indicate the exposure of a person lying in bed to 0.7 μm aerosols.

Furniture-integrated exhaust methods can be used as a pollution source control strategy in facilities where people are seated or bed-bound for considerable amounts of time. The current study examined ventilated mattress and ventilated seat cushion as local pollution exhaust methods. It was found that at reduced background ventilation rate, the use of the ventilated mattress and the ventilated seat cushion improved the air quality substantially when the pollution source was located near the exhaust openings. The pollution was removed from the room through the ventilated mattress or seat cushion's connection with the exhaust system before it was mixed with the room air. An alternate approach was to install a filter inside the mattress in order to clean the exhausted air of body effluents and recirculated it back into the room. This provides flexibility of bed location (the bed with own ventilation can be moved to ventilated or non-ventilated rooms) and avoids installation of additional ducting. This technique can also be applied in the case of the ventilated seat cushion. The ventilated mattress and seat cushion in conjunction with background ventilation at low supply flow rate are effective methods for reducing room pollution and exposure to the level that can be achieved with background ventilation alone at much higher supply flow rate. These findings suggest that the implementation of such user-centred ventilation methods can allow the ventilation rate requirements in buildings to be significantly reduced. The results also showed that the integrated exhaust methods provided body cooling to the parts in contact with their surface. The most affected body parts were the back, back side, pelvis, and thighs. It is expected that the local cooling will have a positive effect on thermal comfort in summer seasons and in regions with subtropical or tropical climate conditions. This positive effect must be verified with human subject experiments.

The results from the performed energy simulations showed that the use of the ventilated mattress and the ventilated seat cushion offers potential for energy savings. The ventilated mattress in conjunction with background ventilation at 3 air change per hour (ACH) can decrease the annual energy use by 24% to 52% for a double patient room located in a cold
climate or hot and humid climate in comparison with conventional mixing ventilation at 4 - 6 ACH. It was found that combining the ventilated seat cushion with mixing ventilation and a chilled ceiling in a call-centre with 14 employees, each using a ventilated seat cushion, reduced the annual energy use by 7 % compared to a system with only mixing ventilation.

**General information**
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics
Authors: Bivolarova, M. P. (Intern), Melikov, A. K. (Intern), Bolashikov, Z. D. (Intern)
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**Cooling load calculations of radiant and all-air systems for commercial buildings**
The authors simulated in TRNSYS three radiant systems coupled with a 50% sized variable air volume (VAV) system and a 50% sized all-air VAV system with night ventilation. The objective of this study was to identify the differences in the cooling load profiles of the examined systems when they are sized based on different levels of the maximum cooling demand. The authors concluded that for high thermal mass radiant system nocturnal operation was adequate for providing an acceptable thermal environment even when the radiant system was sized based on the 50% of the maximum cooling demand. The 50% all-air system alone was able to provide comfort if night cooling was implemented. On the other hand, radiant cooling panels (low thermal mass) should be operating during the occupancy period. When sizing a high thermal mass radiant cooling system, the effect of thermal inertia and the response time should always be taken into account.

**General information**
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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, University of California at Berkeley
Authors: Bourdakis, E. (Intern), Bauman, F. (Ekstern), Schiavon, S. (Ekstern), Raftery, P. (Ekstern), Olesen, B. W. (Intern)
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**Data for occupancy internal heat gain calculation in main building categories**
Heat losses from occupant body by means of convection, radiation, vapor, and sweat are essential data for indoor climate and energy simulations. Heat losses depend on the metabolic activity and body surface area. Higher variations of body surface area of occupants are observed in day care centers, kinder gardens and schools compared to other building categories (Tables 2 and 3) and these variations need to be accounted, otherwise in these building categories heat gains, CO2 and humidity generation are overestimated. Indoor temperature, humidity level, air velocity, and clothing insulation have significant influences on dry and total heat losses from occupant body leading to typical values for summer and winter. The data presented in this article are related to the research article entitled Occupancy schedules for energy simulation in new prEN16798-1 and ISO/FDIS 17772-1 standards (Ahmed et al., 2017) [1].

**General information**
Dermal uptake of benzophenone-3 from clothing

Benzophenone-3 (aka BP-3, oxybenzone) is added to sunscreens, plastics, and some coatings to filter UV radiation. A suspected endocrine disruptor, BP-3 has been widely detected and only in summertime, where a more intended use of sunscreen might be expected in the urine of Danish children (Frederiksen et al., 2016; Krause et al, 2016) and other populations. BP-3 has been found in the air and settled dust of homes (Wan et al., 2015) and is expected to redistribute from its original sources to other indoor compartments, including clothing. As has been previously observed for phthalates (Morrison et al., 2016), we hypothesized that dermal uptake from clothing would occur and could contribute to the body burden of this compound.

First, cotton shirts were exposed to air at an elevated concentration of BP-3 for 32 days; the final air concentration was 4.4 μg/m³. Next, three participants wore the exposed shirts for 3 h. After 3 h of exposure, participants wore their usual clothing.
during the collection of urine samples for the next 48 h. Urine was analyzed for BP-3, a metabolite (BP-1), and six other UV filters. The rate of urinary excretion of the sum of BP-1 and BP-3 increased for all participants during and following the 3 h of exposure. The summed mass of BP-1 and BP-3 excreted during the first 24 h attributable to wearing exposed t-shirts were 12, 9.9, and 82μg for participants 1, 2, and 3, respectively. Analysis of these results, coupled with predictions of steady-state models, suggest that dermal uptake of BP-3 from clothing could meaningfully contribute to overall body burden.

**General information**
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Missouri University of Science and Technology, Fraunhofer Wilhelm-Klauditz-Institut (WKI), University of Copenhagen
Authors: Morrison, G. C. (Ekstern), Bekö, G. (Intern), Weschler, C. J. (Intern), Schripp, T. (Ekstern), Salthammer, T. (Ekstern), Hill, J. (Ekstern), Andersson, A. (Ekstern), Toftum, J. (Intern), Clausen, G. (Intern), Frederiksen, H. (Ekstern)
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BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.777 SNIP 2.017 CiteScore 5.5
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BFI (2011): BFI-level 2
Scopus rating (2011): SJR 3.178 SNIP 1.953 CiteScore 5.16
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.964 SNIP 1.729
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.835 SNIP 1.803
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 2.943 SNIP 1.942
Web of Science (2008): Indexed yes
Dermal uptake of nicotine from air and clothing: Experimental verification

This study aims to elucidate in greater detail the dermal uptake of nicotine from air or from nicotine-exposed clothes, which was demonstrated recently in a preliminary study. Six non-smoking participants were exposed to gaseous nicotine (between 236 and 304 μg/m³) over 5 hours while breathing clean air through a hood. Four of the participants wore only shorts and 2 wore a set of clean clothes. One week later, 2 of the bare-skinned participants were again exposed in the chamber, but they showered immediately after exposure instead of the following morning. The 2 participants who wore clean clothes on week 1 were now exposed wearing a set of clothes that had been exposed to nicotine. All urine was collected for 84 hours after exposure and analyzed for nicotine and its metabolites, cotinine and 3OH-cotinine. All participants except those wearing fresh clothes excreted substantial amounts of biomarkers, comparable to levels expected from inhalation intake. Uptake for 1 participant wearing exposed clothes exceeded estimated intake via inhalation by >50%. Biomarker excretion continued during the entire urine collection period, indicating that nicotine accumulates in the skin and is released over several days. Absorbed nicotine was significantly lower after showering in 1 subject but not the other. Differences in the normalized uptakes and in the excretion patterns were observed among the participants. The observed cotinine half-lives suggest that non-smokers exposed to airborne nicotine may receive a substantial fraction through the dermal pathway. Washing skin and clothes exposed to nicotine may meaningfully decrease exposure.

General information

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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Missouri University of Science and Technology, Institute for Prevention and Occupational Medicine of the German Social Accident Insurance, Fraunhofer Wilhelm-Klauditz-Institut (WKI)
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Publication information

Journal: Indoor Air Online
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Biomonitoring, Exposure pathway, Indoor environment, Metabolism, Skin, Smoking

DOIs: 10.1111/ina.12437

Dermal uptake of nicotine from air and clothing: Experimental verification.

Studies suggest that dermal uptake of certain semivolatile organic compounds (SVOC) directly from air can be a significant exposure pathway. This has been experimentally confirmed for two phthalates (Weschler et al., 2015). Morrison et al. (2016) showed that clean clothing can impede, while clothing that has previously absorbed/adsorbed indoor air pollutants can increase dermal uptake. A recent experiment demonstrated that dermal uptake of airborne nicotine directly from air or from clothing can occur (Bekö et al., 2017). The current study aims to expand our knowledge on the dermal uptake of nicotine, by conducting more extensive experiments.

General information

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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Institute for Prevention and Occupational Medicine of the German Social Accident Insurance, Missouri University of Science and Technology, Fraunhofer Wilhelm-Klauditz-Institut (WKI)
Authors: Bekö, G. (Intern), Morrison, G. (Ekstern), Weschler, C. J. (Intern), Koch, H. (Ekstern), Pälmke, C. (Ekstern), Salthammer, T. (Ekstern), Schripp, T. (Ekstern), Toftum, J. (Intern), Clausen, G. (Intern)
Number of pages: 2
Publication date: 2017
Dermal uptake of phthalates from clothing: Comparison of model to human participant results

In this research, we extend a model of transdermal uptake of phthalates to include a layer of clothing. When compared with experimental results, this model better estimates dermal uptake of diethylphthalate and di-n-butylphthalate (DnBP) than a previous model. The model predictions are consistent with the observation that previously exposed clothing can increase dermal uptake over that observed in bare-skin participants for the same exposure air concentrations. The model predicts that dermal uptake from clothing of DnBP is a substantial fraction of total uptake from all sources of exposure. For compounds that have high dermal permeability coefficients, dermal uptake is increased for (i) thinner clothing, (ii) a narrower gap between clothing and skin, and (iii) longer time intervals between laundering and wearing. Enhanced dermal uptake is most pronounced for compounds with clothing-air partition coefficients between $10^3$ and $10^7$. In the absence of direct measurements of cotton cloth-air partition coefficients, dermal exposure may be predicted using equilibrium data for compounds in equilibrium with cellulose and water, in combination with computational methods of predicting partition coefficients.
Desorption of SVOCs from Heated Surfaces in the Form of Ultrafine Particles

Ultrafine particles (UFP) produced by electric heating of stoves and metal cooking pans, absent food, have been hypothesized to be created from a surface film of semivolatile organic compounds (SVOCs) sorbed from the surrounding air. This study tests that hypothesis by size-resolved measurements extending the lower range of the UFP studied from 10 to 2.3 nm, and including other surfaces (glass, aluminum, and porcelain). Heating glass Petri dishes or squares of aluminum foil to about 350-400 degrees C for 4-6 min removed all sorbed organic substances completely. Subsequent exposure of these "clean" Petri dishes and foil squares to indoor air in two different residences for successively longer periods (1 h to 281 days), followed by heating the materials for 4-6 min, indicated a strong relationship of the number, size distribution, and mass of the UFP to the time exposed. Estimates of the accumulation rate of SVOCs on surfaces were similar to those in studies of organic film buildup on indoor windows. Transfer of skin oils by touching the glass or foil surfaces, or after washing the glass surface with detergent and bare hands, was also observed, with measured particle production comparable with that produced by long-term exposure to indoor air.

General information
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Scopus rating (2016): CiteScore 6.26 SJR 2.538 SNIP 1.889
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BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.584 SNIP 1.828 CiteScore 5.61
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.777 SNIP 2.017 CiteScore 5.5
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.956 SNIP 2.103 CiteScore 5.52
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 3.146 SNIP 2.056 CiteScore 5.17
ISI indexed (2012): ISI indexed yes
Development and evaluation of a building integrated aquifer thermal storage model

An aquifer thermal energy storage (ATES) in combination with a heat pump is an excellent way to reduce the net energy usage of buildings. The use of ATES has been demonstrated to have the potential to provide a reduction of between 20 and 40% in the cooling and heating energy use of buildings. ATES systems are however a complex system to analyse as a number of ground conditions influence heat losses within the aquifer. ATES is also not confined from the sides and is therefore vulnerable to heat losses through conduction, advection and dispersion. The analyses of ATES system is even further complicated when the dynamic of a building is considered. When connected to a building, the temperature in the aquifer is influenced by the amount of heat exchange with the varying building load. Given the energy saving potentials of ATES systems in building operation, detailed understanding of the influence of buildings on the ATES systems and vice versa would facilitate improved operation and efficiency of ATES and building coupled systems. Therefore, taking into account the variations in the building and below ground conditions, there is the need for the development of a model that can potentially handle the dynamics on both sides. Finite element and finite volume methods are frequently used in the development of ATES models and proven as adequate tools for modelling complex ground conditions, however, most developed ATES models are often analysed independent of the building. Therefore, in this study, an ATES model that also integrates building dynamics is developed using the finite element method (FEM). The developed model was validated using data from an ATES and building in the Netherlands. The developed model was shown to have an absolute mean error of 0.17 C and 0.12 C for the cold and warm wells respectively.
Displacement ventilation
The aim of this Guidebook is to give the state-of-the-art knowledge of the displacement ventilation technology, and to simplify and improve the practical design procedure. The Guidebook discusses methods of total volume ventilation by mixing ventilation and displacement ventilation and it gives insights of the performance of the displacement ventilation. It also shows practical case studies in some typical applications and the latest research findings to create good local micro-climatic conditions.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Aalto University, Royal Institute of Technology, Halton OY, Aalborg University
Authors: Kosonen, R. (Ekstern), Melikov, A. K. (Intern), Mundt, E. (Ekstern), Mustakalio, P. (Ekstern), Nielsen, P. V. (Ekstern)
Number of pages: 96
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Original language: English
Series: REHVA Guidebooks
Number: 23
Main Research Area: Technical/natural sciences
Publication: Research - peer-review › Book – Annual report year: 2017

Effective Energy-efficient Classroom Ventilation for Temperate Zones

General information
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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics
Authors: Toftum, J. (Intern), Wargocki, P. (Intern)
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Final report ASHRAE Research Project 1624-RP.
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Effect of airflow interaction in the breathing zone on exposure to bio-effluents

General information
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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Technical University of Denmark, Silesian University of Technology
Authors: Bivolarova, M. P. (Intern), Kierat, W. (Ekstern), Zavrl, E. (Ekstern), Popiolek, Z. (Ekstern), Melikov, A. K. (Intern)
Number of pages: 11
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BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.51 SJR 2.015 SNIP 2.198
Web of Science (2016): Indexed yes
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Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.938 SNIP 2.797 CiteScore 4.14
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.581 SNIP 2.602 CiteScore 3.57
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.331 SNIP 2.875 CiteScore 3.06
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.144 SNIP 2.255 CiteScore 2.76
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.235 SNIP 2.001
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.028 SNIP 1.865
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.924 SNIP 1.38
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.788 SNIP 1.778
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.03 SNIP 1.63
Scopus rating (2005): SJR 0.95 SNIP 1.225
Web of Science (2005): Indexed yes
Effect of energy renovation on indoor air quality in multifamily residential buildings in Slovakia

Buildings are responsible for a substantial portion of the global energy consumption. Most of the multifamily residential buildings built in the 20th century in Central and Eastern Europe do not satisfy the current requirements on energy efficiency. Nationwide measures taken to improve the energy efficiency of these buildings rarely consider their impact on the indoor air quality (IAQ). The objective of the present study was to evaluate the impact of simple energy renovation on IAQ, air exchange rates (AER) and occupant satisfaction in Slovak residential buildings. Three pairs of identical naturally ventilated multifamily residential buildings were examined. One building in each pair was newly renovated, the other was in its original condition. Temperature, relative humidity (RH) and the concentration of carbon dioxide (CO2) were measured in 94 apartments (57%) during one week in the winter. A questionnaire related to perceived air quality, sick building syndrome symptoms and airing habits was filled by the occupants. In a companion experiment, the IAQ was investigated in 20 apartments (50%) of a single residential building before and after its renovation. In this experiment, concentrations of nitrogen dioxide (NO2), formaldehyde and total and individual volatile organic compounds (VOC) were also measured. CO2 concentrations were significantly higher and AERs were lower in the renovated buildings. Formaldehyde concentrations increased after renovation and were positively correlated with CO2 and RH. Energy renovation was associated with lower occupant satisfaction with IAQ. Energy retrofitting efforts should be complemented with improved ventilation in order to avoid adverse effects on IAQ.

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BFI (2015): BFI-level 1
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BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.938 SNIP 2.797 CiteScore 4.14
Web of Science (2014): Indexed yes
Effect of supply air temperature on air distribution in a room with radiant heating and mechanical ventilation

The present study focused on the effect of supply air temperature on air distribution in a room with floor heating (FH) or ceiling heating (CH) and mixing ventilation (MV) or displacement ventilation (DV). The vertical distribution of air temperature and velocity in the occupied zone and the horizontal distribution of containment concentration in the breathing zone were measured as the supply air temperature ranged from 15.0°C (59°F) to 19.0°C (66.2°F). The results showed that the vertical air temperature differences were less than 0.3°C (32.5°F) with FH+MV or CH+MV and between 1.9°C (35.4°F) and 4.2°C (39.6°F) with FH+DV or CH+DV. The turbulence intensity varied from 12.5% to 15.5% with FH+MV or CH+MV and from 6.0% to 10.8% with FH+DV or CH+DV. The air-distribution effectiveness was close to 1.0 with FH+MV or CH+MV and between 1.06 and 1.16 with FH+DV or CH+DV. The results in this paper are relevant to the design and control of the hybrid systems with radiant heating systems and mechanical ventilation systems.

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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Xi'an Jiaotong University, Harbin Institute of Technology
Effects of acoustic ceiling units on the cooling performance of thermally activated building systems (TABS)

Europe, with a building stock responsible for about 40% of the total energy use, needs to reduce the primary energy use in buildings in order to meet the 2020 energy targets of the European Union. High temperature cooling and low temperature heating systems, and as an example, Thermally Activated Building Systems (TABS), have proven to be an energy efficient solution to provide buildings with an optimal indoor thermal environment. This solution uses the structure of the building to store heat and decrease the primary energy use. TABS require the active (heated or cooled) surfaces to be as exposed as possible to the room, but exposing bare concrete surfaces will have a diminishing effect on the acoustic qualities of indoor spaces. Acoustic solutions capable of providing optimal acoustic comfort while allowing the heat exchange between the TABS and the room are desirable. This study quantifies the effects of two types of free hanging ceiling absorbers (horizontal and vertical) on the cooling performance of the TABS and the implications this has on the occupant thermal comfort. The measurements were carried out in a full-scale TABS test facility. The results show a reduction of 11% of the...
heat removed by the TABS when 43% of the ceiling area was covered with free hanging horizontal sound absorbers at 300 mm (0.98 ft) from the active surface. This reduction was 23% for a ceiling coverage ratio of 60%. The decrease in heat absorbed by the TABS is less pronounced in the case of vertical sound absorbers for equivalent levels of sound absorption. A reduction of 12% of the heat removed by the TABS has been measured for vertical sound absorbers (equivalent sound absorption levels to 60% coverage ratio with horizontal sound absorbers). This reduction was of 13% for vertical sound absorbers (equivalent sound absorption levels to 80% coverage ratio with horizontal sound absorbers).

Effects of Exposure to Carbon Dioxide and Bioeffluents on Perceived Air Quality, Self-assessed Acute Health Symptoms and Cognitive Performance

The purpose of this study was to examine the effects on humans of exposure to carbon dioxide (CO₂) and bioeffluents. In three of the five exposures, the outdoor air supply rate was high enough to remove bioeffluents, resulting in a CO₂ level of 500 ppm. Chemically pure CO₂ was added to this reference condition to create exposure conditions with CO₂ at 1,000 ppm or 3,000 ppm. In two further conditions, the outdoor air supply rate was restricted so that the bioeffluent CO₂ reached 1,000 ppm or 3,000 ppm. The same twenty-five subjects were exposed for 255 minutes to each condition. Subjective ratings, physiological responses and cognitive performance were measured. No statistically significant effects on perceived air quality, acute health symptoms or cognitive performance were seen during exposures when CO₂ was added. Exposures to bioeffluents with CO₂ at 3,000 ppm reduced perceived air quality, increased the intensity of reported headache, fatigue, sleepiness and difficulty in thinking clearly, and reduced speed of addition, the response time in a redirection task and the number of correct links made in the cue-utilisation test. This suggests that moderate concentrations of bioeffluents, but not pure CO₂, will result in deleterious effects on occupants during typical indoor exposures.
Effects of Free-Hanging Horizontal Sound Absorbers on the Cooling Performance of Thermally Activated Building Systems

Thermally Activated Building Systems (TABS) have proven to be an energy-efficient solution to provide buildings with an optimal indoor thermal environment. This solution uses the structure of the building to store heat, reduce the peak loads, and decrease the primary energy demand. TABS require the heated or cooled surfaces to be as exposed as possible to the indoor space, but exposing the bare concrete surfaces has a diminishing effect on the acoustic qualities of the spaces in a building. Acoustic solutions capable of providing optimal acoustic comfort and allowing the heat exchange between the TABS and the room are desirable. In this study, the effects of free-hanging units on the cooling performance of TABS and the occupants’ thermal comfort was measured in a full-scale TABS laboratory. Investigations demonstrate that the use of freehanging sound absorbers are compatible with the performance of TABS and the occupant’s thermal comfort, but an appropriate acoustic design is needed to find the most suitable solution for each case. The results show a reduction of
11% of the cooling performance of the TABS when 43% of the ceiling area is covered with free-hanging horizontal sound absorbers, of 23% for 60% ceiling coverage ratio and of 36% for 80% coverage. Measurements in actual buildings showed an increase of the room operative temperature of 0.3 K when 50% of the ceiling surface is covered with horizontal panels and of 0.8 to 1 K for a 70% coverage ratio. According to numerical simulations using a new TRNSYS Type, the use of comfort ventilation has a considerable influence on the thermal conditions in the room; if the ventilation is removed, then the operative temperature increases by 1.8 K for a 60%-covered ceiling.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Technical University of Denmark
Authors: Lacarte, L. M. D. (Ekstern), Rage, N. (Intern), Kazanci, O. B. (Intern), Olesen, B. W. (Intern)
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Electronic versions: Untitled_2.pdf
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Source-ID: 130484794
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Enhancing demand side flexibility in Nordhavn buildings for integrated multi-energy systems

General information
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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Department of Electrical Engineering, Center for Electric Power and Energy, Distributed Energy Resources
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Conference: Sustain 2017, Kgs. Lyngby, Denmark, 06/12/2017 - 06/12/2017
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Evaluation of computational domain on CFD simulation of flow in a long street canyon under a perpendicular wind direction

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Hong Kong Polytechnic University, University of Hong Kong
Authors: Ai, Z. (Intern), Mak, C. M. (Ekstern), Wong, H. M. (Ekstern)
Publication date: 2017

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Title of host publication: 7th European and African Conference on Wind Engineering
Publisher: International Association for Wind Engineering (IAWE)
Main Research Area: Technical/natural sciences
Conference: 7th European and African Conference on Wind Engineering, Liege, Belgium, 04/07/2017 - 04/07/2017
Experimental analysis of indoor air quality improvement achieved by using a Clean-Air Heat Pump (CAHP) air-cleaner in a ventilation system

This study investigated the air purification effect of a Clean-Air Heat Pump (CAHP) air-cleaner which combined a silica gel rotor with a heat pump to achieve air cleaning, heating and ventilation in buildings. The experiments were conducted in a field laboratory and compared a low outdoor air supply rate with CAHP air purification of recirculated air with three different outdoor air supply rates without recirculation or air cleaning. Sensory assessments of perceived air quality and chemical measurements of TVOC concentration were used to evaluate the air-cleaning performance of the CAHP. The results of the experiment showed that the operation of the CAHP significantly improved the perceived air quality in a room polluted by both human bio-effluents and building materials. At the outdoor airflow rate of 2 L/s per person, the indoor air quality with CAHP was equivalent to what was achieved in the same room with 10 L/s per person of outdoor air ventilation without air cleaning. The percentage dissatisfied was as low as 5.2% with the CAHP in operation, based on adapted perception assessment. The outdoor air supply rate can be reduced by 76% by using CAHP, as the Clean Air Delivery Rate (CADR) was over three times the outdoor air supply rate when the CAHP was in operation. The chemical measurements indicated a single-pass efficiency of over 92% for the removal of indoor air pollutants when the regeneration temperature was 60 °C. No VOC accumulation on the desiccant wheel was observed.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Tianjin University, Beijing University of Civil Engineering and Architecture
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Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.938 SNIP 2.797 CiteScore 4.14
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BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.581 SNIP 2.602 CiteScore 3.57
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.331 SNIP 2.875 CiteScore 3.06
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.144 SNIP 2.255 CiteScore 2.76
ISI indexed (2011): ISI indexed yes
Experimental and numerical analyses on thermal performance of different typologies of PCMs integrated in the roof space

The study investigates the thermal performances of Phase Change Materials (PCM) integrated in a roof space to be used as a residential attic in Torino, Italy. Three different solutions were applied to a roof continuously monitored under summer climatic conditions. The roof was divided into three portions, one, the bare roof, representing the reference case without PCMs, the other two integrating two PCM's typologies with different melting/solidification temperatures range. A numerical model was furthermore developed implementing the equivalent capacitance numerical method to describe the substance phase transition and the measured data set were used for its validation. The study demonstrates that PCM-enhanced components are a promising solution toward a higher thermal performance efficiency in roof attic spaces during the summer season. Experimental results showed a reduction of the ongoing heat peak load between 13% and 59% depending on the PCM typology, highlighting that to reach the expected performance the proper PCM type should be carefully selected.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Politecnico di Torino, University of Padua
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Web of Science (2014): Indexed yes
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Scopus rating (2013): SJR 1.897 SNIP 2.433 CiteScore 3.79
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Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.816 SNIP 2.737 CiteScore 3.36
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.506 SNIP 2.536 CiteScore 3.23
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.631 SNIP 2.081
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.564 SNIP 1.79
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
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Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.033 SNIP 1.718
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.411 SNIP 1.788
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Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 0.81 SNIP 1.628
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 1.567 SNIP 1.4
Scopus rating (2002): SJR 1.172 SNIP 1.631
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.942 SNIP 1.095
Scopus rating (2000): SJR 0.505 SNIP 1.226
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 0.25 SNIP 0.589
Original language: English
Experimental analysis, Numerical simulations, Pcm, RC model, Roof attic space
DOIs:
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Source-ID: 2371788080
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Experimental and Numerical Studies of Solar Chimney for Ventilation in Low Energy Buildings

As an effective way to protect environment and save energy in buildings, passive ventilation method has generated intense interest for improving indoor thermal environment in recent years. Among these passive ventilation solutions, design of solar chimney in buildings is a promising approach for guiding natural ventilation orderly. Many studies about solar chimneys have mainly focused on achieving a better ventilation performance both experimentally and theoretically in ideal condition, whereas experimental studies are mainly focused on small-sized equipment. This research examines the performance of a full-scale solar chimney in a real building in Eastern China. The measured performance is compared with theoretical calculation and numerical simulation. In a solar chimney of 6.2m length, 2.8m width and 0.35m air gap, the experimental results show that air flow rate of 70.6 m³/h~1887.6 m³/h can be achieved during the daytime in the testing day. Comparing measured value with theoretical value, the flow rate is generally lower than the theoretical value. By data analysis, the suggested discharge coefficient Cd of solar energy in real engineering project is 0.51. With the use of this suggested value, the simulation results show that during the transition seasons (from April to October), solar chimney can be used for saving energy with an energy saving rate around 14.5% in Shanghai. It is shown solar chimney is an effective approach to save energy for residential buildings in transition seasons in hot summer and cold winter area in China.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Nanjing University
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ISI indexed (2013): ISI indexed no
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Source: Scopus
Source-ID: 85033394506
Publication: Research - peer-review » Conference article – Annual report year: 2017
With horizontal sound absorbers, the cooling performance of the Thermally Active Building System decreased by 11%, 23% and 36% for ceiling coverage ratios of 43%, 60% and 80%, respectively. With vertical sound absorbers, the decrease in cooling performance was 8%, 12%, and 14% for the corresponding cases, respectively. The numerical model predicted closely the cooling performance reduction, air temperatures and ceiling surface temperatures in most cases, while there were differences in mean radiant temperatures and cooling capacity coefficients, indicating that the model can be improved in certain aspects.

**General information**

State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Technical University of Denmark
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  - Web of Science (2016): Indexed yes
  - BFI (2015): BFI-level 1
  - Scopus rating (2016): CiteScore 4.51 SJR 2.015 SNIP 2.198
  - Web of Science (2016): Indexed yes
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  - Scopus rating (2015): SJR 2.093 SNIP 2.49 CiteScore 4.37
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  - BFI (2014): BFI-level 1
  - Scopus rating (2014): SJR 1.938 SNIP 2.797 CiteScore 4.14
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  - ISI indexed (2013): ISI indexed yes
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  - BFI (2012): BFI-level 1
  - Scopus rating (2012): SJR 1.331 SNIP 2.875 CiteScore 3.06
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  - Web of Science (2012): Indexed yes
  - BFI (2011): BFI-level 1
  - Scopus rating (2011): SJR 1.144 SNIP 2.255 CiteScore 2.76
  - ISI indexed (2011): ISI indexed yes
  - Web of Science (2011): Indexed yes
  - BFI (2010): BFI-level 1
  - Scopus rating (2010): SJR 1.235 SNIP 2.001
  - Web of Science (2010): Indexed yes
  - BFI (2009): BFI-level 1
  - Scopus rating (2009): SJR 1.028 SNIP 1.865
  - Web of Science (2009): Indexed yes
  - BFI (2008): BFI-level 1
  - Scopus rating (2008): SJR 0.924 SNIP 1.38
  - Web of Science (2008): Indexed yes
  - Scopus rating (2007): SJR 0.788 SNIP 1.778
Experimental study on air cleaning effect of clean air heat pump and its impact on ventilation requirement

This study investigated air purification effect of a Clean-Air Heat Pump (CAHP) which combined a desiccant wheel with a heat pump for both air cleaning and HVAC of buildings. The experiment was conducted in a field lab at four different outdoor air supply rates with and without air cleaning by CAHP. Both sensory assessments of perceived air quality and chemical measurements of TVOC concentrations were conducted for evaluating the air cleaning performance of the CAHP. The results of experiment showed that running the CAHP improved significantly perceived air quality. At 2 L/s per person of outdoor air supply rate with operating the CAHP, the air quality was equivalent to the value at the higher outdoor air supply rate of 10 L/s per person without running CAHP. The TVOC measurements observed over 92% of efficiency on removal of indoor air VOCs and no VOCs accumulation on the desiccant wheel was observed.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Tianjin University, Beijing University of Civil Engineering and Architecture
Authors: Fang, L. (Intern), Sheng, Y. (Ekstern), Nie, J. (Ekstern)
Publication date: 2017

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Air purification, Adsorption, Silica gel wheel, VOCs
Source: PublicationPreSubmission
Source-ID: 138915082
Publication: Research - peer-review › Article in proceedings – Annual report year: 2017

Flexibility of Large-Scale Solar Heating Plant with Heat Pump and Thermal Energy Storage

In the future energy system, based wholly on renewable energy sources, biomass is likely to become a scarce resource because of high demand especially by the transport sector. The current paper investigates, what is the possibility of utilizing excess electrical energy from renewable generation to decrease biomass use in a district heating system. The paper focuses on the renewable energy-based district heating system in Marstal, Denmark, with heat produced in central solar heating plant, wood pellet boiler, heat pump and bio-oil boiler. The plant has been the object of research and developments since its construction in 1996 and its operation is well documented. In the first part of the paper, the background of the current study is explained and the system in question is presented. Subsequently, the methodology of the study is explained and the model used in the study is described. Due to lack of widely accepted definition of a metrics for comparing system flexibility the paper proposes such an indicator. It was concluded, that cheap electricity can partially replace scarce biomass for heat production for district heating system.

General information
Growth of organic films on indoor surfaces

We present a model for the growth of organic films on impermeable indoor surfaces. The model couples transport through a gas-side boundary layer adjacent to the surface with equilibrium partitioning of semivolatile organic compounds (SVOCs) between the gas phase and the surface film. Model predictions indicate that film growth would primarily be influenced by the gas-phase concentration of SVOCs with octanol-air partitioning (Koa) values in the approximate range $10 \leq \log K_{oa} \leq 13$. Within the relevant range, SVOCs with lower values will equilibrate with the surface film more rapidly. Over time, the film becomes relatively enriched in species with higher log Koa values, while the proportion of gas-phase SVOCs not in equilibrium with the film decreases. Given stable airborne SVOC concentrations, films grow at faster rates initially and then subsequently diminish to an almost steady growth rate. Once an SVOC is equilibrated with the film, its mass per unit film volume remains constant, while its mass per unit area increases in proportion to overall film thickness. The predictions of the conceptual model and its mathematical embodiment are generally consistent with results reported in the peer-reviewed literature.
Absorption, Octanol-air partition coefficient, Partitioning, Semivolatile organic compounds, Surface chemistry, Window films
Impact of Building Design Parameters on Thermal Energy Flexibility in a Low-Energy Building

This work focuses on demand-side management potential for the heating grid in residential buildings. The possibility to increase the flexibility provided to the heat network through specific building design is investigated. The role of different parts of the building structure on thermal flexibility is assessed through a parameter variation on a building model. Different building designs are subjected to heat cut-offs, and flexibility is evaluated with respect to comfort preservation and heating power peak creation.

Under the conditions of this study, the thermal transmittance of the envelope appears to have the largest impact on thermal flexibility. The importance of window design, namely the size, U-value and orientation, is underlined due to its critical influence on solar gains and heat losses. It is eventually observed that thermal mass has a secondary influence on the evaluated indicators; its variation only affects thermal flexibility if the thermal resistance of the envelope is sufficient.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Technical University of Denmark
Authors: Sarran, L. (Ekstern), Foteinaki, K. (Intern), Gianniou, P. (Intern), Rode, C. (Intern)
Number of pages: 10
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Main Research Area: Technical/natural sciences

Impact of Weather and Occupancy on Energy Flexibility Potential of a Low-energy Building

The introduction of renewable energy sources in the energy market leads to instability of the energy system itself; therefore, new solutions to increase its flexibility will become more common in the coming years. In this context the implementation of energy flexibility in buildings is evaluated, using heat storage in the building mass. This study focuses on the influence of weather conditions and internal gains on the energy flexibility potential of a nearly-zero-energy building in Denmark. A specific six hours heating program is used to reach the scope. The main findings showed that the direct solar radiation and the outdoor temperature appeared to have the larger impact on the thermal flexibility of the building. Specifically, the energy flexibility potential of the examined apartment can ensure its thermal autonomy up to 200 h in a typical sunny winter day.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Technical University of Denmark
Authors: Zilio, E. (Ekstern), Foteinaki, K. (Intern), Gianniou, P. (Intern), Rode, C. (Intern)
Number of pages: 10
Publication date: 2017
Main Research Area: Technical/natural sciences

Implementation of Energy Strategies in Communities (Annex 63) Volume 1: Inventory of measures
This report describes the existing national political framework conditions, energy and land-use planning processes, strategies for energy planning and existing national measures in the field of urban and energy planning. In this research, the term measure refers to any action, program, policy or other activity that can demonstrate or influence a change in process. Amongst other background information, 22 planning processes and 89 measures from 11 countries are described in detail in this report.

General information
Implementation of Energy Strategies in Communities (Annex 63) Volume 2: Development of strategic measures

This report describes the further development of the analysed measures from Volume 1 into strategic measures. As with the term measure, a strategic measure refers to an essential measure in concept that can be used to develop individual implementation strategies on a local level for part or the whole life cycle of a project (from the first vision to monitoring of the implemented solution). The developed strategic measures deal with the following topics: Setting Vision and Targets Developing Renewable Energy Strategies Making Full use of Legal Frameworks Designing an Urban Competition ProcessesMaking use of Tools Supporting the Decision Making Process Implementing Monitoring of Energy Consumption and GHG Emission practices Enhancing Stakeholder Engagement &amp; Involvement Including Socio Economic Criteria Implementing Effective and Efficient Organisational Processes <p> The report includes both a summary of each strategic measure supported by nine appendices, each a detailed description of each strategic measure.

General information

State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Section for Building Energy, Aalborg University, Norwegian University of Science and Technology, Osaka University, RWTH Aachen University, University of Minnesota
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Implementation of Energy Strategies in Communities – Results within the Context of IEA Annex 63

Cities are responsible for more than 70 % of global greenhouse gas emissions. Thus, cities can play a major part within the CO2 emission reduction goals of the Paris agreement. Lack of technical knowledge and solutions has often been seen as major challenge for energy efficiency implementation. However, findings of the International Energy Agency (IEA) Annex 51 – Case Studies & Guidelines for Energy Efficient Communities – showed that the primary challenges result from inefficient organizational processes and unsupportive framework for implementation. Thus, solutions have to be found how the energy and urban planning can act more efficiently to successfully support the implementation of energy strategies within urban areas. Within the IEA Energy in Buildings and Communities (EBC) Program, the Annex 63 – Implementation of Energy Strategies in Communities – aims at giving recommendations for an optimized energy and urban planning process to support decision makers as well as planners. Therefore, existing legal frameworks, processes and case studies within energy planning in communities were analysed. This paper shows first results of the Annex 63 to serve as orientation for decision makers and other interested persons in the field of urban energy planning.

Implementing Occupant Behaviour in the Simulation of Building Energy Performance and Energy Flexibility: Development of Co-Simulation Framework and Case Study

Occupant behaviour has a substantial impact on the prediction of building energy performance. To capture this impact, co-simulation is considered an effective approach. It is still a new method in need of more development. In this study, a co-simulation framework is established to couple EnergyPlus with Java via Functional Mock-up Interface (FMI) using the EnergyPlusToFMU software package. This method is applied to a case study of a single occupant office with control of lighting, plug load and thermostat. Two control scenarios are studied. These are occupancy and occupant behaviour based control (OC), and sensor based control (SBC) triggered by dynamic electricity price under demand side management (DSM) program. The building energy performance in the OC scenario is then used as reference to evaluate the building energy (cost) saving and energy flexibility. This is an improvement of current studies on DSM and building energy flexibility, in which predefined user schedules are commonly used.
Intelligent Scheduling of a Grid-Connected Heat Pump in a Danish Detached House
This study proposes a methodology for intelligent scheduling of a heat pump installed in a refurbished grid-connected detached house in Denmark. This scheduling is conducted through the coupling of a dynamic building simulation tool with an optimization tool. The optimization of the operation of the system is based on a price-signal considering a three-day period for different weather cases. The results show that the optimal scheduling of the system is successful in terms of reducing the peak load during times when electricity prices are high, thus achieving cost savings as well as maintaining good thermal comfort conditions. The proposed methodology bridges dynamic building modelling with optimization of real-time operation of HVAC systems offering a detailed model for building physics, especially regarding thermal mass and a stochastic price-based control.

General information
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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Section for Building Energy
Authors: Gianniou, P. (Intern), Foteinaki, K. (Intern), Heller, A. (Intern), Rode, C. (Intern)
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Authors: Toftum, J. (Intern)
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ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: Danish
Electronic versions:
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Source: PublicationPreSubmission
Source-ID: 137263270
Publication: Communication › Journal article – Annual report year: 2017

Kan man forudsige brugernes adfærd?

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Technical University of Denmark
Authors: Andersen, R. K. (Intern), Kirstein, M. L. (Ekstern)
Pages: 22-28
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information
Journal: HVAC Magasinet
Volume: 53
Issue number: 2
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ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: English
Electronic versions:
Andersen_Rune_and_Kirsterin_Maren_Lea_HVAC_Magasinet_nr_2_2017.pdf
Source: PublicationPreSubmission
Source-ID: 131009617
Publication: Communication › Journal article – Annual report year: 2017

Kinetics of dermal uptake of nicotine from air

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Fraunhofer Wilhelm-Klauditz-Institut (WKI), Institute for Prevention and Occupational Medicine of the German Social Accident Insurance, Missouri University of Science and Technology
Authors: Morrison, G. (Ekstern), Bekö, G. (Intern), Clausen, G. (Intern), Koch, H. (Ekstern), Paelmke, C. (Ekstern), Salthammer, T. (Ekstern), Schripp, T. (Ekstern), Toftum, J. (Intern), Weschler, C. J. (Intern)
Publication date: 2017

Host publication information
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Article number: TH-PL-D2-650
Main Research Area: Technical/natural sciences
Conference: 27th Annual meeting of the International Society of Exposure Science, Research Triangle Park, United States, 15/10/2017 - 15/10/2017
A-indoor environment, A-biomonitoring, A-second-hand smoke, B-VOCs, C-air
Electronic versions:
Untitled.pdf
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2017

Klimavenlig beton

General information
State: Published
Organisations: Department of Civil Engineering, Section for Structural Engineering, Section for Indoor Climate and Building Physics, Section for Building Design, ARTEK, Section for Arctic Engineering and Sustainable Solutions
Authors: Goltermann, P. (Intern), Wargocki, P. (Intern), Hertz, K. D. (Intern), Ottosen, L. M. (Intern), Jensen, P. E. (Intern), Rode, C. (Intern)
Number of pages: 54
Publication date: 2017

Publication information
Publisher: DTU Byg, Danmarks Tekniske Universitet
Volume: Rapport BYG R-371
ISBN (Electronic): 9788778774651
Original language: Danish
Main Research Area: Technical/natural sciences
Electronic versions:
Untitled.pdf
Laboratory study of subjective perceptions to low temperature heating systems with exhaust ventilation in Nordic countries

Given the global trends of rising energy demand and the increasing utilization of low-grade renewable energy, low-temperature heating systems can play key roles in improving building energy efficiency while providing a comfortable indoor environment. To meet the need to retrofit existing buildings in Nordic countries for greater energy efficiency, this study focused on human subjects’ thermal sensation, thermal comfort, thermal acceptability, draft acceptability, and perceived air quality when three low-temperature heating systems were used: conventional radiator, ventilation radiator, or floor heating with exhaust ventilation. Human subject tests were carried out in the climate chamber at the Technical University of Denmark. In total, 24 human subjects, 12 females and 12 males, participated in the tests during the winter season. The results show that no significant differences in thermal sensation and thermal comfort between the three heating systems. Ventilation radiator promised a comfortable indoor environment with a decreased water supply temperature and floor heating with exhaust ventilation can provide a basic thermal comfort level. Thermal acceptability and draft acceptability show variations in different heating systems. Gender has significant influences on thermal sensation, draft acceptability, and preference of clo values. Personal thermal preference is observed between males and females. The males prefer to dress lighter than the females, but both can get the same thermal comfort level. It is concluded that low-temperature heating systems using exhaust air ventilation are a potentially solution when buildings are being retrofitted for improved energy efficiency and comfort of the occupants.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Chalmers University of Technology, KTH - Royal Institute of Technology
Authors: Jin, Q. (Ekstern), Simone, A. (Intern), Olesen, B. W. (Intern), Holmberg, S. K. (Ekstern), Bourdakis, E. (Intern)
Number of pages: 12
Pages: 457-468
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information
Journal: Science and Technology for the Built Environment
Volume: 23
ISSN (Print): 2374-4731
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.01
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.514 SNIP 0.731
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.561 SNIP 0.891
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.544 SNIP 1.104
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.498 SNIP 0.742
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Six males clad only in shorts were exposed to high levels of airborne di(n-butyl) phthalate (DnBP) and diethyl phthalate (DEP) in chamber experiments conducted in 2014. In two 6 h sessions, the subjects were exposed only dermally while breathing clean air from a hood, and both dermally and via inhalation when exposed without a hood. Full urine samples were taken before, during, and for 48 h after leaving the chamber and measured for key DnBP and DEP metabolites. The data clearly demonstrated high levels of DnBP and DEP metabolite excretions while in the chamber and during the first 24 h once leaving the chamber under both conditions. The data for DnBP were used in a modeling exercise linking dose models for inhalation and transdermal permeation with a simple pharmacokinetic model that predicted timing and mass of metabolite excretions. These models were developed and calibrated independent of these experiments. Tests included modeling of the “hood-on” (transdermal penetration only), “hood-off” (both inhalation and transdermal) scenarios, and a derived “inhalation-only” scenario. Results showed that the linked model tended to duplicate the pattern of excretion with regard to timing of peaks, decline of concentrations over time, and the ratio of DnBP metabolites. However, the transdermal model tended to overpredict penetration of DnBP such that predictions of metabolite excretions were between 1.1 and 4.5 times higher than the cumulative excretion of DnBP metabolites over the 54 h of the simulation. A similar overprediction was not seen for the “inhalation-only” simulations. Possible explanations and model refinements for these overpredictions are discussed. In a demonstration of the linked model designed to characterize general population exposures to typical airborne indoor concentrations of DnBP in the United States, it was estimated that up to one-quarter of total exposures could be due to inhalation and dermal uptake.
Measurements of dermal uptake of nicotine directly from air and clothing

In this preliminary study, we have investigated whether dermal uptake of nicotine directly from air or indirectly from clothing can be a meaningful exposure pathway. Two participants wearing only shorts and a third participant wearing clean cotton clothes were exposed to environmental tobacco smoke (ETS), generated by mechanically "smoking" cigarettes, for three hours in a chamber while breathing clean air from head-enveloping hoods. The average nicotine concentration (420 μg/m³) was comparable to the highest levels reported for smoking sections of pubs. Urine samples were collected immediately before exposure and 60 hour post-exposure for bare-skinned participants. For the clothed participant, post-exposure urine samples were collected for 24 hour. This participant then entered the chamber for another three-hour exposure wearing a hood and clothes, including a shirt that had been exposed for five days to elevated nicotine levels. The urine samples were analyzed for nicotine and two metabolites-cotinine and 3OH-cotinine. Peak urinary cotinine and 3OH-cotinine concentrations for the bare-skinned participants were comparable to levels measured among non-smokers in hospitality environments before smoking bans. The amount of dermally absorbed nicotine for each bare-skinned participant was conservatively estimated at 570 μg, but may have been larger. For the participant wearing clean clothes, uptake was similar to 20 μg, and while wearing a shirt previously exposed to nicotine, uptake was similar to 80 μg. This study demonstrates meaningful dermal uptake of nicotine directly from air or from nicotine-exposed clothes. The findings are especially relevant for children in homes with smoking or vaping.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Missouri University of Science and Technology, Institute for Prevention and Occupational Medicine of the German Social Accident Insurance, Fraunhofer Wilhelm-Klauditz-Institut (WKI)
Authors: Beko, G. (Intern), Morrison, G. (Exter), Weschler, C. J. (Intern), Koch, H. M. (Exter), Paelmke, C. (Exter), Salthammer, T. (Exter), Schripp, T. (Exter), Toftum, J. (Intern), Clausen, G. (Intern)
Number of pages: 7
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information
Journal: Indoor Air Online
Volume: 27
Issue number: 2
ISSN (Print): 1600-0668
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Web of Science (2018): Indexed yes
Web of Science (2017): Indexed yes
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Scopus rating (2015): CiteScore 3.88
Web of Science (2015): Indexed yes
Scopus rating (2014): CiteScore 4.57
Web of Science (2014): Indexed yes
Scopus rating (2013): CiteScore 3.63
ISI indexed (2013): ISI indexed no
Web of Science (2013): Indexed yes
Scopus rating (2012): CiteScore 2.72
ISI indexed (2012): ISI indexed no
Web of Science (2012): Indexed yes
Scopus rating (2011): CiteScore 2.42
ISI indexed (2011): ISI indexed no
Web of Science (2011): Indexed yes
Web of Science (2010): Indexed yes
Web of Science (2009): Indexed yes
Web of Science (2008): Indexed yes
Web of Science (2007): Indexed yes
Web of Science (2006): Indexed yes
Web of Science (2005): Indexed yes
Moisture Buffer Effect and its Impact on Indoor Environment
The moisture buffer effect of building materials may have great influence on indoor hygrothermal environment. In order to characterize the moisture buffering ability of materials, the basic concept of moisture buffer value (MBV) is adopted. Firstly, a theoretical correction factor is introduced in this paper. The moisture uptake/release by hygroscopic materials can be calculated with the factor and the basic MBV. Furthermore, the validation of the correction factor is carried out. The impact of moisture buffering on indoor environment is assessed by using numerical simulations. The results show that the application of hygroscopic materials with large MBV values could reduce the fluctuation of indoor relative humidity, thus decreasing the energy demand for dehumification. The potential energy saving rate of the test building in temperate climates and semi-arid climates could be up to 25-30%. Finally, the relationship between MBV and potential energy saving rate is discussed.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Nanjing University
Authors: Zhang, M. (Ekstern), Qin, M. (Intern), Chen, Z. (Ekstern)
Pages: 1123-1129
Publication date: 2017
Conference: 10th International Symposium on Heating, Ventilation and Air Conditioning (ISHVAC2017), Jinan, China, 19/10/2017 - 19/10/2017
Main Research Area: Technical/natural sciences

Publication information
Journal: Procedia Engineering
Volume: 205
ISSN (Print): 1877-7058
Ratings:
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 0.74
Scopus rating (2015): CiteScore 0.56
Scopus rating (2014): CiteScore 0.53
Scopus rating (2013): CiteScore 0.4
ISI indexed (2013): ISI indexed no
Scopus rating (2012): CiteScore 0.28
ISI indexed (2012): ISI indexed no
Scopus rating (2011): CiteScore 0.45
ISI indexed (2011): ISI indexed no
Web of Science (2010): Indexed yes
Original language: English
Building energy conservation, Hygroscopic material, Indoor humidity condition, Moisture Buffer Effect, Test method
Moisture buffering phenomenon and its impact on building energy consumption

Moisture buffering is the ability of surface materials in the indoor environment to moderate the indoor humidity variations through adsorption or desorption. Materials with high moisture buffering capacity could be used to passively control the indoor moisture condition and consequently improve the indoor environmental quality and reduce the latent heat load of buildings. In order to characterize the moisture buffering ability of materials, the basic concept of moisture buffer value (MBV) is adopted. The paper first proposes a new mathematical expression of basic MBV, and then introduces a theoretical correction factor that could be used together with the MBV to calculate the moisture uptake/release by hygroscopic materials exposed to different types of humidity variations. Secondly, a simplified two-bottle test method is proposed to measure the MBV in the present study. The impact of moisture buffering on building energy consumption in different climate conditions is assessed by using numerical simulations. The results show that the potential energy saving rate could be up to 25–30% when using proper hygroscopic materials in the test building in temperate climates and semi-arid climates. Finally, the relationship between MBV and potential energy saving rate is also discussed.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Nanjing University
Authors: Zhang, M. (Ekstern), Qin, M. (Intern), Rode, C. (Intern), Chen, Z. (Ekstern)
Number of pages: 9
Pages: 337-345
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information
Journal: Applied Thermal Engineering
Volume: 124
ISSN (Print): 1359-4311
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.78 SJR 1.462 SNIP 1.828
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.734 SNIP 1.898 CiteScore 3.32
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.576 SNIP 2.206 CiteScore 3.16
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.516 SNIP 2.5 CiteScore 3.31
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.54 SNIP 2.432 CiteScore 2.7
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.389 SNIP 2.186 CiteScore 2.83
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.425 SNIP 2.045
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.435 SNIP 2.126
Web of Science (2009): Indexed yes
Moisture damage with magnesium oxide boards in Danish facade structures
Magnesium oxide boards have been widely used on facades in Denmark during 2010-2015. However, the magnesium salts absorb humidity from the ambient, and they begin to leak salty water, which is highly corrosive, and leads to moisture and mould problems in wooden members of the structures. MgO-boards were not tested for their hygrothermal function before being used on exterior wall structures, which has had detrimental consequences, such as an expected cost of repair of around 2 billion DKK. Properties for moisture transport and retention properties have been determined and will be shown together with some examples of damaged structures.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Section for Building Design, Bunch Bygningsfysik ApS
Authors: Rode, C. (Intern), Bunch-Nielsen, T. (Ekstern), Hansen, K. K. (Intern), Grelk, B. (Intern)
Pages: 765-770
Publication date: 2017
Conference: 11th Nordic Symposium on Building Physics, Trondheim, Norway, 11/06/2017 - 11/06/2017
Main Research Area: Technical/natural sciences

Publication information
Journal: Energy Procedia
Volume: 132
ISSN (Print): 1876-6102
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.16 SJR 0.467 SNIP 0.586
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.365 SNIP 0.561 CiteScore 0.92
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.433 SNIP 0.81 CiteScore 1.09
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.425 SNIP 0.785 CiteScore 1.02
ISI indexed (2013): ISI indexed no
Web of Science (2013): Indexed yes
Scopus rating (2012): SJR 0.425 SNIP 0.563 CiteScore 1.08
New criteria for assessing low wind environment at pedestrian level in Hong Kong

The choice of proper wind comfort criterion is considered to be crucial to reliable assessment of pedestrian level wind comfort. This paper aims to propose a wind comfort criterion that can be applied to Hong Kong, in which the wind comfort is seriously deteriorated by the moderated airflow, particularly in the hot and humid summer. By thoroughly reviewing and comparing exiting wind comfort criteria, the parameters in Lawson (1978) criterion are adopted for acceptable, tolerable and intolerable category and the parameters in NEN8100 (2006) criterion are adopted for danger category in the proposed criteria. Besides, a low wind parameter suggested by AVA scheme (2005) is adopted for unfavourable category in summer criterion. The adopted parameters provide scientific foundations and they are carefully chosen to adapt the weak wind conditions. The prominent features of the criteria are proposed seasonally (summer and winter, respectively) and the overall mean wind velocity ratio (OMVR) is used as threshold wind velocity parameter. The wind tunnel tests of Hong Kong Polytechnic University (HKPolyU) campus model were used as a case study. The results show that the proposed criteria can reasonably represent the weak wind condition and provide suitable assessments of the wind comfort in Hong Kong. Moreover, the findings in this study provide scientific basis for future policy-making and the proposed criteria can also help city planners to improve the pedestrian level wind comfort.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Hong Kong Polytechnic University, University of Western Sydney, University of Sydney, Hong Kong Observatory
Authors: Du, Y. (Ekstern), Mak, C. M. (Ekstern), Kwok, K. (Ekstern), Tse, K. (Ekstern), Lee, T. (Ekstern), Ai, Z. (Intern), Liu, J. (Ekstern), Niu, J. (Ekstern)
Number of pages: 14
Pages: 23-36
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information
Journal: Building and Environment
Volume: 123
ISSN (Print): 0360-1323
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.51 SJR 2.015 SNIP 2.198
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 2.093 SNIP 2.49 CiteScore 4.37
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.938 SNIP 2.797 CiteScore 4.14
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
This study reports the development of occupancy, lighting and appliance hourly schedules for new energy calculation input data standards. Developed schedules apply for 10 building categories which are described by one to three space categories, and include the separation between weekdays and weekends if needed. The approach used allowed to keep the full set of schedules compact and easy to implement in building energy simulation tools. The average values can be used in monthly calculation tools. Occupant density values have local nature and occupancy patterns also depend on culture. The structure of the schedules, i.e. the way how the occupancy patterns are described, may be seen as an original result and its application has no geographical limitations. The main focus of the study was in the occupancy heat emission modeling and schedule development for prEN16798-1 and ISO/FDIS 17772-1 standards, supported by appliances and lighting schedules which are similarly needed as energy calculation input data. Hourly schedules allow to model occupant behaviour effects, for instance the peak cooling load in an office room was increased by factor of 1.1–1.3 compared to the use of constant average value. Single office schedule increased the delivered cooling energy by 8% compared to an open plan office schedule. The findings emphasize the importance of realistic schedules for specific categories of buildings.
Optimal scheduling for electric heat booster under day-ahead electricity and heat pricing

Multi-energy system (MES) operation calls for active management of flexible resources across energy sectors to improve efficiency and meet challenging environmental targets. Electric heat booster, a solution for Domestic Hot Water (DHW) preparation under Low-Temperature-District-Heating (LTDH) context, is identified as one of aforementioned flexible resources for electricity and heat sectors. This paper extends the concept of optimal load scheduling under day-ahead pricing from electricity sector only to both electricity and heat sectors. A case study constructing day-ahead energy prices to shift energy consumption to low carbon content energy is provided. Results show that 0.5 DKK/kWhel add-ons on top of electricity spot price makes electricity and heat price not comparable such that electricity price variation will have no impact on load scheduling. This result suggests aforementioned concept is not feasible with current Danish electricity taxation.

General information
State: Published
Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Energy System Management, Department of Civil Engineering, Section for Building Energy , Section for Indoor Climate and Building Physics
Authors: Cai, H. (Intern), You, S. (Intern), Bindner, H. W. (Intern), Klyapovskiy, S. (Intern), Yang, X. (Intern), Li, R. (Intern)
Number of pages: 4
Publication date: 2017

Host publication information
Title of host publication: Proceedings of the Universities Power Engineering Conference (UPEC), 2017 52nd International
Publisher: IEEE
Main Research Area: Technical/natural sciences
Conference: 52nd International Universities’ Power Engineering Conference, Heraklion, Greece, 28/08/2017 - 28/08/2017
Parametric analysis of the operation of nocturnal radiative cooling panels coupled with in room PCM ceiling panels

The scope of this parametric simulation study was to identify the optimal combination of set-points for different parameters of a radiant PCM ceiling panels cooling system that will result in the best indoor thermal environment with the least possible energy use. The results showed that for each parameter examined, a different set-point value was optimal for the thermal environment than the value that was optimal for the reduction of energy use. Therefore, two additional simulations were run, one with the combination of set-point values that resulted in the improvement of the thermal environment and one with the set-point values resulting in the reduction of energy use. In the first case, the temperature was within the range of Category III of EN 15251 (23 – 26°C, 73.4 – 78.8°F) for 83.5% of the occupancy time, while in the second case it was within Category III for 39.4%. In the first simulation, the energy usage of the pumps and the heat pump was 178 kWh, 608 kBtu, while for the second one it was 36 kWh, 121 kBtu. It was concluded that the optimal combination of set-point values to provide the most comfortable thermal environment was to activate the pump circulating water to the PCM no earlier than 03:00 and get activated when the temperature in the storage tank was below 21°C, 69.8°F, activate the heat pump no earlier than 05:00 and get activated when the temperature in the storage tank was below 15°C, 59°F, and lastly have a temperature difference between the output of the solar panels and the temperature in the middle of the storage tanks of 5 K, 9°F.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Polytechnic University of Catalonia
Authors: Bourdakis, E. (Intern), Kazanci, O. B. (Intern), Péan, T. (Ekstern), Olesen, B. W. (Intern)
Number of pages: 8
Publication date: 2017

Performance, acute health symptoms and physiological responses during exposure to high air temperature and carbon dioxide concentration

Human subjects were exposed for 3 h in a climate chamber to the air temperature of 35 °C that is an action level, at which the working time needs to be diminished in China. The purpose was to put this action level to test by measuring physiological responses, subjective ratings and cognitive performance, and compare them with responses at temperature of 26 °C (reference exposure). Moreover, CO₂ was increased to 3000 ppm (CO₂ exposure) at 35 °C to further examine, whether this change will have any effect on the measured responses. Compared with the reference exposure, exposure to 35 °C caused subjects to report feeling uncomfortably warm, to rate the air quality as worse, to report increased sleepiness and higher intensity of several acute health symptoms. Eardrum temperature, skin temperature, heart rate and body weight loss all increased significantly at this exposure, arterial oxygen saturation decreased significantly, while the percentage of adjacent inter-beat cardiac intervals differing by > 50 m (pNN50) decreased significantly, indicating elevated stress. The performance of addition and subtraction tasks decreased significantly during this exposure, as well. Increasing CO₂ to 3000 ppm at 35 °C caused no significant changes in responses. Present results reaffirm the selection of 35 °C as an action level, and show that concurrently occurring high CO₂ levels should not exacerbate the hazards.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Central South University
Authors: Liu, W. (Intern), Zhong, W. (Ekstern), Wargocki, P. (Intern)
Number of pages: 10
Pages: 96-105
Publication date: 2017
Main Research Area: Technical/natural sciences
Performance evaluation of radiant and convective cooling/heating systems & Survey on HVAC related potential research themes for office buildings - Final Report

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics
Authors: Kazanci, O. B. (Intern), Khovalyg, D. (Intern), Olesen, B. W. (Intern)
Number of pages: 135
Publication date: 2017

Performance maps for the control of thermal energy storage
Predictive control in building energy systems requires the integration of the building, building system, and component dynamics. The prediction accuracy of these dynamics is crucial for practical applications. This paper introduces performance maps for the control of water tanks, phase change material tanks, and thermochemical material tanks. The results show that these performance maps can fully account for the dynamics of thermal energy storage tanks.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Eindhoven University of Technology
Authors: Finck, C. (Ekstern), Li, R. (Intern), Zeiler, W. (Ekstern)
Pages: 1387-1393
Publication date: 2017

Phase Change Humidity Control Material and its Application in Buildings
The synthesis of novel phase change humidity control material (PCHCM) was achieved by using composite microencapsulated phase change material (MPCM) and hygroscopic material. The PCHCM composite can moderate indoor hygrothermal fluctuations by absorbing or releasing both heat and moisture. The MPCM was synthesized by the microencapsulated phase change material (PCM) with SiO2 shell. The diatomite was used as hygroscopic material. The morphology of MPCM and PCHCM were measured by scanning electron microscopy (SEM). The thermal properties of the new composites were analyzed with differential scanning calorimetry (DSC). The thermal gravimetric analysis (TGA) was used to study the thermal stability. Both the moisture transfer coefficient and moisture buffer value (MBV) of the PCHCM were measured by two bottle method. The DSC results show that the super-cooling degrees of microcapsule and PCHCM are lower than pure PCM. Both the moisture transfer coefficients and the MBV of PCHCM are higher than pure hygroscopic materials. The influence of PCHCM on indoor hygrothermal environment and building energy consumption was also studied. The results show that the PCHCM can effectively regulate the indoor temperature and relative humidity, thus own a potential energy saving rate of 18% for the test building in research. The overall hygrothermal performance of PCHCM is better than the simple combination of two separate layers of PCM and hygroscopic materials. The PCHCM could be used as an innovative passive material to improve the building energy efficiency.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Nanjing University
Authors: Wu, Z. (Ekstern), Qin, M. (Intern), Chen, Z. (Ekstern)
Number of pages: 8
Pages: 1011-1018
Publication date: 2017
Physiological responses during exposure to carbon dioxide and bioeffluents at levels typically occurring indoors

Twenty-five subjects were exposed to different levels of carbon dioxide (CO₂) and bioeffluents. The ventilation rate was set high enough to create a reference condition of 500 ppm CO₂ with subjects present; additional CO₂ was then added to supply air to reach levels of 1000 or 3000 ppm, or the ventilation rate was reduced to allow metabolically generated CO₂ to reach the same two levels (bioeffluents increased as well). Heart rate, blood pressure, end-tidal CO₂ (ETCO₂), oxygen saturation of blood (SPO₂), respiration rate, nasal peak flow, and forced expiration were monitored, and the levels of salivary α-amylase and cortisol were analyzed. The subjects performed a number of mental tasks during exposures and assessed their levels of comfort and the intensity of their acute health symptoms. During exposure to CO₂ at 3000 ppm, when CO₂ was added or ventilation was restricted, ETCO₂ increased more and heart rate decreased less than the changes that occurred in the reference condition. Exposure to bioeffluents, when metabolically generated CO₂ was at 3000 ppm, significantly increased diastolic blood pressure and salivary α-amylase level compared with pre-exposure levels, and reduced the performance of a cue-utilization test: These effects may suggest higher arousal/stress. A model is proposed describing how mental performance is affected by exposure to bioeffluents.

General information

State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Technical University of Denmark, Shanghai Jiao Tong University
Authors: Zhang, X. (Ekstern), Wargocki, P. (Intern), Lian, Z. (Ekstern)
Pages: 65-77
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information

Journal: Indoor Air
Volume: 27
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Physically harmful secondary metabolites produced by indoor *Chaetomium* species on artificially and naturally contaminated building materials

The presence of the fungal genus *Chaetomium* and its secondary metabolites in indoor environments is suspected to have a negative impact on human health and wellbeing. About 200 metabolites have been currently described from *Chaetomium* spp., but only the bioactive compound group, chaetoglobosins, have been screened for, and thus detected in buildings. In this study, we used a liquid chromatography-high resolution mass spectrometry approach to screen both...
artificially and naturally infected building materials for all the *Chaetomium* metabolites described in the literature. Pure agar cultures were also investigated in order to establish differences between metabolite production *in vitro* and on building materials as well as comparison to non-indoor reference strains. On building materials six different chaetoglobosins were detected in total concentrations of up to 950 mg/m² from *C. globosum* along with three different chaetoviridins/chaetomugilins in concentrations up to 200 mg/m². Indoor *Chaetomium* spp. preferred wood-based materials over gypsum, both in terms of growth rate and metabolite production. Cochliodones were detected for the first time on all building materials infected by both *C. globosum* and *C. elatum*, and are thus candidates as *Chaetomium* biomarkers. No sterigmatocystin was produced by *Chaetomium* spp. from indoor environment.

**General information**

*State:* Published

*Organisations:* Department of Systems Biology, Metabolomics Platform, Department of Civil Engineering, Section for Indoor Climate and Building Physics

*Authors:* Dosen, I. (Intern), Nielsen, K. F. (Intern), Clausen, G. (Intern), Andersen, B. (Intern)

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- Web of Science (2018): Indexed yes
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- BFI (2016): BFI-level 1
- Scopus rating (2016): CiteScore 3.55
- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 1
- Scopus rating (2015): CiteScore 3.88
- Web of Science (2015): Indexed yes
- BFI (2014): BFI-level 1
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- Web of Science (2014): Indexed yes
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- Scopus rating (2013): CiteScore 3.63
- ISI indexed (2013): ISI indexed yes
- Web of Science (2013): Indexed yes
- BFI (2012): BFI-level 1
- Scopus rating (2012): CiteScore 2.72
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- Scopus rating (2011): CiteScore 2.42
- ISI indexed (2011): ISI indexed yes
- Web of Science (2011): Indexed yes
- BFI (2010): BFI-level 2
- Web of Science (2010): Indexed yes
- BFI (2009): BFI-level 2
- Web of Science (2009): Indexed yes
- BFI (2008): BFI-level 1
- Scopus rating (2008): SJR 0.757 SNIP 2.168
- Web of Science (2008): Indexed yes
- Scopus rating (2007): SJR 0.933 SNIP 3.724
- Web of Science (2007): Indexed yes
**PV-PCM integration in glazed building. Co-simulation and genetic optimization study**

The study describes a multi-objective optimization algorithm for an innovative integration of forced ventilated PV-PCM modules in glazed façade buildings: the aim is to identify and optimize the parameters that most affect thermal and energy performances. 1-D model, finite difference method FDM, thermal resistances technique and enthalpy method were applied to describe different façade solutions and transient thermal performance of PCM. The coupling between the PV-PCM façade code implemented in MATLAB and the TRNSYS software was developed to estimate the dynamic thermal energy profiles. An exploratory step has also been considered prior to the optimization algorithm: it evaluates the energy profiles before and after the application of PCM to PV module integrated in glazed building. The optimization analysis investigate parameters such as ventilation flow rates and time schedule to obtain the best combination suiting the PCM performance and external-internal loads. A group of solution were identified on the Pareto front. Savings in thermal loads for the best individual reached 26.4% while the best in temperature increment in operating temperatures was recorded as 6.8% comparing to the design set temperature.

**General information**

**State:** Published  
**Organisations:** Department of Civil Engineering, Section for Indoor Climate and Building Physics, University of Padua  
**Authors:** Elarga, H. (Intern), Dal Monte, A. (Ekstern), Andersen, R. K. (Intern), Benini, E. (Ekstern)  
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BFI (2016): BFI-level 1  
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BFI (2015): BFI-level 1  
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BFI (2014): BFI-level 1  
Scopus rating (2014): SJR 1.938 SNIP 2.797 CiteScore 4.14  
Web of Science (2014): Indexed yes
Renovering af skoleventilation – Elevernes velvære og præstationer

General information
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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics
Authors: Toftum, J. (Intern), Wargocki, P. (Intern)
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ISI indexed (2013): ISI indexed no

BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.581 SNIP 2.602 CiteScore 3.57
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.331 SNIP 2.875 CiteScore 3.06
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.144 SNIP 2.255 CiteScore 2.76
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.235 SNIP 2.001
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.028 SNIP 1.865
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.924 SNIP 1.38
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.788 SNIP 1.778
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.03 SNIP 1.63
Scopus rating (2005): SJR 0.955 SNIP 1.225
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 0.548 SNIP 1.266
Scopus rating (2003): SJR 0.948 SNIP 0.921
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.998 SNIP 1.39
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.777 SNIP 1.098
Scopus rating (2000): SJR 0.526 SNIP 1.14
Scopus rating (1999): SJR 0.564 SNIP 1.175
Original language: English
DOIs:
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Publication: Research - peer-review > Journal article – Annual report year: 2017
Responses to Human Bioeffluents at Levels Recommended by Ventilation Standards

The purpose of this study was to examine whether exposure to human bioeffluents, at the levels recommended by the current ventilation standards, would cause any effects on humans. Ten subjects were exposed in a low-emission stainless-steel climate chamber for 4.25 hours. The outdoor air supply rate was set to 33 or 4 l/s per person, creating two levels of bioeffluents with carbon dioxide (CO₂) at 500 or 1600 ppm. Subjective ratings were collected, cognitive performance was examined and physiological responses were monitored. The results show that exposures to human bioeffluents at ventilation rate of 4 l/s per person caused sensory discomfort of visitors, reduced pNN50 (a domain of ECG measurement), but did not produce negative effects on cognitive performance or health symptoms.
SciCloud: A Scientific Cloud and Management Platform for Smart City Data

The pervasive use of Internet of Things and smart meter technologies in smart cities increases the complexity of managing the data, due to their sizes, diversity, and privacy issues. This requires an innovative solution to process and manage the data effectively. This paper presents an elastic private scientific cloud, SciCloud, to tackle these grand challenges. SciCloud provides on-demand computing resource provisions, a scalable data management platform and an in-place data analytics environment to support the scientific research using smart city data.

General information

State: Published
Organisations: Department of Management Engineering, Systems Analysis, Department of Civil Engineering, Section for Building Energy, Section for Indoor Climate and Building Physics
Authors: Liu, X. (Intern), Nielsen, P. S. (Intern), Heller, A. (Intern), Gianniou, P. (Intern)
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ISBN (Electronic): 978-1-5386-1051-0
Main Research Area: Technical/natural sciences
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output.pdf
DOIs:
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2017

Sensitivity of energy and exergy performances of heating and cooling systems to auxiliary components

Heating and cooling systems in buildings consist of three main subsystems: heating/cooling plant, distribution system, and indoor terminal unit. The choice of indoor terminal unit determines the characteristics of the distribution system and the heating and cooling plants that can be used.

Different forms of energy (electricity and heat) are used in heating and cooling systems, and therefore, a holistic approach to system design and analysis is needed. In particular, distribution systems use electricity as a direct input to pumps and fans, and to other components. Therefore, exergy concept should be used in design and analysis of the whole heating and cooling systems, in addition to the energy analysis.

In this study, water-based (floor heating and cooling, and radiator heating) and air-based (air heating and cooling) heating and cooling systems were compared in terms of their energy use and exergy consumption for auxiliary components (pumps and fans). The effects of the auxiliary components on whole system energy and exergy performance were identified.
Water-based heating systems required 68% lower auxiliary exergy input than the warm-air heating system with heat recovery, and floor cooling system required 53% lower auxiliary exergy input than the air cooling system, showing a clear benefit for the water-based systems over the air-based systems. The auxiliary energy and exergy input to different systems is an important parameter for the whole system performance. Its effects become more pronounced and can be studied better in terms of exergy than energy. The required exergy input to the power plant for space heating and cooling purposes are comparable to the required exergy input for auxiliary components. The exergy input to auxiliary components should be minimized to fully benefit from the water-based low temperature heating and high temperature cooling systems, and in general in heating and cooling systems, and to integrate effectively the renewable energy resources to building heating and cooling systems.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Tokyo City University
Authors: Kazanci, O. B. (Intern), Shukuya, M. (Ekstern), Olesen, B. W. (Intern)
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Strengthening requirement specification in sustainable procurement - an investigation of challenges
To reap the benefits of sustainability in the construction sector, it is crucial that the stakeholders involved can implement it in practice. Investigations have shown that choices made in the early phases of the building process are of very great importance for the outcome and the initiatives and decisions taken by the building owner are crucial. This paper presents research on Danish building practitioners' ability to make requirements for sustainability in procurement. On the basis of an action research strategy, we asked practitioners to help identify the challenges involved in requiring sustainable solutions through procurement. These included among others a lack of knowledge or experience in sustainable procurement and interdisciplinary challenges. The research showed that practitioners are able to formulate specific requirements for sustainability in procurement. However the challenges found imply that a sustainable approach in procurement is not fully implemented in a Danish context. This suggests that there is a need for guidance in the area, if the practitioners are to move from good intentions to making more specific requirements for sustainability in procurement.

General information
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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Section for Building Design
Authors: Eriksen, M. S. H. (Intern), Bjarlev, S. P. (Intern), Rode, C. (Intern)
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Web of Science (2017): Indexed yes
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Web of Science (2016): Indexed yes
Scopus rating (2015): SJR 0.217 SNIP 0.476 CiteScore 0.34
Subjective rating and objective evaluation of the acoustic and indoor climate conditions in video conferencing rooms

Today, face-to-face meetings are frequently replaced by video conferences in order to reduce costs and carbon footprint related to travels and to increase the company efficiency. Yet, complaints about the difficulty of understanding the speech of the participants in both rooms of the video conference occur. The aim of this study is to find out the main causes of difficulties in speech communication. Correlation studies between subjective perceptions were conducted through questionnaires and objective acoustic and indoor climate parameters related to video conferencing. Based on four single-room and three combined-room measurements, it was found that the traditional measure of speech, such as the speech transmission index, was not correlated with the subjective classifications. Thus, a correlation analysis was conducted as an attempt to find the hidden factors behind the subjective perceptions, revealing the speech intelligibility during video conferencing was highly correlated to EDT, D50, and MTI in the 125 Hz frequency band.

General information
State: Published
Organisations: Department of Electrical Engineering, Acoustic Technology, Department of Civil Engineering, Section for Indoor Climate and Building Physics, Technical University of Denmark, Rambøll Danmark A/S
Authors: Hauervig-Jørgensen, C. (Ekstern), Jeong, C. (Intern), Toftum, J. (Intern), Christensen, E. C. (Ekstern)
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Source-ID: 134381165
Publication: Research - peer-review › Article in proceedings – Annual report year: 2017

Synthesis and characteristics of composite phase change humidity control materials
A new kind of phase change humidity control material (PCHCM) was prepared by using PCM microcapsules and different hygroscopic porous materials. The PCHCM composite can regulate the indoor hygrothermal environment by absorbing or releasing both heat and moisture. The PCM microcapsules were synthesized with methyl triethoxysilane by the sol–gel method. The vesuvianite, sepiolite and zeolite were used as hygroscopic materials. The scanning electron microscopy (SEM) was used to measure the morphology profiles of the microcapsules and PCHCM. The differential scanning calorimetry (DSC) and the thermal gravimetric analysis (TGA) were used to determine the thermal properties and thermal stability. Both the moisture transfer coefficient and moisture buffer value (MBV) of different PCHCMs were measured by the improved cup method. The DSC results showed that the SiO2 shell can reduce the super-cooling degree of PCM. The super-cooling degrees of microcapsules and PCHCM are lower than that of the pure PCM. The onset temperature of thermal degradation of the microcapsules and PCHCMs is higher than that of pure PCM. Both the moisture transfer coefficient and MBV of PCHCMs are higher than that of the pure hygroscopic materials. The results indicated the PCHCMs have better thermal properties and moisture buffer ability.
Ten questions about radiant heating and cooling systems

Radiant heating and cooling (RHC) systems are being increasingly applied not only in residential but also in non-residential buildings such as commercial buildings, education facilities, and even large scale buildings such as airport terminals. Furthermore, with the combined ventilation system used to handle latent load, the radiant cooling system has proven applicable in hot and humid climates. It is well known that the RHC system has advantages of low draught risk, quiet operation, low energy consumption, and ability for design integration with building elements. These merits have motivated numerous studies on RHC systems in terms of comfort, heat transfer analysis, energy simulation, control strategy, system configurations and so on. Many studies have demonstrated that the RHC system is a good solution to improve indoor environmental quality while reducing building energy consumption for heating and cooling. On the other hand, the RHC system has limitations such as complicated control of Thermally Activated Building System (TABS), acoustical issues, higher capital cost and cooling load than conventional air systems, and so on. For now, the required mitigation of these limitations and the need to extend the applicability of the RHC system are providing the continuous impetus for research on RHC systems. This paper summarizes the important issues involved in the research on RHC system, whereby ten questions and answers concerning the RHC system are discussed, which will help researchers to conduct relevant studies.
This paper investigates the concern that green buildings may promote energy efficiency and other aspects of sustainability, but not necessarily the health and well-being of occupants through better indoor air quality (IAQ). We ask ten questions to explore IAQ challenges for green buildings as well as opportunities to improve IAQ within green buildings and their programs. Our focus is on IAQ, while recognizing that many factors influence human health and the healthfulness of a building. We begin with an overview of green buildings, IAQ, and whether and how green building certifications address IAQ. Next, we examine evidence on whether green buildings have better IAQ than comparable conventional buildings. Then, we identify so-called green practices and green products that can have unintended and unfavorable effects on IAQ. Looking ahead, we offer both immediate and longer-term actions, and a set of research questions, that can help green buildings to more effectively promote IAQ. This article supports a growing recognition of the importance of IAQ in green buildings, and the opportunities for improvements. As the World Green Building Council [95] and others have emphasized, people are the most valuable asset of organizations, and efforts to improve IAQ can improve health, well-being, productivity, and profitability.

Ten questions concerning green buildings and indoor air quality

This paper investigates the concern that green buildings may promote energy efficiency and other aspects of sustainability, but not necessarily the health and well-being of occupants through better indoor air quality (IAQ). We ask ten questions to explore IAQ challenges for green buildings as well as opportunities to improve IAQ within green buildings and their programs. Our focus is on IAQ, while recognizing that many factors influence human health and the healthfulness of a building. We begin with an overview of green buildings, IAQ, and whether and how green building certifications address IAQ. Next, we examine evidence on whether green buildings have better IAQ than comparable conventional buildings. Then, we identify so-called green practices and green products that can have unintended and unfavorable effects on IAQ. Looking ahead, we offer both immediate and longer-term actions, and a set of research questions, that can help green buildings to more effectively promote IAQ. This article supports a growing recognition of the importance of IAQ in green buildings, and the opportunities for improvements. As the World Green Building Council [95] and others have emphasized, people are the most valuable asset of organizations, and efforts to improve IAQ can improve health, well-being, productivity, and profitability.
Ten questions concerning thermal and indoor air quality effects on the performance of office work and schoolwork

Energy conservation in buildings as a way to reduce the emission of greenhouse gases is forcing an urgent re-examination of how closely thermal and air quality conditions should be controlled in buildings. Allowing conditions to drift outside the optimum range would conserve very large amounts of energy and would in most cases have only marginal effects on health or subjective comfort. The question that then arises is whether occupant performance would be negatively affected and if so, by how much. This information is required for cost-benefit analyses. The answers in this paper are based on laboratory and field experiments that have been carried out since the massive increase in energy costs that took place in the 1970s. Although only a few of the mechanisms by which indoor environmental effects occur have been identified, it is already clear that any economies achieved by energy conservation will be greatly exceeded by the costs incurred due to decreased performance. Reducing emissions by allowing indoor environmental conditions to deteriorate would thus be so expensive that it would justify greatly increased investment in more efficient use of energy in buildings in which conditions are not allowed to deteriorate. Labour costs in buildings exceed energy costs by two orders of magnitude, and as even the thermal and air quality conditions that the majority of building occupants currently accept can be shown to reduce performance by 5e10% for adults and by 15e30% for children, we cannot afford to allow them to deteriorate still further.
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Theoretical modelling and experimental study of air thermal conditioning process of a heat pump assisted solid desiccant cooling system

Taking the integrated gaseous contaminants and moisture adsorption potential of desiccant material, a new heat pump assisted solid desiccant cooling system (HP-SDC) was proposed based on the combination of desiccant rotor with heat pump. The HP-SDC was designed for dehumidification, cooling and air purification aimed at improving indoor air quality and reducing building energy consumption. The heat and moisture transfer in adsorption desiccant rotor was theoretical modelled with one-dimensional partial differential equations. The theoretical model was validated with experimental measurements, and the results showed the model could be used to predict the heat and moisture transfer in desiccant rotor. The air thermal conditioning process and energy consumption of HP-SDC was then experimental measured under varied outdoor thermal environments. Results showed that compared to conventional ventilation system, the energy performance of HP-SDC was more efficient mainly due to high efficient air purification capacity, reduction of cooling load and raised evaporation temperature. The energy performance of HP-SDC was sensitive to outdoor humidity ratio. Further improvements of HP-SDC energy efficiency are suggested to be focused on low regeneration temperature desiccant rotor and more efficient high temperature refrigerant.
Thermal environment in a simulated double office room with convective and radiant cooling systems

The thermal environment in a double office room obtained with chilled beam (CB), chilled beam with radiant panel (CBR), chilled ceiling with ceiling installed mixing ventilation (CCMV) and overhead mixing total volume ventilation (MTVV) under summer (cooling) condition was compared. Design (peak) and usual (average) heat load from solar radiation, office equipment, lighting and occupants was simulated, respectively at 62 W/m² and 38 W/m² under four different workstation layouts. Air temperature, globe (operative) temperature, radiant asymmetry, air velocity and turbulent intensity were measured and draught rate was calculated. Manikin-based equivalent temperature (MBET) was determined by using two thermal manikins. CCMV provided slightly more uniform thermal environment and the least sensitive to different workstation layouts than the other systems. CB provided a bit higher draught rate levels than CCMV especially in the design heat load cases. With CBR, the thermal environment was found to be between CB and CCMV. MTVV generated high draught level under the tested design heat load cases. All cooling systems generated similar thermal environment in the usual heat load cases. It would be recommended to include the measurement height of 0.05 m in indoor climate testing standards for obtaining more generic view of the draught risk.

General information

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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Halton OY, NIRAS A/S, Silesian University of Technology, Technical University of Denmark, Aalto University
Authors: Mustakallio, P. (Ekstern), Bolashikov, Z. D. (Ekstern), Rezgals, L. (Ekstern), Lipczynska, A. (Ekstern), Melikov, A. K. (Intern), Kosonen, R. (Ekstern)
Towards the definition of indicators for assessment of indoor air quality and energy performance in low-energy residential buildings

A major obstacle for integrating energy and indoor air quality (IAQ) strategies in the design and optimization of buildings is the non-existence of an agreed measure, which can quantitatively describes the IAQ and will allow the assessment of measures to improve energy performance. A complication to develop such an IAQ index is that hundreds of chemical compounds are present in indoor air, including residential environments, at concentrations much lower than occurring during occupational exposures. There is a lack of clear consensus on which pollutant or group of pollutants should be used to form such an index as well as on how they should be integrated into one index. IEA EBC Annex 68 was formed with the objective to discuss Indoor Air Quality Design and Control in Low Energy Residential Buildings. The objective of Subtask 1 of this Annex described in this paper was to review, discuss and propose methods and approaches to define an IAQ index and to develop such an index so that it can be used as a key performance indicator to examine the methods to control IAQ, which are integral parts of other subtasks in this IEA EBC project. To meet this objective, the pollutants measured in low-energy houses were compared with pollutants measured in traditional houses. Pollutants measured and known to be harmful for health were identified and selected to be represented on a list of pollutants that should be considered when the IAQ index is defined. The selected pollutants were: acetaldehyde, acrolein, α-pinene, benzene, carbon dioxide, formaldehyde, naphthalene, nitrogen dioxide, PM10, PM2.5, radon, styrene, toluene, trichloroethylene, TVOC and mould. Both short-term and long-term effects of these pollutants were considered. The compound with the highest ratio of concentration to its exposure limit value was proposed as the IAQ index for the short term effects so that the existing exposure limits could be referred to and to avoid problems associated with the aggregation of many air quality indices. The same approach was proposed for the IAQ index for the long-term effects together with the calculation of the burden of disease caused by the compounds of concern expressed as the sum of disability-adjusted life years. It is recognized that the proposed IAQ indices are crude, and the list of compounds is incomplete. It should be progressively updated once new data on exposure limits and pollutants of concern become available.
Accounting for the uncertainty related to building occupants with regards to visual comfort: A literature survey on drivers and models

The interactions between building occupants and control systems have a high influence on energy consumption and on indoor environmental quality. In the perspective of a future of "nearly-zero" energy buildings, it is crucial to analyse the energy-related interactions deeply to predict realistic energy use during the design stage. Since the reaction to thermal, acoustic, or visual stimuli is not the same for every human being, monitoring the behaviour inside buildings is an essential step to assert differences in energy consumption related to different interactions. Reliable information concerning occupants' behaviours in a building could contribute to a better evaluation of building energy performances and design robustness, as well as supporting the development of occupants' education to energy awareness. The present literature survey enlarges our understanding of which environmental conditions influence occupants' manual controlling of the system in offices and by consequence the energy consumption. The purpose of this study was to investigate the possible drivers for light-switching to model occupant behaviour in office buildings. The probability of switching lighting systems on
or off was related to the occupancy and differentiated for arrival, intermediate, and departure periods. The switching probability has been reported to be higher during the entering or the leaving time in relation to contextual variables. In the analysis of switch-on actions, users were often clustered between those who take daylight level into account and switch on lights only if necessary and people who totally disregard the natural lighting. This underlines the importance of how individuality is at the base of the definition of the different types of users.

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Airflow characteristics and pollution distribution around a thermal manikin - Impact of specific personal and indoor environmental factors
This study presents a summary of experimental measurements on the airflow characteristics and pollution distribution around a non-breathing thermal manikin. The two objectives are: (1) to examine the extent to which personal (body posture, clothing insulation, table positioning) and environmental factors (room air temperature and ventilation flow) affect the airflow characteristic (velocity and temperature) around the thermal manikin and (2) to examine the pollution distribution within the convective boundary layer (CBL) around a thermal manikin and personal exposure to two types of airborne pollutants under factors that influence the CBL. The results show that the CBL generated by the thermal manikin influenced the airflow characteristics and pollution distribution in the breathing zone. Parameters such as room air temperature, body posture, clothing insulation, table positioning, and ventilation flow considerably affected airflow characteristics and pollution distribution around the thermal manikin. Under the specific set of conditions studied, the most favorable airflow patterns in preventing the feet pollution from reaching the breathing zone was transverse flow from the front, as it minimized the exposure at the minimum supply air velocity. Certain airflow directions exhibited a nonlinear dependence between the supply airflow rate and personal exposure. This suggests that without a better understanding of the airflow patterns in a room, the ventilation rate may therefore be increased in vain.
Analysis of occupants' behavior related to the use of windows in German households

Real energy performances of buildings depend not only on deterministic aspects, such as building physics and HVAC systems, but also on stochastic aspects such as weather and occupants' behavior. Typically, occupant behavior is not adequately considered when calculating the expected performance. As a result, field test studies all over Europe have shown discrepancies between real and expected energy performance of buildings. In order to bridge this gap, stochastic occupants' behavior models could be embedded into building energy performance simulation software. In order to make such models, there is a need for a better understanding of occupants' behavior and in particular the reasons of their adjustments of building controls such as window opening, heating set points, etc. The purpose of this paper was to analyze window opening behavior in residential buildings, investigate which drivers lead occupants to interact with windows and how these actions can be modeled. A method to analyze the probability of a state change of the windows, based on logistic regression, was applied to monitored data (measured each minute) from two refurbished demonstration buildings. The weather and the five rooms of the 60 apartments located in the buildings were monitored in terms of air quality and thermal environment (presence of occupants was not monitored) during four years. The most common driver to open a window was the time of the day, followed by the carbon dioxide concentration. The most common driver to close a window was the daily average outdoor temperature, followed by the time of the day. (C) 2016 Elsevier Ltd. All rights reserved.
Analysis of the occupants' behavior related to natural ventilation

The real energy performance of buildings depends both upon deterministic aspects (building's physics and engineering systems) and probabilistic aspects such as weather and occupant behavior. Occupant behavior is usually not directly considered when calculating the expected energy performance of buildings. In fact, field test studies all over the world have shown discrepancies between expectation and real energy performances of buildings. This gap could be bridged, by embedding stochastic occupants' behavior models within buildings' energy performances simulation software.
work, an established method to analyze the probability of a state change of the windows, based on logistic regression, was applied to monitored data (measured each minute) from two refurbished residential buildings. The weather as well as the five rooms of each of the 60 apartments located in the buildings were monitored in terms of indoor environmental quality and window operation for four years. The aim of this work is the investigation of the drivers leading occupants to open and close windows. The evaluation of the 300 windows showed: the two most common drivers leading to the opening action were the time of the day and the carbon dioxide concentration in the room. The two most common drivers leading to the closing action were: the daily average outdoor temperature, and the time of the day.

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Occupant behavior, Logistic regression, Natural ventilation, Buildings' energy performance, Case study

An International Project on Indoor Air Quality Design and Control in Low Energy Residential Buildings
In order to achieve nearly net zero energy use, both new and energy refurbished existing buildings will in the future need to be still more efficient and optimized. Since such buildings can be expected to be already well insulated, airtight, and have heat recovery systems installed, one of the next focal points to limiting energy consumption for thermally conditioning the indoor environment will be to possibly reducing the ventilation rate, or making it in a new way demand controlled. However, this must be done such that it does not have adverse effects on indoor air quality (IAQ).

Annex 68, Indoor Air Quality Design and Control in Low Energy Residential Buildings, is a project under IEA’s Energy Conservation in Buildings and Communities Program (EBC), which will endeavor to investigate how future residential buildings are able to have very high energy performance whilst providing comfortable and healthy indoor environments. New paradigms for demand control of ventilation will be investigated, which consider the pollution loads and occupancy in buildings. As well, the thermal and moisture conditions of such advanced building shall be considered because of interactions between the hygrothermal parameters, the chemical conditions, ventilation and the wellbeing of occupants. The project is divided into the five subtasks: 1. Defining the metrics. 2. Pollutant loads in residential buildings. 3. Modeling. 4. Strategies for design and control of buildings. 5. Field measurements and case studies. A flagship outcome of the project will be a guidebook on design and operation of ventilation in residential buildings to achieve high IAQ with least possible energy consumption. The paper illustrates the working program of each of these activities.

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Bed-integrated local exhaust ventilation system combined with local air cleaning for improved IAQ in hospital patient rooms

The performance of a ventilated mattress (VM) used as a bed-integrated local exhaust ventilation system combined with air cleaning fabric (acid-treated activated carbon fibre (ACF) fabric) was developed and studied. The separate and combined effect of the VM and the local air cleaning for reducing the exposure to body generated bio-effluents in a hospital room was determined. Full-scale experiments were conducted in a climate chamber furnished as a single-bed patient room. Two heated dummies were used to simulate a patient and a doctor in the room. The patient was lying on a bed equipped with the VM. The patient's body was covered with either a cotton sheet or with the ACF material used as a blanket. Ammonia gas released from the patient's groins simulated the body generated bio-effluents. At the location of the groins the surface area of the VM was perforated through which the contaminated air of the bed micro-environment was exhausted. Two modes of operation were studied: 1) the exhausted polluted air was discharged out of the room and 2) the polluted air was cleaned by the ACF material installed inside the mattress and recirculated back into the room. Both modes of operation efficiently reduced the generated bio-effluents in the room with about 70%. Reduction in the exposure to body-emitted ammonia was up to 96% when the VM was operated at only 1.5 L/s and the ACF was used as a blanket.
Beyond nearly zero-energy buildings: Experimental investigation of the thermal indoor environment and energy performance of a single-family house designed for plus-energy targets

A detached, one-story, single-family house in Denmark was operated with different heating and cooling strategies for 1 year. The strategies compared during the heating season were floor heating without ventilation, floor heating supplemented by warm air heating (ventilation system), and floor heating with heat recovery from exhaust air. During the cooling season, the house was cooled by floor cooling and was ventilated mechanically. Air and globe (operative, when applicable) temperatures at different heights at a central location were recorded. The thermal indoor environment, local thermal discomfort and overheating were evaluated based on EN 15251 (2007), EN ISO 7730 (2005), and DS 469 (2013), respectively. Energy performance was evaluated based on the energy production and HVAC system energy use. The thermal indoor environment during the heating season was satisfactory but it was not possible to reach the intended
operative temperature when the outside temperatures were very low. During the cooling season, the cooling demand was high and overheating was a problem. Although the house was designed as a plus-energy house, it did not perform as one under the Danish climate conditions. It would be possible to decrease the heating and cooling demand during the design phase through careful consideration of parameters such as the orientation, glazing area, solar shading, and thermal mass. With a lower demand, plus-energy levels can be achieved even with the minimum contribution from the energy producing components.

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Can the interaction between occupant behaviour and the indoor environment in residences be influenced?

In the context of global climate change it has been broadly recognized that energy use in buildings must be reduced. In many cases this has been achieved by decreasing the natural infiltration rate in buildings by means of a focus on airtightness. Increasing airtightness does decrease energy use, but it also increases the impact of occupant behaviour on energy use and indoor environment.

In Denmark the indoor environment is directly linked to energy use for heating. In most buildings the indoor environment is controlled by the occupant (via thermostat setting, window opening), so any change in the occupants' control of the indoor environment will influence energy use.

Both older and more recent studies of the influence of occupant behaviour on energy use report that an increased information level and feedback on energy use can be effective in influencing occupant behaviour. The market penetration of smart meters has made it possible to measure and visualize energy use in real-time. Visualizing real-time consumption made it theoretically possible to provide feedback.

Some authors were reluctant to recommend feedback from smart meters and a national roll-out of this approach, as national savings would then depend on the truth of an unproven assumption: that all occupants will act adaptively when provided with more information. Their studies questioned the value of providing feedback to households not motivated to conserve energy and suggested that alternative approaches should be tested.

The purpose of this Ph.D. project was to investigate whether feedback on the indoor environment could be used to adaptively influence occupants' control of the indoor environment in such a way as to obtain healthy and comfortable homes and reduced energy use for heating. The project consisted of a literature study and four field studies that focused on how to affect occupants' control of the indoor environment. The four studies used measurements of the temperature, relative humidity, and CO₂ concentration in 84 rental apartments. The conclusions made in the thesis are derived from an analysis of the measurements performed in the apartments. The apartments were in three multi-storey buildings in three different municipalities of the Copenhagen area of Denmark.

The influence of how total heat cost was allocated between tenants was studied in two buildings and a significant influence on the control of indoor environment was demonstrated. The measurements indicated that heat cost allocation was a driver for occupants' behaviour. The measurements further showed the energy-saving potential of shifting from master-metering to submetering.

Two different feedback procedures were used to test the effect of providing indoor environmental feedback. The first method combined real-time feedback with monthly feedback letters. The second method combined real-time feedback with weekly feedback letters. The effects of the feedback procedures were investigated by using measurements, interviews and questionnaires.

Feedback on energy use gave occupants a monetary incentive and an environmental incentive to conserve energy. By using indoor environmental feedback it was possible to use health, comfort, monetary and environmental incentives to promote energy conservation.

The studies highlighted the importance of occupants being motivated to adapt their control of the indoor environment by acting on feedback. The results further indicated that occupants without a monetary incentive were not as interested in using the feedback as occupants with a monetary incentive.

The difference between the feedback procedures supported the findings of earlier studies, that feedback should be disseminated as frequently as possible. The studies demonstrated the importance of barrier-free access to real-time feedback, as even a little barrier caused the occupants to ignore the feedback. It is recommended that feedback should be disseminated by using a mobile platform, as a dedicated application, and not just through a website.
Daytime space cooling with phase change material ceiling panels discharged using rooftop photovoltaic/thermal panels and night-time ventilation

The possibility of using photovoltaic/thermal panels for producing cold water through the process of night-time radiative cooling was experimentally examined. The cold water was used to discharge phase change material in ceiling panels in a climatic chamber. Both night-time radiative cooling and night-time ventilation were used as the discharging method in five experiments, simulating summer conditions. The operative temperature remained within the range of Category III of standard DS/EN 15251 for 50% to 99% of the occupancy period. The percentage of electrical energy usage covered from the photovoltaic/thermal varied from 56% to 122%. The phase change material ceiling panels were thus, capable of providing an acceptable thermal environment and the photovoltaic/thermal panels were able to provide most of the required electricity and cold water needed for cooling.
Dermal uptake directly from air under transient conditions: advances in modeling and comparisons with experimental results for human subjects

To better understand the dermal exposure pathway, we enhance an existing mechanistic model of transdermal uptake by including skin surface lipids (SSL) and consider the impact of clothing. Addition of SSL increases the overall resistance to uptake of SVOCs from air but also allows for rapid transfer of SVOCs to sinks like clothing or clean air. We test the model by simulating di-ethyl phthalate (DEP) and di-n-butyl phthalate (DnBP) exposures of six bare-skinned (Weschler et al. 2015, Environ. Health Perspect., 123, 928) and one clothed participant (Morrison et al. 2016, J. Expo. Sci. Environ. Epidemiol., 26, 113). The model predicts total uptake values that are consistent with the measured values. For bare-skinned participants, the model predicts a normalized mass uptake of DEP of 3.1 (µg/m²)/(µg/m³), whereas the experimental results range from 1.0 to 4.3 (µg/m²)/(µg/m³); uptake of DnBP is somewhat overpredicted: 4.6 (µg/m²)/(µg/m³) vs. the experimental range of 0.5-3.2 (µg/m²)/(µg/m³). For the clothed participant, the model predicts higher than observed uptake for both species. Uncertainty in model inputs, including convective mass transfer coefficients, partition coefficients, and diffusion coefficients, could account for overpredictions. Simulations that include transfer of skin oil to clothing improve model predictions. A dynamic model that includes SSL is more sensitive to changes that impact external mass transfer such as putting on and removing clothes and bathing.
Dermal uptake of phthalates from clothing: comparison of model to human participant results

In this research, we extend a model of transdermal uptake of phthalates to include a layer of clothing. When compared with experimental results, this model better estimates dermal uptake of diethylphthalate (DEP) and di-n-butylphthalate (DnBP) than a previous model. It also demonstrates that uptake is sensitive to both the gap between skin and clothing and the time clothing is allowed to adsorb phthalates. The model predictions are consistent with the observation that exposed clothing increases dermal uptake when compared with uptake observed in bare-skin participants. Extension of this model beyond the cotton-phthalate system will be challenging until data on partition coefficients are quantified for other combinations of SVOCs, fabric materials and environmental conditions.

Det beboelige drivhus

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Diurnal and seasonal variation in air exchange rates and interzonal airflows measured by active and passive tracer gas in homes

Outdoor air delivery to buildings is an important parameter in the assessment of pollutant exposure indoors. Detailed and well controlled measurements of air exchange rates (AER) and interzonal airflows in residential environment are scarce. We measured the outdoor AERs in up to six rooms in five dwellings across four seasons using active tracer gas. Night time AERs were also estimated in the bedrooms based on occupant-generated CO2. Passive tracer gas measurements were performed for comparison. AERs changed frequently during the day. Differences in outdoor AERs were observed between individual rooms. Window opening behavior had a strong influence on AERs, which were highest during occupied daytime periods, lowest in the night; highest in the summer, lowest in the winter. Significant differences were found between AERs measured by the different techniques. The median nighttime AER in all bedrooms across the four seasons was 0.49 h⁻¹ with the active tracer gas technique and 1.20 h⁻¹ with the CO2 method. The average winter AER in the five homes with the passive tracer (0.63 h⁻¹) differed substantially from the corresponding AER measured with the active tracer gas (0.25 h⁻¹). Additionally, we studied the pollutant distribution from one room (source room) and interzonal airflows across the dwellings. The air within a given floor was well mixed, with the average tracer gas concentration in the non-source rooms reaching approximately 70% of the source room concentration. There was less air movement between different floors. The position of the internal doors had a strong influence on the air movement.

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Diurnal and seasonal variation in air exchange rates and interzonal flows measured by active tracer gas in five Danish homes

We measured the air exchange rates (AER) in up to six rooms in five naturally ventilated dwellings across four seasons using active tracer gas. Night time AER was also estimated in all bedrooms based on occupant-generated CO2. Additionally, we studied the pollutant distribution across the dwellings and airflows between rooms. Occupant behavior (window opening) strongly influenced the AERs. AERs...
were highest in the summer, lowest in the winter. Interzonal airflow measurements indicated that the air within a given floor is well mixed, while there is less air movement between different floors. The position of the internal doors (open/closed) had a strong influence on the air movements within the dwelling.

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Do new and renovated schools and kindergartens secure sufficiently high indoor environmental quality?

The present work is the part of the RENEW SCHOOL project granted by the Intelligent Energy Europe programme supported by European Commission. The aim is to promote sustainable renovation of educational buildings (schools and kindergartens) that use timber facades. The paper describes the measurements in educational buildings that are newly constructed or that have undergone energy renovation and use timber facades. The purpose of the measurements was to examine the quality of indoor environment in these buildings. The quality was assessed by physical measurements of temperature, relative humidity, light intensity and carbon dioxide concentration performed for a period of up to two months between January and April 2015. The measurements were carried out in one representative classroom in each building. The pupils assessed the classroom environment and rated the intensity of their acute health symptoms. Additionally the teachers assessed the environment in these buildings. To create the reference, measurements were also carried out in five conventional educational buildings, where no renovations were performed. The results suggest that the renovated and new buildings perform more or less similar as their conventional counterparts as regards measured parameters of indoor environment. Subjective evaluations made by pupils and teachers did not always match the physical measurements. There were also differences in subjective evaluations made by children and by teachers. In conclusion, there is no indication that the renovation of educational buildings would reduce indoor environmental quality conditions. Likewise, no considerable improvements are to be expected as well.

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Effect of building renovation on energy use and indoor environment: Comparison of simulations and measurements in six apartment buildings

Energy performance and the indoor environmental quality (IEQ) in three naturally ventilated original and three identical but renovated residential buildings were compared using actual measurements. Although the implemented energy saving measures had the potential to improve energy performance of the dwellings, they led to poorer indoor air quality (IAQ).
Additional simulations revealed that a simple intervention, such as using exhaust systems in kitchens and bathrooms and at the same time keeping doors of rooms open, may improve the IAQ in retrofitted multifamily buildings.

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**Effect of façade impregnation on feasibility of capillary active thermal internal insulation for a historic dormitory – A hygrothermal simulation study**
Internal insulation of external walls is known to create moisture performance challenges due to increased moisture levels and condensation risk on the cold side of the insulation. Capillary active/hydrophilic insulations have been introduced to solve these moisture problems, since they are able to transport liquid moisture to the inner surface and enable it to dry. Experience with this insulation type is rare in Denmark. In hygrothermal 1D computer simulations, several more or less capillary active insulation systems (AAC, calcium silicate, IQ-Therm) in various thicknesses (30–150 mm) have been tested for their hygrothermal performance. The original construction was a 228 mm solid brick masonry wall in a Copenhagen historic dormitory. All simulated systems showed critical relative humidity values above 80% and high risk of mould growth behind the insulation and some also on the interior surface. A moisture safe construction was only achieved when exterior façade impregnation shielding against driving rain was added. The best system showed acceptable relative humidity values both behind the insulation and on the interior surface, a significant increase in minimum temperature on the interior surface, and a reduction of heat loss through the external wall by 85%. The solely application of impregnation also resulted in a moisture safe solution with significant improvements in all parameters and heat loss reduction by 45%. The main conclusion is that capillary active insulation may not be feasible on solid bare masonry walls without additional driving rain protecting especially in case of multi-storey buildings with thin walls in high precipitation areas.

**General information**
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Organisations: Department of Civil Engineering, Section for Building Design, Section for Indoor Climate and Building Physics
Authors: Finken, G. R. (Intern), Bjarløv, S. P. (Intern), Peuhkuri, R. H. (Intern)
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Effect of Set-point Variation on Thermal Comfort and Energy Use in a Plus-energy Dwelling

When designing buildings and space conditioning systems, the occupant thermal comfort, health, and productivity are the main criteria to satisfy. However, this should be achieved with the most energy-efficient space conditioning systems (heating, cooling, and ventilation). Control strategy, set-points, and control dead-bands have a direct effect on the thermal environment in and the energy use of a building. The thermal environment in and the energy use of a building are associated with the thermal mass of the building and the control strategy, including set-points and control dead-bands. With thermally active building systems (TABS), temperatures are allowed to drift within the comfort zone, while in spaces with air-conditioning, temperatures in a narrower interval typically are aimed at. This behavior of radiant systems provides certain advantages regarding energy use, since the temperatures are allowed to drift, and it also allows the occupants to benefit from adaptive opportunities. This study presents the results of thermal environment measurements and energy use in a single-family dwelling during a one year period. A radiant floor heating and cooling system was used to condition the indoor space and the operative temperature set-points were varied during the heating and cooling seasons. The results show that a lower temperature set-point will result in a decreased energy use but it might require the occupants to adapt to slightly lower temperatures in the heating season, and vice versa in the cooling season. The terminal unit and the thermal mass of the building have significant effects on the applicability of lowered indoor temperature set-points.
Effects of Floor Covering Resistance of a Radiant Floor on System Energy and Exergy Performances

Floor covering resistance (material and thickness) can be influenced by subjective choices (architectural design, interior design, texture, etc.) with significant effects on the performance of a radiant heating and cooling system. To study the effects of floor covering resistance on system performance, a water-based radiant floor heating and cooling system (dry, wooden construction) was considered to be coupled to an air-to-water heat pump, and the effects of varying floor covering resistances (0.05 m²K/W, 0.09 m²K/W and 0.15 m²K/W) on system performance were analyzed in terms of energy and exergy.

In order to achieve the same heating and cooling outputs, higher average water temperatures are required in the heating mode (and lower temperatures in the cooling mode) with increasing floor covering resistance. These temperature requirements decrease the heat pump’s performance (lower coefficient of performance). This requires higher electricity input to the heat pump, corresponding to an increased exergy demand and consumption, to achieve the same space heating or cooling.

The required exergy input to the system (power plant where the electricity is generated) increased by 14% and 5% for heating and cooling, respectively. Increased floor covering resistance has a similar effect to an increased space heating or cooling load, on the water side of the radiant system while in fact the space heating and cooling loads are not changing. The floor covering resistance should be kept to a minimum in order not to hinder the performance of the floor heating/cooling and the whole system and to benefit from the low temperature heating and high temperature cooling potential.
Energiforbrug til ventilation på operationsstuer

Der stilles høje krav til indeklimaet på operationsstuer, både i forhold til hygiejne og termiske forhold. Dette stiller samtidig krav til de tekniske installationer og kan medføre et højt energiforbrug til drift af operationsstuerne. En af de mest energiforbrugende installationer er ventilationen, som typisk enten er Turbulent Air Flow (TAF) eller Laminar Air Flow (LAF). Denne artikel fokuserer på forskellen i energiforbrug ved anvendelse af de to ventilationsprincipper. En tidligere artikel beskrev fordelene ved brugen af LAF frem for TAF i forhold til en reduceret kontamineringsrisiko under operationer. Der er dog betænkeligheder omkring brugen af LAF frem for TAF, da kravet om højere luftmængder for LAF medfører et større energiforbrug.

General information

State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Technical University of Denmark
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Pages: 14-16
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Energy and exergy analyses of the benefits and limitations of air-to-air heat recovery

General information

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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Tokyo City University
Authors: Kazanci, O. B. (Intern), Shukuya, M. (Ekstern), Olesen, B. W. (Intern)
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Main Research Area: Technical/natural sciences
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Energy and Exergy Performances of Air-Based vs. Water-Based Heating and Cooling Systems: A Case Study of a Single-Family House

Different indoor terminal units can be used to heat and cool indoor spaces. These terminal units mostly rely on convection and radiation heat transfer mechanisms but their relative ratios can vary significantly for air-based and water-based systems with implications on whole system performance, in terms of energy and exergy. In addition to the energy and exergy input required at the heating and cooling plants, the energy use of auxiliary components (fans and pumps) also vary depending on the chosen terminal unit.

In order to study the energy and exergy performances of air-based and water-based systems, an air heating and cooling system, and a radiant floor heating and cooling system were chosen, respectively. A single-family house was used as a case study assuming that different space heating and cooling systems were used to condition the indoor space of this house. In addition to the thermal energy and exergy inputs to the system, energy and exergy inputs to the auxiliary components were also studied. Both heating and cooling cases were considered and three climatic zones were studied; Copenhagen (Denmark), Yokohama (Japan), and Ankara (Turkey).

The analysis showed that the water-based radiant heating and cooling system performed better than the air-based system both in terms of energy and exergy input to the heating/cooling plant. The relative benefits of the water-based system over the air-based system vary depending on the climatic zone. The air-based system also requires higher auxiliary energy input compared to the water-based system and this difference is mainly due to the required air-flow rates to address the heating and cooling demands, indicating a clear benefit for the water-based system over the air-based system.

The auxiliary energy and exergy input to different systems is an important parameter for the whole system performance and its effects become more pronounced and can be studied better in terms of exergy than energy. In order to fully benefit from the water-based systems, the auxiliary energy use should be minimized.

General information
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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Tokyo City University
Authors: Kazanci, O. B. (Intern), Shukuya, M. (Ekstern), Olesen, B. W. (Intern)
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Source: PublicationPreSubmission
Source-ID: 124336545
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2016

Energy concepts for self-supplying communities based on local and renewable energy sources: A case study from northern Germany
The reduction of GHG emissions in buildings is a focus area of national energy policies, because buildings are responsible for a major share of energy consumption. Policies to increase the share of renewable energies and energy efficiency measures are implemented at local scale. Municipalities, as responsible entities for physical planning, can hold a key role in transforming energy systems towards carbon-neutrality, based on renewable energies. The implementation should be approached at community scale, which has advantages compared to only focusing on buildings or cities. But community energy planning can be a complex and time-consuming process. Many municipalities hesitate to initiate such a process, because of missing guidelines and uncertainty about possible energy potentials. Case studies help to understand applied methodologies and could show available energy potentials in different local settings. The current case study presents a community energy concept for the inner-city of Elmshorn. By estimating the energy demand, consideration of local energy saving potentials, and available energy potentials within the community, it was possible to develop several energy system variants that virtually allow a heating energy and electricity supply fully based on local, renewable energy resources. The most feasible and cost-efficient variant is the use of local food production waste in a CHP plant feeding a district heating grid. The overall aim is to show that a self-sufficient heat- and electricity supply of typical urban communities is possible and can be implemented in a cost-efficient way, if the energy planning is done systematically and in coherence with urban planning.
EnergyLab Nordhavn – Progress and Physical Implementation

EnergyLab Nordhavn is a large-scale integrated research and demonstration project that contributes to the grand challenge of transforming the energy system to efficiently integrate a large share of renewable energy. The project focuses on a cost-effective future smart energy system that integrates multiple energy infrastructures (electricity, thermal, transportation) and provides an intelligent control of subsystems and components – providing necessary flexibility for efficient utilisation of renewable energy. The project results will be based on combining a number of elements established or under establishment in Copenhagen’s Nordhavn, one of the largest development districts in Europe. With a diverse set of such elements in the electrical and heating grids, in the built environment, and involving citizens in the area, the EnergyLab Nordhavn project is well on the way to establish itself as a living laboratory and an environment for strong research-based innovation in smart energy technologies, innovative business models and energy management tools for the future sustainable low-energy city districts. Particularly exciting is the synergy between • the physical density of the environment in Nordhavn • the “settler attitude” of the new local population • new trends of co-creation and participation. • new tools creating awareness on carbon footprint and other environmental impact. EnergyLab Nordhavn partners are DTU BYG, DTU MEK, DTU CEE, Københavns Kommune, DONG Energy Electricity Distributions, HOFOR, By&Havn, ABB, Danfoss, Balslev, MetroTherm, Glen Dimplex, CleanCharge and the PowerLab facilities. The project has a total budget of € 19 mio, of which € 11 mio are funded in two rounds by the Danish Energy Technology Development and Demonstration Programme (EUDP).
Energy Performance of Water-based and Air-based Cooling Systems in Plus-energy Housing

Energy use in buildings accounts for a large part of the energy use globally and as a result of this, international building energy performance directives are becoming stricter. This trend has led to the development of zero-energy and plus-energy buildings. Some of these developments have led to certain issues regarding thermal indoor environments, such as overheating.

Thermal comfort of occupants should not be sacrificed for energy efficiency but rather, these should be achieved simultaneously. Although the priority should be to minimize the cooling demand during the design, this is not always achieved and cooling might be needed even in residential buildings.

This paper focuses on the cooling operation of a detached, single-family house, which was designed as a plus-energy house in Denmark. The simulation model of the house was created in IDA ICE and it was validated with measurement data in a previous study. The effects of the cooling demand (internal vs. external solar shading), the space cooling method (floor cooling vs. air-cooling with ventilation system), and the availability of a nearby natural heat sink (intake air for the ventilation system being outdoor air vs. air from the crawl-space, and air-to-water heat pump vs. ground heat exchanger as cooling source) on the system energy performance were investigated while achieving the same thermal indoor conditions.

The results show that the water-based floor cooling system performed better than the air-based cooling system in terms of energy performance and also regarding the energy use of auxiliary components such as pumps and fans. The total reduction in primary energy used was 31% compared to the air-based systems with intake air from outdoors. The integration of natural heat sinks into the cooling system of the house results in significant energy use reductions. The coupling of radiant floor with the ground enables to obtain "free" cooling, although the brine pump power should be kept to a minimum to fully take advantage of this solution. By implementing a ground heat exchanger instead of the heat pump and use the crawl-space air as intake air an improvement of 37% was achieved.

The cooling demand should be minimized in the design phase as a priority and then the resulting cooling load should be addressed with the most energy efficient cooling strategy. The floor cooling coupled with a ground heat exchanger was shown to be an effective means to minimize the energy use for cooling purposes, and this can contribute to achieving zero-energy or plus-energy targets in future buildings.

Electronic versions:
energy_performance.pdf

Energy Saving by Novel Bed-Integrated Local Exhaust Ventilation

High quality indoor environment in hospitals is important for patients' healing and performance of the personnel. A novel method for minimizing spread of bio-effluents generated from hospitalized patients lying in bed was developed. The method consists of ventilated mattress (VM) which is able to suck the human bio-effluents at the area of the body where they are generated before they spread in the room. The air polluted with released bio-effluents is exhausted into the mattress near the body and is either cleaned and released back in the room or is removed from the room by connecting the mattress to the exhaust of the room background ventilation system. Comprehensive research reveals that the method is highly efficient for removal of bio-effluents. The energy saving potential of the VM combined with constant air volume (CAV) ventilation operating at reduced ventilation rate in a single-bed hospital patient room (1.3 air changes per hour (ACH)) and double-bed patient room (1.6 ACH) was assessed by means of dynamic computer simulations. The estimated
The annual energy consumption for the rooms using the VM combined with CAV was compared to the annual energy consumption when the CAV ventilation was used alone at 4, 6 and 12 ACH. The air exhausted through the mattress was 1.5 L/s. The occupants were present 24 hours every day including weekends. Compared to the CAV ventilation used alone at 4, 6 and 12 ACH the use of the VM in the single-bed room decreased the annual energy consumption respectively with 55%, 71.1% and 85.9% and in the double room with 39.3%, 60.0%, and 80.4%. The use of the VM with reduced background CAV ventilation is an effective energy saving strategy for both double and single patient hospital rooms.

General information
State: Published
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Publication date: 2016

The thermal indoor environment and the energy performance of a plus-energy house are evaluated in the present study. The study case is EMBRACE, a two-storey dwelling of 59 m2 designed to host a single family. The building includes a semi-outdoor space covered by a glazed envelope, where the thermal environment is also investigated. The house is located in Nordborg, Denmark, where it is undergoing a year-round measurement campaign, of which are presented hereafter the results ranging from June to September 2015. The thermal environment proved to be satisfactory, with 58 and 15 hours above 26°C respectively in the first and ground floors. In general, the indoor climate was quantitatively better during the heating period (June and September) than in the cooling period (July and August). Overheating did not result to be an issue, which suggests that the installation of a cooling system could have been avoided. The energy balance proved to be positive, with a total of 1563 kWh of electricity produced by the photovoltaic cells installed on the roof, and 333 kWh used by the mechanical systems of the house during the four studied months. The air temperature in the semi-outdoor space frequently reached 2 to 3°C higher than outdoors, which increases the amount of comfortable occupancy hours in this space. The results suggest that the house could perform effectively as a plus-energy house during the whole year.

General information
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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Technical University of Denmark
Authors: Pean, T. Q. (Intern), Gennari, L. (Ekstern), Kazanci, O. B. (Intern), Olesen, B. W. (Intern)
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Plus-energy house, Summer performance evaluation, Low temperature heating and high temperature cooling, Radiant floor system
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Evaluation of the energy and comfort performance of a plus-energy house under Scandinavian winter conditions
A plus-energy house was studied in terms of indoor environmental conditions and energy balance, during Scandinavian winter conditions. The studied building, EMBRACE, is a single-family detached dwelling of 59 m² with two floors. The house also integrates a semi-outdoor space, covered by a glazed envelope, whose thermal environment has been investigated. The house is located in Nordborg, Denmark and was undergoing a year-round measurement campaign, of which are hereby presented the results from 16/11/2015 to 04/03/2016. During this period, the house was operated in heating mode, with five different cases investigated, combining different set-points (20 to 22°C) and ventilation heat recovery settings.
The thermal comfort indoors proved to be satisfactory, depending on the chosen set-point. Up to 92 and 98% of the time was reported within the range 21-25°C (Category I of EN 15251) respectively on the ground and first floors when the set-point was 22°C. The electrical energy balance resulted to be negative, with a photovoltaic (PV) production of 432 kWh and a consumption from the mechanical systems of 1521 kWh during the studied winter period of almost four months. Put into perspective with the summer evaluation, these results show an encouraging trend towards achieving an annual positive energy balance as designed for this plus-energy house. The thermal environmental conditions in the semi-outdoor space resulted more comfortable than the outdoors, with reduced wind velocity, protection from rain, and temperature increase of up to 2-3°C during sunny days, which increases the possibilities of occupancy in this area.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Technical University of Denmark, Tsinghua University
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Main Research Area: Technical/natural sciences
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Exergy performance of different space heating systems: A theoretical study
Three space heating systems (floor heating with different floor covering resistances, radiator heating with different working temperatures, warm-air heating with and without heat recovery) were compared using a natural gas fired condensing boiler as the heat source. For the floor heating systems, the effects of floor covering resistance on the whole system performance were studied using two heat sources; a natural gas fired condensing boiler and an air-source heat pump. The heating systems were also compared in terms of auxiliary exergy use for pumps and fans.
The low temperature floor heating system performed better than other systems in terms of exergy demand. The use of boiler as a heat source for a low-exergy floor heating system creates a mismatch in the exergy supply and demand. Although an air-source heat pump could be a better heat source, this depends on the origin of the electricity supplied to the heat pump. The coefficient of performance (COP) of the heat pump has a critical value (2.57 in this study); it is beneficial to use a heat pump instead of a boiler only when the COP is above this critical value.
The floor covering resistance should be kept to a minimum, in order not to hinder the performance of the floor heating and the whole system. The exergy input to auxiliary components plays a significant role in the overall exergy performance of systems, and its effects become even more significant for low temperature heating systems.

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Experimental studies on removal of airborne haloanisoles by non-thermal plasma air purifiers

A laboratory study was conducted to test the performance of non-thermal plasma air purifiers on its removal effectiveness of two haloanisoles – 2,4,6-trichloroanisole (TCA) and 2,4,6-Tribromoanisole (TBA). TCA and TBA are the two major compounds found in wine cellars that can contaminate wine to produce unpalatable mouldy and musty tastes. The test was first conducted in a climate chamber. The plasma air purifier was installed in a test rig developed for the testing and challenged by airflow with certain concentrations of TCA and TBA. Air samples upstream and downstream of the air purifier was collected by Tenax tubes and the concentration of TCA and TBA were analyzed by thermal desorption GC–MS. The results showed that the plasma air purifier was effective on removing TCA and TBA with a single pass efficiency of better than 82%. The effect was further validated in a wine cellar under a realistic condition. The concentrations of TCA and TBA in the wine cellar decreased 94% and 50% respectively after running two plasma air purifiers for 5 days. The non-thermal plasma air purification technology may be used in wine cellar to remove the two airborne contaminants and prevent the wine from being contaminated during storage.

General information
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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Dnota Medio Ambiente, Airmanager Technologies ApS
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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.088 SNIP 2.174 CiteScore 4.07
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Scopus rating (2014): SJR 2.123 SNIP 2.936 CiteScore 4.21
Web of Science (2014): Indexed yes
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Scopus rating (2013): SJR 1.897 SNIP 2.433 CiteScore 3.79
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Web of Science (2013): Indexed yes
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Scopus rating (2012): SJR 1.816 SNIP 2.737 CiteScore 3.36
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Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.506 SNIP 2.536 CiteScore 3.23
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.631 SNIP 2.081
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Experimental study of discharging PCM ceiling panels through nocturnal radiative cooling

PhotoVoltaic/Thermal (PV/T) panels were used for cooling water through the principle of nocturnal radiative cooling. This water was utilised for discharging Phase Change Material (PCM) which was embedded in ceiling panels in a climate chamber. Three different sets of flow rates were examined for the solar and the PCM loops, for five days each. The highest examined water flow rate (210 l/h) in the PCM loop provided the best thermal environment in the climate chamber, namely 92% of the occupancy time was within the range of Category III of Standard EN 15251. Although the lowest examined water flow rate (96 l/h) in the solar loop provided the highest average cooling power, due to the significant variations in the weather conditions during the three experimental cases, made it impossible to determine to which extent the difference in the cooling power is due to the different water flow rate. The percentage of electrical energy use that could be covered from the PV/Ts on site was 71.5% for Case 1, 68.3% for Case 2 and 86.8% for Case 3. In any case, the PV/T panels proved to be an efficient solution for the production of electrical energy, heated and chilled water.

General information
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Publication date: 2016
Exposure Reduction to Human Bio-effluents Using Seat-integrated Localized Ventilation in Quiescent Indoor Environment

Local airflows generated from people such as the natural convection flow may determine the distribution of pollutants indoors. New seat-integrated ventilated method was developed to improve the inhaled air quality of occupants while sitting. The method named "Ventilated Cushion" was designed to suck gaseous pollutants (i.e. bio-effluents) emitted from the body of a sedentary person and exhaust them before they entrained in the person's breathing zone or mix with the surrounding air. Full-scale experiments were performed in a climate chamber. The chamber was ventilated by an upward piston flow through the floor. A sitting person was simulated using a dressed thermal manikin which had a body shape and surface temperature distribution of a real average person under state of thermal comfort. The chair on which the thermal manikin was sitting was equipped with the ventilated cushion (VC). The interaction between the natural convection flow around the human body and the suction from the VC was studied in terms of transport of gaseous pollutants. The experiments were conducted at two room air temperatures. The performance of the VC was assessed by measuring the pollution concentration in the breathing zone of the manikin and at 0.5 m above the head of the manikin. The results showed that the concentration of the pollutants decreased when the VC was in operation. The results from this study showed that the use of the VC provides an efficient method for control of body-emitted gaseous pollutants in order to improve the inhaled air and indoor air quality.

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Exposure to aerosol and gaseous pollutants in a room ventilated with mixing air distribution

The present study investigates the aerosol and gas dispersal in a mechanically ventilated room and the personal exposure to these contaminants. The study was performed in a full-scale climate chamber. The room was air conditioned via mixing total volume ventilation system. The room occupancy was simulated by a sitting dressed thermal manikin with realistic body shape. During the experiments monodisperse aerosols of three sizes and nitrous oxide tracer gas were generated simultaneously from one location in the room. The aerosol and gas concentrations in the bulk room air and in the breathing zone of the thermal manikin were measured. The results showed higher exposure to the contaminants measured at the breathing zone than at the ambient air. The behaviour of the tracer gas and the aerosols was similar.

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Exposure to ultrafine particles, intracellular production of reactive oxygen species in leukocytes and altered levels of endothelial progenitor cells

Exposure to particles in the fine and ultrafine size range has been linked to induction of low-grade systemic inflammation, oxidative stress and development of cardiovascular diseases. Declining levels of endothelial progenitor cells within systemic circulation have likewise been linked to progression of cardiovascular diseases. The objective was to determine if exposure to fine and ultrafine particles from indoor and outdoor sources, assessed by personal and residential indoor monitoring, is associated with altered levels of endothelial progenitor cells, and whether such effects are related to leukocyte-mediated oxidative stress. The study utilized a cross sectional design performed in 58 study participants from a larger cohort. Levels of circulating endothelial progenitor cells, defined as either late (CD34(+)KDR(+) cells) or early (CD34(+)CD133(+))KDR(+) cells) subsets were measured using polychromatic flow cytometry. We additionally measured production of reactive oxygen species in leukocyte subsets (lymphocytes, monocytes and granulocytes) by flow cytometry using intracellular 2’’,7’’-dichlorofluoroscein. The measurements encompassed both basal levels of reactive oxygen species production and capacity for reactive oxygen species production for each leukocyte subset. We found that the late endothelial progenitor subset was negatively associated with levels of ultrafine particles measured within the participant residences and with reactive oxygen species production capacity in lymphocytes. Additionally, the early endothelial progenitor cell levels were positively associated with a personalised measure of ultrafine particle exposure and negatively associated with both basal and capacity for reactive oxygen species production in lymphocytes and granulocytes, respectively. Our results indicate that exposure to fine and ultrafine particles derived from indoor sources may have adverse effects on human vascular health.

General information
State: Published
Organisations: Department of Mechanical Engineering, Department of Civil Engineering, Section for Indoor Climate and Building Physics, University of Copenhagen
Authors: Jantzen, K. (Ekstern), Møller, P. H. (Intern), Karottki, D. G. (Forskerdatabase), Olsen, Y. (Ekstern), Bekö, G. (Intern), Clausen, G. (Intern), Hersoug, L. (Ekstern), Loft, S. (Ekstern)
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Web of Science (2016): Indexed yes
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BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.21 SNIP 1.257 CiteScore 3.39
BFI (2013): BFI-level 1
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BFI (2012): BFI-level 1
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Scopus rating (2011): SJR 1.266 SNIP 1.347 CiteScore 3.75
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Further advances in modeling transdermal uptake of SVOCs

To better simulate dermal uptake of SVOCs from air, we develop an enhanced transport model that includes skin surface lipids (SSL). As modeled, clothing can remove SSL by contact transfer and it can act as a source or sink for gas-phase transfer to and from SSL. Addition of SSL increases the overall resistance to uptake of SVOCs from air but also allows for more rapid release of SVOCs to sinks like clothing or clean air. We compare the model results to reported experimental uptake of di-ethyl phthalate (DEP) and di-n-butyl phthalate (DnBP), normalized by exposed skin area and the phthalate air concentration during exposure (Weschler et al., 2015). Overall, the model predicts total uptake values that are consistent with those observed in the experiments. The model predicts a normalized mass uptake of DEP of 3.1 (µg/m²)/(µg/m³) whereas the experimental results range from 1.0 to 4.3 (µg/m²)/(µg/m³). The model somewhat over-predicts uptake of DnBP: 4.6 (µg/m²)/(µg/m³) vs the experimental range of 0.49 to 3.2 (µg/m²)/(µg/m³).

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Missouri University of Science and Technology
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House Owners’ Interests and Actions in Relation to Indoor Temperature, Air Quality and Energy Use

In order to make better and more realistic predictions of energy consumption in dwellings, more knowledge is needed about how individuals and households control the indoor environment. A questionnaire survey was conducted with the objective of studying the interest and actions taken in relation to indoor temperature, air quality and energy consumption by Danish house owners living in single-family detached houses with district heating. The house owners state that they are interested in, and concerned about, the indoor temperature and air quality and that it is an important element in caring for each other in the family. Actions are taken in relation to the temperature in the way that house owners are trying to keep different temperatures in differently heated rooms, e.g. to sleep in a cool bedroom or to save heat. Besides they wear warmer clothing, slippers or thick socks indoors during the winter compared with the rest of the year. Actions are taken to improve the air quality by the majority of the house owners by opening windows. The most frequent reasons for opening windows once or several times a day was “to get fresh air” and “in relation to showering”. House owners are interested in saving energy for the sake of the environment and for their own economy, and quite a lot of households indicate that they know their own energy consumption, though only few follow it closely. Thus being concerned about energy is not necessarily related to an interest in detailed feedback on one’s own energy consumption. Results show that well-planned communication about feedback possibilities is important. Women and men answer slightly differently to some of the questions, e.g. women are more active in airing, and they wear warmer clothing, whereas men are more actively following their energy consumption.

Human responses to carbon dioxide, a follow-up study at recommended exposure limits in non-industrial environments

To extend the results of a previous study on the effects of carbon dioxide (CO₂) and bioeffluents on humans, the new study reported in this paper was carried out. The purpose of this study was to examine, whether exposure to CO₂ at 5000 ppm would cause sensory discomfort, evoke acute health symptoms, reduce the performance of cognitive tasks, or result in changes in physiological responses. The outdoor air supply rate was set high enough in a low-emission stainless-steel climate chamber to create a reference condition with CO₂ at 500 ppm when subjects were present, and chemically pure CO₂ was added to the supply air to create an exposure condition with CO₂ at 5000 ppm (the measured exposure level was ca. 4900 ppm). Ten healthy college-age students were exposed twice to each of the two conditions for 2.5 h in a design balanced for order of presentation. The raised CO₂ concentration had no effect on perceived air quality or physiological responses except for end-tidal CO₂ (ETCO₂), which increased more (to 5.3 kPa) than it was in the reference condition (5.1 kPa). Other results indicate additionally that a 2.5-h exposure to CO₂ up to 5000 ppm did not increase intensity of health symptoms reported by healthy young individuals and their performance of simple or moderately difficult cognitive tests and some tasks resembling office work. These results accord well with the current occupational exposure limit recommendation for CO₂ and with many other reports published in the literature.
Identification of parameters affecting the variability of energy use in residential buildings

Energy use of buildings varies significantly. When aggregating the demand profiles of a group of buildings, the variations of energy demand are critical to determine the aggregated load profile. Especially when dimensioning district energy systems, it is important to know the variability of energy demand that can guarantee the efficient operation of the system. For this reason, it is useful to distinguish the parameters that affect building energy performance the most and to estimate the magnitude of these variations on each parameter. The aim of the present study is to identify the parameters that lead to the largest variations in energy performance of residential buildings in Denmark. A set of sensitivity analysis has been carried out using an extensive search algorithm. These sensitivity analyses were then applied for modelling a reference building representing Danish single-family houses of the 1940's. The study was able to determine the key variables that affect energy use in old Danish single-family houses using sensitivity analysis and proposes a methodology for parameter optimization. This analysis pointed out that the insulation in external walls and roof lead to the largest variations in space heating demand. Also, the infiltration rate and occupancy behavior play important role on space heating consumption. It was concluded that these findings highly depend on the specific case study and the characteristics of the buildings that are examined. If outdoor climate and location differ from the current case, a different set of parameters should be investigated upon its effect on building energy use.
IEA Project on Indoor Air Quality Design and Control in Low Energy Residential Buildings

Both new and renovated existing buildings will in the future need to be optimized in such a way that can achieve to have nearly no energy use while still providing impeccable indoor climates. Since such buildings can already be assumed to be very well insulated, airtight, and to be equipped with heat recovery systems, one of the next focal points to limiting energy consumption for thermally conditioning the indoor environment will be to possibly reducing the ventilation rate, or to make it in a new way demand controlled. However, this must be done such that it has no have adverse effects on Indoor Air Quality (IAQ).

Annex 68, Indoor Air Quality Design and Control in Low Energy Residential Buildings, is a project under IEA’s Energy Conservation in Buildings and Communities Program (EBC), which will endeavor to investigate how future residential buildings are able to have very high energy performance whilst providing comfortable and healthy indoor environments. New paradigms for demand control of ventilation will be investigated, which consider the pollution loads and occupancy in buildings. The thermal and moisture conditions of such will be considered because of interactions between the hygrothermal parameters, the chemical conditions, ventilation and the wellbeing of occupants. A flagship outcome of the project is anticipated to be a guidebook on design and operation of ventilation in residential buildings to achieve high IAQ with smallest possible energy consumption.

Implementation synergies that exploit situational knowledge strategically

This paper illustrates how strategic and situated forms of knowledge may increase capacity to implement energy strategies in local urban development projects. Through analysis of front runner implementation projects, we show that the involved planners utilize situational learning processes strategically to develop more viable implementation trajectories. These findings resonate well with relational and network orienteered research in contemporary planning theory. In the selected case studies, we can see that planners deliberately seek to extend traditional planning approaches, like e.g. regulation, with broader context-specific learning processes. In doing so, we argue that – what we call – an implementation synergy is established by interlacing different forms of situational knowledge with strategic knowledge about how to reach a desired energy target. In conclusion, the paper identifies different domains of knowledge that can be exploited strategically in order to create an implementation synergy in local development projects.
Indeklima, energiforbrug og brugeradfærd

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics
Authors: Toftum, J. (Intern)
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Indeklima og bygningers totalværdi

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Individually controlled localized chilled beam in conjunction with chilled ceiling: Part 1 – Physical environment
This study investigates the indoor environment generated by localized chilled beam coupled with chilled ceiling (LCBCC) and compares it with the environment generated by mixing ventilation coupled with chilled ceiling (CCMV). The experiments were performed in a mock-up of single office (4.1 m × 4.0 m × 3.1 m, L× W× H). Thermal manikin was used
to simulate room occupant. The LCBCC was placed above the workstation to improve the environment locally. Combinations of indoor temperature of 26 °C and 28 °C and ventilation airflow rate of 10 and 13 l/s were studied. The total heat load in the room was 60 W/m² (including simulation of solar radiation and miscellaneous heat loads). The results showed that uniform thermal conditions (differences smaller than 1 °K) were generated in the occupied zone with the studied system configurations. The LCBCC diminished the effect of the buoyancy flow from the simulated window and this resulted in more acceptable thermal conditions at the workstation.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, University of Gävle, Halton OY, Uponor Group
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Localized chilled beam, Mixing Ventilation, Chilled ceiling, Individual control, Local environment
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2017

Individually controlled localized chilled beam in conjunction with chilled ceiling: Part 2 – Human response
The response of 24 subjects to the local environment established by localized chilled beam combined with chilled ceiling (LCBCC) was studied and compared with response to the environment generated by mixing ventilation combined with chilled ceiling (CCMV) at two temperature conditions of 26°C and 28°C. The supply airflow rate from the LCBCC was controlled by the subjects within the range of 10 to 13 L/s. In the case of CCMV subjects did not have control over the flow rate. The results showed that occupants’ overall and local thermal sensation acceptability improved at the workstation by using the LCBCC system compared to CCMV. The subjects felt less warm with the LCBCC and their thermal sensation was close to neutral. Most of the subjects achieved acceptable air movement at the workstation by the provided individual control of the flow rate from the LCBCC. Need for air movement was reported in the case of CCMV.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, University of Gävle, Silesian University of Technology, Halton OY, Uponor Group
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Localized chilled beam, Mixing Ventilation, Chilled ceiling, Individual control, Local environment
Electronic versions:
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Indoor air quality in a multifamily apartment building before and after energy renovation
Buildings are responsible for a substantial portion of global energy consumption. Most of the multifamily residential buildings in central Europe built in the 20th century do not satisfy the current requirements on energy efficiency. Nationwide remedial measures are taken to improve the energy efficiency of these buildings and reduce their energy consumption. Since the impact of these measures on the indoor air quality is rarely considered, they often compromise
indoor air quality due to decreased ventilation and infiltration rate. We compared the indoor air quality in a multifamily apartment building in Slovakia before and after energy renovation, during two subsequent winters. Measurements of temperature, relative humidity, concentrations of CO2, formaldehyde, NO2, and volatile organic compounds were performed during one week in January 2015 in 20 apartments in one multifamily building in Slovakia. Subjective evaluation of the indoor environment and occupant satisfaction using questionnaire has been also performed. The measurements were repeated in January 2016, after the building was energy-renovated. The renovation included thermal insulation of the façade. Natural ventilation was used in the building. Exhaust ventilation was present in bathrooms and toilets. No changes to the ventilation were done during renovation. After renovation, the ventilation rates in the apartments were significantly lower than before. Concentrations of formaldehyde, TVOC and certain individual VOCs were higher. The occupants indicated more dissatisfaction and a higher prevalence of some sick building syndrome symptoms after renovation. When residential buildings in central Europe are upgraded to more energy efficient ones, the retrofitting effort should include improved ventilation in order to ensure sufficient air exchange rates and acceptable and healthy IAQ. Without these considerations, energy reconstruction can adversely affect the quality of the indoor environment.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, SP Technical Research Institute of Sweden, Slovak University of Technology, Swedish Environmental Research Institute
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Indoor-outdoor particle effects on health in middle-aged and elderly
A series of 5 studies in a total of 300 middle-aged and elderly individuals have related exposure to indoor and outdoor ultrafine and fine particles for 5-48 h to effects on vascular and lung function with possible explanatory inflammation and oxidative stress biomarkers. The data consistently support detrimental effect of UFP from traffic on vascular function. Indoor UFP and PM2.5 might contribute to cardiovascular risk through endothelial damage and vascular dysfunction, respectively, whereas indoor UFP dominated by candle burning appears to have adverse lung effects. The biomarkers provided no mechanistic explanation.

General information
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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, University of Copenhagen, Aarhus University
Authors: Karottki, D. G. (Ekstern), Bekó, G. (Intern), Hemmingsen, J. G. (Ekstern), Jantzen, K. (Ekstern), Clausen, G. (Intern), Sigsgaard, T. (Ekstern), Møller, P. (Ekstern), Loft, S. (Ekstern)
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Karottki_2016_IA_Ghent_UFP_health.pdf
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Indoor temperatures for calculating room heat loss and heating capacity of radiant heating systems combined with mechanical ventilation systems
In this study, a typical office room with a radiant heating system and a mechanical ventilation system was selected as the research subject. Indoor temperature formulas for calculating the room heat loss (including transmission heat loss and
ventilation heat loss) and heating capacity of the hybrid system were determined according to the principle of heat
transfer. A model to predict indoor temperatures in the room was proposed, and it was determined that the predicted
indoor temperatures agreed well with the measured data. Qualitative analyses of the effects of heated surface
temperature and air change rates on the indoor temperatures were performed using the proposed model. When heated
surface temperatures and air change rates were from 21.0 to 29.0 degrees C and from 0.5 to 4.0 h⁻¹, the indoor
temperatures for calculating the transmission heat loss and ventilation heat loss were between 20.0 and 20.3 degrees C
and between 19.6 and 20.5 degrees C, respectively, and the indoor temperature for calculating the heating capacity of the
hybrid system was between 18.2 and 19.8 degrees C. Accordingly, the relative calculation errors were between 0.3% and
0.5% and between -10.2% and 11.8% for calculating the transmission heat loss and ventilation heat loss, respectively, and
between 16.0% and 17.4% for calculating the heating capacity of the hybrid system. Due to large relative calculation
errors, it is necessary to consider the effect of heated surface and cool supply air on indoor temperatures for calculating
ventilation heat loss and heating capacity of radiant heating systems combined with mechanical ventilation systems. (C)
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Scopus rating (2016): CiteScore 4.64 SJR 2.093 SNIP 1.965
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Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
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Scopus rating (2012): SJR 1.816 SNIP 2.737 CiteScore 3.36
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Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.506 SNIP 2.536 CiteScore 3.23
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.631 SNIP 2.081
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.564 SNIP 1.79
Influence of heat cost allocation on occupants' control of indoor environment in 56 apartments: Studied with measurements, interviews and questionnaires

People who pay their energy bills individually based on meter readings tend to spend less energy than people who pay collectively e.g. based on floor areas. It has been hypothesised that these savings are an effect of lower indoor temperatures and ventilation rates during heating seasons. The aim of this paper was to study the indoor environment in buildings with collective and individual heat cost allocation plans, to investigate how the heat cost allocation influenced occupant behaviour and how occupants controlled the indoor environment.

The effects of the heat cost allocation type were studied by comparing indoor environmental measurements between two buildings: one with collective payment and one with individual payment. The measurements were collected at 5 min intervals at a central location in each of 56 apartments in Copenhagen, Denmark over a period of two months. Questionnaires and semi-structured interviews showed a strong influence of the heat cost allocation plan on the occupants' control strategies. Occupants whose heating bills were based on floor area focused on a healthy and comfortable indoor environment. Occupants whose heating bills were based on meter readings focused on energy conservation and heat cost savings at the expense of thermal comfort and air quality.

The differences in average temperature, average CO2 concentration and average vapour pressure were 2.8 °C, 161 ppm, and 93 Pa, respectively between apartments with collective and individual heat cost allocation.

General information
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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics
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Scopus rating (2014): SJR 1.938 SNIP 2.797 CiteScore 4.14
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Scopus rating (2013): SJR 1.581 SNIP 2.602 CiteScore 3.57
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Scopus rating (2012): SJR 1.331 SNIP 2.875 CiteScore 3.06
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BFI (2011): BFI-level 1
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ISI indexed (2011): ISI indexed yes
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BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.235 SNIP 2.001
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.028 SNIP 1.865
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.924 SNIP 1.38
Web of Science (2008): Indexed yes
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Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.03 SNIP 1.63
Scopus rating (2005): SJR 0.955 SNIP 1.225
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 0.548 SNIP 1.266
Scopus rating (2003): SJR 0.948 SNIP 0.921
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.998 SNIP 1.39
Web of Science (2002): Indexed yes
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Scopus rating (2000): SJR 0.526 SNIP 1.14
Scopus rating (1999): SJR 0.564 SNIP 1.175
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Influence of the environmental parameters on nocturnal radiative cooling capacity of solar collectors

General information
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Authors: Pean, T. Q. (Intern), Gennari, L. (Ekstern), Kazanci, O. B. (Intern), Bourdakis, E. (Intern), Olesen, B. W. (Intern)
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Nocturnal radiative cooling, photovoltaic/thermal panels, Unglazed collector, Parametric analysis, Computational simulation
Electronic versions:
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Stachybotrys mycotoxins: from culture extracts to dust samples
The filamentous fungus Stachybotrys chartarum is known for its toxic metabolites and has been associated with serious health problems, including mycotoxicosis, among occupants of contaminated buildings. Here, we present results from a case study, where an ultra-high performance liquid chromatography-tandem mass spectrometry (UHPLC-MS/MS) method was developed for known and tentatively identified compounds characterized via UHPLC-quadruple time-of-flight (QTOF) screening of fungal culture extracts, wall scrapings and reference standards. The UHPLC-MS/MS method was able to identify 12 Stachybotrys metabolites, of which four could be quantified based on authentic standards and a further six estimated based on similarity to authentic standards. Samples collected from walls contaminated by S. chartarum in a water-damaged building showed that the two known chemotypes, S and A, coexisted. More importantly, a link between mycotoxin concentrations found on contaminated surfaces and in settled dust was made. One dust sample, collected from a water-damaged room, contained 10 pg/cm² macrocyclic trichothecenes (roridin E). For the first time, more than one spirocyclic drimane was detected in dust. Spirocyclic drimanes were detected in all 11 analysed dust samples and in total amounted to 600 pg/cm² in the water-damaged room and 340 pg/cm² in rooms adjacent to the water-damaged area. Their wide distribution in detectable amounts in dust suggested they could be good candidates for exposure biomarkers.

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Organisations: Department of Systems Biology, Metabolomics Platform, Department of Civil Engineering, Section for Indoor Climate and Building Physics
Authors: Dosen, I. (Intern), Andersen, B. (Intern), Phippen, C. (Intern), Clausen, G. (Intern), Nielsen, K. F. (Intern)
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BFI (2016): BFI-level 1
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Laboratory study on the cooling effect of flash water evaporative cooling technology for ventilation and air-conditioning of buildings

This paper presents a simple cooling technology using flash water evaporation. The technology combines a water atomizer with a plate heat exchanger used for heat recovery of a ventilation system. It is mainly used to cool the ventilation airflow from outdoors and is particularly suitable to be used in warm/hot and dry environment where dehumidification of outdoor air is not needed. A laboratory experiment was designed and conducted to evaluate the cooling effectiveness of

Stachybotrys, Mycotoxin, Dust, Spirocyclic drimane, QTOF, QqQ
this technology. The experiment was conducted in a twin-climate chamber. One chamber simulated warm/hot and dry outdoor environments and the other simulated an air-conditioned indoor environment. The flash water evaporation cooling device was installed in the chamber that simulated indoor environment. The air from the chamber simulating outdoor environment was introduced into the cooling device and cooled by the flash water evaporation. Two outdoor summer climates were simulated in the study, i.e. the design summer climate of Las Vegas and the extreme summer climate of Copenhagen represented hot/dry and warm/dry climates. The results showed that the flash evaporative cooling technology, a simple and green cooling technology, is effective for ventilation and air-conditioning in warm/hot and dry climate zones. The technology can provide fresh outdoor air with a temperature of 4 to 7 °C lower than room air temperature.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Shanghai Research Institute of Building Sciences, Technical University of Denmark
Authors: Fang, L. (Intern), Yuan, S. (Ekstern), Yang, J. (Ekstern)
Number of pages: 8
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Indirect evaporative cooling, Heat recovery, Water atomizer, Ventilation
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Source: PublicationPreSubmission
Source-ID: 128497285
Publication: Research - peer-review › Article in proceedings – Annual report year: 2017

Large-scale CO₂ measurement campaigns in Danish schools
In two large measurement campaigns performed in 2009 and 2014 more than 1500 spot measurements of CO₂ were made by pupils in Danish primary school classes. In 2009 56% of the measurements exceeded the recommended value of 1000 ppm CO₂. This percentage had increased to 60% in 2014. Changing the behaviour of the pupils had a positive effect, as the proportion of classrooms exceeding 1000 ppm CO₂ in separate measurement (students outside and airing in the break preceding the measurement lesson in which the measurement was made) was 39%. The principle of ventilation had a substantial impact on the measured CO₂ concentrations. In 80% of the classrooms with natural ventilation the concentration of CO₂ exceeded 1000 ppm, while the fraction was 40% in classrooms with balanced mechanical ventilation.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics
Authors: Clausen, G. (Intern), Toftum, J. (Intern), Bekö, G. (Intern)
Number of pages: 2
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Schools, Carbon Dioxide, Children, Ventilation
Source: PublicationPreSubmission
Source-ID: 125224317
Publication: Research - peer-review › Article in proceedings – Annual report year: 2016

Low Temperature Heating and High Temperature Cooling in Buildings
A heating and cooling system could be divided into three parts: terminal units (emission system), distribution system, and heating and cooling plant (generation system). The choice of terminal unit directly affects the energy performance, and the indoor environment in that space. Therefore, a holistic system evaluation is necessary to ensure an optimal indoor environment for the occupants and to achieve energy efficiency simultaneously. Low temperature heating and high temperature cooling systems are one of the possible approaches to heat or cool indoor spaces in buildings. In this thesis, a single-family house designed for plus-energy targets and equipped with a radiant water-based floor
heating and cooling system was studied by means of full-scale measurements, dynamic building simulations and thermodynamic evaluation tools. Thermal indoor environment and energy performance of the house were monitored for one year while different control strategies were tested. Theoretical analyses consisted of comparing the performance of different heating and cooling systems using energy, exergy, and entransy methods under steady-state conditions. Dynamic simulations were used to study the energy performance of heating and cooling systems for achieving the same thermal indoor environment.

The results show that it is crucial to minimize the heating and cooling demands in the design phase since these demands determine the terminal units and heat sources and sinks that could be used. Low temperature heating and high temperature cooling systems (a radiant water-based floor heating and cooling system in this study) proved to be superior to compared systems, evaluated with different system analysis tools; energy, exergy, and entransy. Radiant systems should be coupled to appropriate heating and cooling sources, and energy requirements of auxiliary components (pumps, fans, etc.) should be minimized. Radiant systems could be coupled to renewable heat sources and sinks (e.g. ground), which would result in considerable energy savings. Water-based heating and cooling systems require considerably less auxiliary energy compared to air-based systems. Exergy analysis can be used to optimize a system holistically where different quality energy forms, such as electricity and heat, are used.

Control of the radiant system and its interaction with the ventilation system is critical for an optimized operation. Measurements, simulations, and calculations proved that a system in which the radiant system heats or cools the space and the ventilation system only provides the required amount of fresh air for indoor air quality concerns is the optimal solution. Application of radiant floor heating is particularly beneficial in high-ceilinged spaces, as it can provide a uniform temperature distribution and decrease heat losses due to thermal stratification.

To obtain the most rational use of available resources, energy analysis alone is not sufficient. It is not enough to consider only the quantity of energy; the temperatures and temperature differences within a system should also be considered. Although a single-family house was used for evaluations in this thesis, the results and developed calculation methodologies can be applied to a wider range of buildings using similar heating and cooling systems.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Section for Building Energy
Authors: Kazanci, O. B. (Intern), Olesen, B. W. (Intern), Kolarik, J. (Intern)
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Relations
Projects:
Low Temperature Heating and High Temperature Cooling in Buildings
Publication: Research › Ph.D. thesis – Annual report year: 2016
Magnesium-oxide boards cause moisture damage inside facades in new Danish buildings

Magnesium oxide board, “MgO-board”, is a factory-made sheathing board product, which has been widely used in the last 5 years in ventilated facades on new or renovated buildings in Denmark. In winter 2014/15, a number of problems began to appear with these boards since the boards and adjoining building elements seemed to suffer from some sort of disease, which manifested itself by damages such as significant moisture, boards leaking salty water (‘tears’), corrosion of fittings and anchors and mould growth.

The damages were caused by the fact that MgO-boards absorb moisture from outside air in periods with high outdoor humidity (90-100% RH) and form water drops on the surfaces. The drops contain a high amount of soluble chloride ions and appear on the surfaces of the boards and may often run down the boards and to adjacent structures. Metal fixtures for the MgO-and siding boards may corrode heavily within a few years. The binder in MgO-boards is formed by chemical reaction between MgO and MgCl₂, known as magnesium oxychloride cement or Sorel cement. Also organic matter can be found in the material. The paper presents results of investigations of properties for moisture ab- and desorption curves and transport of MgO-boards.

Managed airing behaviour and the effect on pupil perceptions and indoor climate in classrooms

An intervention study with four different scenarios for airing classrooms were carried out in a school where manual opening of windows was the main source of ventilation. Two scenarios included a visual CO₂ display unit to signal to the pupils and teachers when to open windows. The other two scenarios used two different window opening schedules. Measurements of CO₂, temperature and periods with open windows were recorded, and pupils expressed their perception of the indoor environment in the classroom. With a visual CO₂ display unit in the classroom, pupils were able to modify their behavior and reduce by approximately 40-60% the duration when the CO₂ concentration was above 1000 ppm. With only scheduled window opening, a similar improvement was not observed. Although not significant, pupils’ perception of the air quality seemed better when the intervention was running, but they also perceived the temperature as being colder.
Measurements of Dermal and Oral Emissions from Humans

Human related pollutants (bioeffluents) emitted through skin and via exhaled breath were measured. Two climate chambers were connected via flexible ducts. The ducts were in one chamber attached to a breathing mask, through which five subjects exhaled on one occasion the air into the other chamber: Human bioeffluents emitted orally were in this way isolated from those that were emitted dermally. On another occasion, the subjects exhaled the air into the chamber where they were sitting, thus exposure contained oral and dermal bioeffluents. Another twenty subjects assessed the air quality in the chambers. They judged the air quality in the chamber with dermal bioeffluents to be lower than in the one containing orally exhaled bioeffluents, and similar to the air quality in the chamber with all bioeffluents. The chemical compounds with slightly elevated concentrations differed between the two chambers.

Measurements of dermal uptake of nicotine directly from air and clothing

Dermal uptake directly from air is a significant contributor to total exposure for certain organic compounds, and has been recently experimentally verified for two phthalates. The objective of the current study was to investigate whether airborne nicotine can be dermally absorbed. Two bare-skinned subjects together with a subject wearing clean clothes were dermally exposed to environmental tobacco smoke (ETS) for three hours in a climate chamber; during the exposure all three subjects breathed clean air through hoods covering their heads. The clothed subject later repeated his exposure wearing a shirt previously exposed to tobacco smoke. Urine samples were subsequently analyzed for nicotine and two of its metabolites. The results demonstrate that nicotine can be dermally absorbed directly from air at rates comparable to passive smoking. Wearing clean clothes significantly decreases uptake, while wearing exposed clothes results in substantial uptake.
Measurements of Dermal Uptake of Nicotine Directly from Air and Clothing

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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Institute for Prevention and Occupational Medicine of the German Social Accident Insurance, Fraunhofer Wilhelm-Klauditz-Institut (WKI), Missouri University of Science and Technology
Authors: Bekö, G. (Intern), Morrison, G. (Ekstern), Weschler, C. J. (Intern), Koch, H. (Ekstern), Salthammer, T. (Ekstern), Schripp, T. (Ekstern), Toftum, J. (Intern), Clausen, G. (Intern)
Pages: 356-356
Publication date: 2016

Modeling energy flexibility of low energy buildings utilizing thermal mass
In the future energy system a considerable increase in the penetration of renewable energy is expected, challenging the stability of the system, as both production and consumption will have fluctuating patterns. Hence, the concept of energy flexibility will be necessary in order for the consumption to match the production patterns, shifting demand from on-peak hours to off-peak hours. Buildings could act as flexibility suppliers to the energy system, through load shifting potential, provided that the large thermal mass of the building stock could be utilized for energy storage. In the present study the load shifting potential of an apartment of a low energy building in Copenhagen is assessed, utilizing the heat storage capacity of the thermal mass when the heating system is switched off for relieving the energy system. It is shown that when using a 4-hour preheating period before switching off the heating system, the thermal mass of the building releases sufficient heat to maintain the operative temperature above 20°C for 15 hours. This potential increases with longer preheating period. The thermal behaviour of the external envelope and internal walls is examined, identifying the heat losses of the external envelope and the thermal capacity of the internal walls as the main parameters that affect the load shifting potential of the apartment.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Section for Building Energy
Authors: Foteinaki, K. (Intern), Heller, A. (Intern), Rode, C. (Intern)
Number of pages: 8
Publication date: 2016
Modelling diversity in building occupant behaviour: a novel statistical approach

We propose an advanced modelling framework to predict the scope and effects of behavioural diversity regarding building occupant actions on window openings, shading devices and lighting. We develop a statistical approach based on generalised linear mixed models to account for the longitudinal nature of observations on occupants, and to provide a coherent method to capture observed variability amongst occupant/room pairings through built-in probabilistic terms describing occupant diversity in a tractable manner within building energy simulation. The contribution of the proposed method is demonstrated using collected behavioural data from three long-term monitoring campaigns (an office building in Switzerland and residential units in Germany and Denmark).

General information
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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Gartenmann Engineering SA, RWTH Aachen University
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Number of pages: 18
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Scopus rating (2015): SJR 1.2 SNIP 1.566 CiteScore 2.27
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Scopus rating (2014): SJR 1.285 SNIP 1.679 CiteScore 2.31
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Scopus rating (2013): SJR 1.058 SNIP 1.299 CiteScore 2.48
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.99 SNIP 1.58 CiteScore 1.57
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.556 SNIP 0.928 CiteScore 0.83
BFI (2010): BFI-level 1
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BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.259 SNIP 0.215
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Nearly-zero energy buildings

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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Oak Ridge National Laboratory
Authors: Toftum, J. (Intern), Baxter, V. (Ekstern)
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BFI (2014): BFI-level 1
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Web of Science (2014): Indexed yes
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Scopus rating (2013): SJR 0.561 SNIP 0.891
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Scopus rating (2012): SJR 0.544 SNIP 1.104
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BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.498 SNIP 0.742
ISI indexed (2011): ISI indexed yes
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Scopus rating (2010): SJR 0.93 SNIP 0.956
Web of Science (2010): Indexed yes
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Scopus rating (2009): SJR 1.614 SNIP 1.187
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.791 SNIP 0.903
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.677 SNIP 1.639
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.843 SNIP 1.29
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.4 SNIP 1.26
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.054 SNIP 2.001
Numerical simulation of the effects of hanging sound absorbers on TABS cooling performance

Recently there has been a considerable increase in the use of Thermally-Active Building Systems (TABS) in Europe as an energy-efficient and economical cooling and heating solution for buildings. However, this widespread solution requires large uncovered hard surfaces indoors, which can lead to a degradation of the room acoustic comfort. Therefore, challenges arise when this system has to be combined with acoustic requirements.

Soffit-hanging sound absorbers embody a promising solution. This study focuses on quantifying their impact on the cooling performance of TABS, assessed by means of the cooling capacity coefficient of the ceiling deck. The influence of different ceiling coverage ratios (0-30-45-60 and 80%) as well as the influence of the distance at which the absorbers are placed is studied by numerical simulations using a new, specially-developed TRNSYS Type. Tests were performed in a test room simulating a two-person office of 20 m², with a typical cooling load of 42 W/m².

The results show that covering 60% of the ceiling surface with sound absorbers hanging at 300 mm from the ceiling active deck is expected to reduce the cooling capacity coefficient of TABS by 15.8%. This drops to 25.4% with a coverage of 80%. The presence of acoustic panels also affects the thermal comfort: the operative temperature in the room increases by 0.9°C in the former case and up to 1.6°C in the latter. Results also show that comfort ventilation supplied to the enclosure has a considerable influence on the thermal conditions in the room; if the ventilation is removed, then the operative temperature increases by 1.8°C for a 60%-covered ceiling.

Optimization of energy planning strategies in municipalities: Are community energy profiles the key to a higher implementation rate of renewable energies?

The paper evaluates the current status of community energy planning in northern Europe via a review of literature, practice and the performance of a barrier analysis for successful community energy planning. Main findings of the paper are that current community energy planning lacks a systematic approach, suffers from insufficient information, tools and resources. Municipalities are often unable to take on a steering role in community energy planning. To overcome these barriers and guide municipalities in the pre-project phase, a decision-support methodology, based on community energy profiles (CEP), is presented. The methodology was applied in a case study in Germany. With CEPs, a possibility to merge qualitative data from local settings into generic energy modelling is shown, which could contribute to improved community energy strategies.
Organophosphate esters in dust samples collected from Danish homes and daycare centers

Organophosphates are used in a wide range of materials and consumer products and are ubiquitous in indoor environments. Certain organophosphates have been associated with various adverse health effects. The present paper reports mass fractions of organophosphates in dust samples collected from 500 bedrooms and 151 daycare centers of children living in Odense, Denmark. The identified compounds include: tris(isobutyl) phosphate (TIBP), tri-n-butyl phosphate (TNBP), tris(2-chloroethyl) phosphate (TCEP), tris(2-chloroisopropyl) phosphate (TCIPP), tris(1,3-dichloroisopropyl) phosphate (TDCIPP), tris(2-butoxyethyl) phosphate (TBOEP), triphenylphosphate (TPHP), 2-ethylhexyl-diphenyl phosphate (EHDPD), tris(2-ethylhexyl) phosphate (TEHP) and tris(methylphenyl) phosphate (TMPP). Both the number of organophosphates with median values above the limit of detection and the median values were higher for samples from daycare centers than for samples from homes. Organophosphates with median mass fractions above the limit of detection were: TCEP from homes (6.9 μg g⁻¹), and TCEP (16 μg g⁻¹), TCIPP (5.6 μg g⁻¹), TDCIPP (7.1 μg g⁻¹), TBOEP (26 μg g⁻¹), TPHP (2.0 μg g⁻¹) and EHDP (2.1 μg g⁻¹) from daycare centers. When present, TBOEP was typically the most abundant of the identified OPs. The sum of the organophosphate dust mass fractions measured in this study was roughly in the mid-range of summed mass fractions reported for dust samples collected in other countries. On a global scale, the geographical distribution of organophosphates in indoor dust is quite variable, with higher concentrations in industrialized countries. This trend differs from that for phthalate esters, whose geographic distribution is more homogeneous. Exposure to organophosphates via dust ingestion is relatively low, although there is considerable uncertainty in this assessment.
Understanding the multitude of factors that control pulmonary deposition is important in assessing the therapeutic or toxic effects of inhaled particles. The use of increasingly sophisticated in silico models has improved our overall understanding, but model realism remains elusive. In this work, we use Large Eddy Simulations (LES) to investigate the deposition of inhaled aerosol particles with diameters of $d_p = 0.1, 0.5, 1, 2.5, 5 \mu m$ and 10 $\mu m$ (particle density of 1200 kg/m^3).
We use a reconstructed geometry of the human airways obtained via computed tomography and assess the effects of inlet flow conditions, particle size, electrostatic charge, and flowrate. While most computer simulations assume a uniform velocity at the mouth inlet, we found that using a more realistic inlet profile based on Laser Doppler Anemometry measurements resulted in enhanced deposition, mostly on the tongue. Nevertheless, flow field differences due to the inlet conditions are largely smoothed out just a short distance downstream of the mouth inlet as a result of the complex geometry. Increasing the inhalation flowrate from sedentary to activity conditions left the mean flowfield structures largely unaffected. Nevertheless, at the higher flowrates turbulent intensities persisted further downstream in the main bronchi.

For \(dp>2.5\mu m\), the overall Deposition Fractions (DF) increased with flowrate due to greater inertial impaction in the oropharynx. Below \(dp=1.0\mu m\), the DF was largely independent of particle size; it also increased with flowrate, but remained significantly lower. Electrostatic charge increased the overall DF of smaller particles by as much as sevenfold, with most of the increase located in the mouth–throat. Moreover, significant enhancement in deposition was found in the left and right lung sub-regions of our reconstructed geometry. Although there was a relatively small impact of inhalation flowrate on the deposition of charged particles for sizes \(dp<2.5\mu m\), impaction prevailed over electrostatic deposition for larger particles as the flowrate was increased. Overall, we report a significant interplay between particle size, electrostatic charge, and flowrate. Our results suggest that in silico models should be customized for specific applications, ensuring all relevant physical effects are accounted for in a self-consistent fashion.
Possibilities and Limitations of Thermally Activated Building Systems: Simply TABS and a Climate Classification for TABS

The strong political market drive towards energy savings in the building sector calls for efficient solutions. Using so called low temperature heating and high temperature cooling systems such as for instance thermally activated building systems (TABS) has a significant impact on the required energy source. With TABS it is possible to utilize otherwise insufficient energy sources such as waste heat or ground coupled heat exchangers.

Today simulation of TABS is possible with most building simulation tools. However such simulations are rather time consuming and cost intensive. It would be beneficial to have a tool that can be used to assess the general usability of TABS considering only rough boundary conditions. The Simple Simulation Tool in combination with the Climate Classification for TABS introduced in this thesis offer this solution.

The Simple Simulation Tool has proven to be a valid tool for the early assessment for the use of TABS in modern Buildings. Not only is it possible to runs simulations in accordance to ISO 11855-4 but also to determine the minimal required plant sizes for cooling, the duration until overheating, the maximum internal temperatures for insufficient plant sizes (using a simplified heat loss approach) and the maximum allowed cooling power to prevent undercooling.

The climate Classification can be used to predict the building behaviour throughout Europe. Based on a very select number of building characteristics it can be seen if heating, cooling or both will be mostly needed to operate the building within acceptable boundaries. It will also allow the user to see if dehumidification will be needed for undisturbed operation of TABS.

With the combination of both tools it is possible to provide a holistic evaluation of a building proposal at a very early design stage.

General information
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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics
Authors: Behrendt, B. (Intern), Christensen, J. E. (Intern), Olesen, B. W. (Intern)
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Relations
Projects:
Predicted and actual indoor environmental quality: Verification of occupants' behaviour models in residential buildings

Occupants' interactions with the building envelope and building systems can have a large impact on the indoor environment and energy consumption in a building. As a consequence, any realistic forecast of building performance must include realistic models of the occupants' interactions with the building controls (windows, thermostats, solar shading etc.). During the last decade, studies about stochastic models of occupants' behaviour in relation to control of the indoor environment have been published. Often the overall aim of these models is to enable more reliable predictions of building performance using building energy performance simulations (BEPS). However, the validity of these models has only been sparsely tested. In this paper, stochastic models of occupants' behaviour from literature were tested against measurements in five apartments. In a monitoring campaign, measurements of indoor temperature, relative humidity and CO2 concentration was measured in the living room and bedroom at five minute intervals in five apartments with similar layout in a building located in Copenhagen, Denmark. Outdoor temperature, relative humidity, wind speed and solar radiation were obtained from a weather station close by. The stochastic models of window opening and heating set-point adjustments were implemented in the BEPS tool IDA ICE. Two apartments from the monitoring campaign were simulated using the implemented models and the measured weather data. The results were compared to measurements from the monitoring campaign to get an estimate of the forecast's realism. The simulations resulted in realistic predictions in a sense that the measured values were within or close to the range of the simulated values. The variation in the simulated and measured variables between apartments and over time was similar. However, comparisons of the average stochastic predictions with the measured temperatures, relative humidity and CO2 concentrations revealed that the models did not predict the actual indoor environmental conditions well.

General information
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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Politecnico di Torino
Authors: Andersen, R. K. (Intern), Fabi, V. (Ekstern), Corgnati, S. P. (Ekstern)
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Web of Science (2015): Indexed yes
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Scopus rating (2014): SJR 2.123 SNIP 2.936 CiteScore 4.21
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BFI (2013): BFI-level 2
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Web of Science (2013): Indexed yes
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Scopus rating (2012): SJR 1.816 SNIP 2.737 CiteScore 3.36
ISI indexed (2012): ISI indexed yes
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Rapid detection and identification of *Stachybotrys* and *Chaetomium* species using tissue PCR analysis

Indoor fungi are a worldwide problem causing negative health effects for infected building's occupants and even deterioration of building structures. Different fungal species affect buildings and their inhabitants differently. Therefore, rapid and accurate identification of fungi to the species level is essential for health risk assessment and building remediation. This study focuses on molecular identification of two common indoor fungal genera: *Stachybotrys* and *Chaetomium*. This study proposes two new DNA barcode candidates for *Stachybotrys* and *Chaetomium*: the gene encoding mitogen activated protein kinase (hogA) and the intergenic region between histone 3 and histone 4 (h3-h4) as well as it introduces a rapid - 3.5 h - protocol for direct *Stachybotrys* and *Chaetomium* species identification, which bypasses culture cultivation, DNA extraction and DNA sequencing.

**General information**

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Organisations: Department of Systems Biology, Department of Civil Engineering, Section for Indoor Climate and Building Physics, Eucaryotic Molecular Cell Biology, Aalborg University
Authors: Lewinska, A. M. (Intern), Peuhkuri, R. H. (Ekstern), Rode, C. (Intern), Andersen, B. (Intern), Hoof, J. B. (Intern)
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Web of Science (2016): Indexed yes
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Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.903 SNIP 1.037 CiteScore 2.28
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.917 SNIP 1.019 CiteScore 2.5
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.87 SNIP 1.004 CiteScore 2.32
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.9 SNIP 0.972 CiteScore 2.29
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.945 SNIP 1.05
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.993 SNIP 1.156
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Original language: English
DNA barcoding, Indoor fungi, ITS, PCR, Species identification

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Source-ID: 2343449978
Publication: Research - peer-review › Journal article – Annual report year: 2016

Reducing burden of disease from residential indoor air exposures in Europe (HEALTHVENT project)

Background: The annual burden of disease caused by indoor air pollution, including polluted outdoor air used to ventilate indoor spaces, is estimated to correspond to a loss of over 2 million healthy life years in the European Union (EU). Based on measurements of the European Environment Agency (EEA), approximately 90 % of EU citizens live in areas where the World Health Organization (WHO) guidelines for air quality of particulate matter sized <2.5 mm (PM$_{2.5}$) are not met. Since sources of pollution reside in both indoor and outdoor air, selecting the most appropriate ventilation strategy is not a simple and straightforward task.

Methods: A framework for developing European health-based ventilation guidelines was created in 2010–2013 in the EU-funded HEALTHVENT project. As a part of the project, the potential efficiency of control policies to health effects caused by residential indoor exposures of fine particulate matter (PM$_{2.5}$), outdoor bioaerosols, volatile organic compounds (VOC), carbon oxide (CO), radon and dampness was estimated. The analysis was based on scenario comparison, using an outdoor-indoor mass-balance model and varying the ventilation rates. Health effects were estimated with burden of diseases (BoD) calculations taking into account asthma, cardiovascular (CV) diseases, acute toxication, respiratory infections, lung cancer and chronic obstructive pulmonary disease (COPD).

Results: The quantitative comparison of three main policy approaches, (i) optimising ventilation rates only; (ii) filtration of outdoor air; and (iii) indoor source control, showed that all three approaches are able to provide substantial reductions in the health risks, varying from approximately 20 % to 44 %, corresponding to 400 000 and 900 000 saved healthy life years in EU-26. PM$_{2.5}$ caused majority of the health effects in all included countries, but the importance of the other pollutants varied by country.

Conclusions: The present modelling shows, that combination of controlling the indoor air sources and selecting appropriate ventilation rate was the most effective to reduce health risks. If indoor sources cannot be removed or their emissions cannot be limited to an accepted level, ventilation needs to be increased to remove remaining pollutants. In these cases filtration of outdoor air may be needed to prevent increase of health risks.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, National Institute for Health and Welfare, University of Milan, European Commission - Joint Research Center, University of Porto
Authors: Asikainen, A. (Ekstern), Carrer, P. (Ekstern), Kephalopoulos, S. (Ekstern), Fernandes, E. D. O. (Ekstern), Wargocki, P. (Intern), Hänninen, O. (Ekstern)
Pages: 61-72
Publication date: 2016
Main Research Area: Technical/natural sciences

Publication information
To assess the influence of clothing on dermal uptake of semi-volatile organic compounds (SVOCs), we measured uptake of selected airborne phthalates for an individual wearing clean clothes or air-exposed clothes and compared these results with dermal uptake for bare-skinned individuals under otherwise identical experimental conditions. Using a breathing hood to isolate dermal from inhalation uptake, we measured urinary metabolites of diethylphthalate (DEP) and di-n-butylphthalate (DnBP) from an individual exposed to known concentrations of these compounds for 6h in an experimental chamber. The individual wore either clean (fresh) cotton clothes or cotton clothes that had been exposed to the same
cabinet air concentrations for 9 days. For a 6-h exposure, the net amounts of DEP and DnBP absorbed when wearing fresh clothes were, respectively, 0.017 and 0.007 μg/kg/(μg/m³); for exposed clothes the results were 0.178 and 0.261 μg/kg/(μg/m³), respectively (values normalized by air concentration and body mass). When compared against the average results for bare-skinned participants, clean clothes were protective, whereas exposed clothes increased dermal uptake for DEP and DnBP by factors of 3.3 and 6.5, respectively. Even for non-occupational environments, wearing clothing that has adsorbed/absorbed indoor air pollutants can increase dermal uptake of SVOCs by substantial amounts relative to bare skin.

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Department of Civil Engineering, Section for Indoor Climate and Building Physics, Missouri University of Science and Technology, Ruhr-Universität Bochum, Fraunhofer Wilhelm-Klauditz-Institut (WKI)
Authors: Morrison, G. C. (Ekstern), Weschler, C. J. (Intern), Bekö, G. (Intern), Koch, H. M. (Ekstern), Salthammer, T. (Ekstern), Schripp, T. (Ekstern), Toftum, J. (Intern), Clausen, G. (Intern)
Pages: 113-118
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**Publication information**

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Volume: 26
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BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.8 SJR 1.174 SNIP 1.08
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.294 SNIP 1.222 CiteScore 2.77
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.598 SNIP 1.326 CiteScore 3.07
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.27 SNIP 1.132 CiteScore 2.6
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.338 SNIP 1.162 CiteScore 2.66
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.467 SNIP 1.345 CiteScore 2.47
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.746 SNIP 1.193
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.809 SNIP 1.175
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.603 SNIP 1.118
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.39 SNIP 1.319
Scopus rating (2006): SJR 1.492 SNIP 1.38
Scopus rating (2005): SJR 1.187 SNIP 1.176
Scopus rating (2004): SJR 1.051 SNIP 1.089
Scopus rating (2003): SJR 1.035 SNIP 0.883
Scopus rating (2002): SJR 0.892 SNIP 0.942
Seat-integrated localized ventilation for exposure reduction to air pollutants in indoor environments

A novel ventilation method for minimizing the spread of bioeffluent contaminants generated from sedentary people indoors was developed and studied. The concept of the method consists of a ventilated cushion which is able to suck the human bioeffluents at the area of the body where they are mainly generated before they disperse around a room. The polluted near the body air is exhausted into the cushion and it is removed from the room by a separate exhaust system. The performance of the method was studied in series of experiments. Full-scale room and a dressed thermal manikin sitting in front of a desk were used to simulate one person office. The chair on which the thermal manikin was sitting had the ventilated cushion (VC). Tracer gases, carbon dioxide (CO₂) and nitrous oxide (N₂O), were used to simulate bioeffluents emitted by the manikin’s armpits and groin region respectively. The experiments were conducted at 26°C room air temperature. The performance of the VC in conjunction with mixing total-volume background ventilation at 1 air change per hour (ACH) was compared with that of mixing background ventilation alone operating at 1, 1.5, 3 and 6 ACH. Experiments at exhaust airflow rate from the cushion at 1.5, 3 and 5 L/s were performed. The pollution removal efficiency was assessed by measuring the pollution concentration in the breathing zone of the manikin and at several other locations in the room bulk air. Exhausting air through the VC decreased the concentration of the tracer gases at the breathing zone and in the room. The higher the exhaust flowrate, the more the concentration was decreased.

Sensory ratings of emissions from nontraditional building materials

Twenty-five subjects assessed the emissions from building materials: linoleum, cement mortar with and without fly ash, gypsum board and tiles with air cleaning properties and natural organic sheep wool. The ratings were made at different material loadings and in combinations with linoleum. The results showed that except for natural organic product, increasing loading and combining materials with linoleum increased intensity of odor.
Simulation Study of Discharging PCM Ceiling Panels through Night-time Radiative Cooling

The energy consumption globally has been increasing drastically in recent decades, mainly due to the population growth and the industrial and technological progress. In order to address this issue, the European Union has launched several directives to decrease energy use, increase energy efficiency and increase use of renewable energy sources. The aim is that by 2020 all new buildings should be nearly zero-energy buildings. A solution that could contribute to this is the combination of photovoltaic panels for the production of electricity and phase change material (PCM) for the reduction of peak cooling demand.

In the present simulation study, the coupling of nighttime radiative cooling with PCM for cooling an office room was investigated. For cooling water through nighttime radiative cooling two types of solar panels were utilized, an unglazed solar collector and photovoltaic/thermal (PV/T) panels. Apart from cold water for space cooling, the installation was capable of providing domestic hot water from both types of panels and electricity from the PV/Ts. This system was simulated for the period from 1st of May until 30th of September, under the weather conditions of Copenhagen (Denmark), Milan (Italy) and Athens (Greece).

In Athens and Milan the operative temperature was within the range of Category III of EN 15251 (23 – 26°C, 73.4 – 78.8°F) for 81% and 83% of the occupancy period respectively, while in Copenhagen it was within the range only for 63%. Furthermore, the percentage of PCM used at the end of the occupancy period was 86%, 81% and 80% for Copenhagen, Milan and Athens, respectively. Nighttime radiative cooling provided for Copenhagen 61%, for Milan 36% and for Athens 14% of the cooling energy required for discharging the PCM. Furthermore, the average cooling power per unit area provided by the PV/T panels was 43 W/m² for Copenhagen, while for Milan and Athens it was 36 W/m² and 34 W/m², respectively. The cooling power of the unglazed solar collector was negligible. Finally, the total electricity produced in Copenhagen for the simulated period was 371 kWh, while for Milan and Athens it was 380 and 439 kWh, respectively.

It was concluded that the nighttime radiative cooling can be a satisfying solution for providing space cooling to office buildings. The performance of the installation could be improved by implementing a solar shading system and a more precise control strategy.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Sierra S.p.A
Authors: Bourdakis, E. (Intern), Kazanci, O. B. (Intern), Grossule, F. (Ekstern), Olesen, B. W. (Intern)
Number of pages: 8
Publication date: 2016
The energy performance of systems for achieving the same thermal comfort was compared. The effects of several parameters on system energy performance for each space heating solution were investigated; floor covering resistance of the floor heating system, having a heat recovery on the exhaust in the ventilation system, and different working temperature levels for the radiator heating. For all cases the heat source was a natural gas fired condensing boiler, and for the floor heating cases also an air-to-water heat pump was used to compare two heat sources. The systems were also compared in terms of auxiliary energy use for pumps and fans. The results show that the investigated floor heating systems had the best performance in terms of energy with a total energy saving of 23% compared to warm-air heating with heat recovery. It can furthermore be coupled to other heat sources than a boiler. The floor covering resistance of the floor heating system should be kept to a minimum to fully benefit from the low temperature heating potential since an increased floor covering requires higher average water temperatures in the floor loops and decreases the COP of the heat pump. The water-based heating systems required significantly less auxiliary energy input compared to the air-based heating system. Furthermore, the results show that low temperature heating systems, as seen in floor heating in this study, can contribute to achieving plus-energy targets by minimizing the energy use for space heating purposes while achieving necessary thermal comfort for the occupants.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Technical University of Denmark
Authors: Schøtt, J. (Ekstern), Andersen, M. E. (Ekstern), Kazanci, O. B. (Intern), Olesen, B. W. (Intern)
Number of pages: 9
Publication date: 2016

Host publication information
Title of host publication: CLIMA 2016 - Proceedings of the 12th REHVA World Congress
Volume: 10
Editor: Kvols Heiselberg, P.
ISBN (Print): 87-91606-36-5
BFI conference series: REHVA World Congress (5010061)
Main Research Area: Technical/natural sciences
Conference: 12th REHVA World Congress, Aalborg, Denmark, 22/05/2016 - 22/05/2016
Floor heating, Warm-air heating, Radiator heating, Plus-energy house
Electronic versions: simulation_study.pdf
Publication: Research - peer-review › Article in proceedings – Annual report year: 2016

Structures that Include a Semi-Outdoor Space: Part 2: Thermal Environment
The thermal environment of buildings with a second "skin" and semi-outdoor space is examined in the present study. A literature review was conducted on similar structures and only a few studies were found focusing on the thermal environment. Two different building case studies were chosen with different building and shield geometry, different levels of insulation but same shield material; Dome of Visions (DoV) and EMBRACE. Both buildings were modelled in IDA ICE 4.6.2 simulation software in order to assess the thermal environment of the building and assess how long the semi outdoor space of each building can be used by the occupants. The study was based on weather data for Copenhagen. In addition to the simulations, physical measurements were performed in DoV to assess the thermal environment in the semi-outdoor space. Since existing standards are not applicable for semi-outdoor spaces, an alternative method was followed with adjustable clothing level and three different tolerance levels. The semi-outdoor area of both buildings was found to provide more than double the comfortable occupancy hours compared to outdoors and the semi outdoor spaces can be roughly used for 45% of the year. Finally, the semi-outdoor space’s temperature in DoV was higher than the ambient throughout winter by at least 3ºC.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Technical University of Denmark
Authors: Papachristou, C. (Ekstern), Foteinaki, K. (Intern), Kazanci, O. B. (Intern), Olesen, B. W. (Intern)
Number of pages: 10
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Title of host publication: CLIMA 2016 - Proceedings of the 12th REHVA World Congress
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Editor: Kvols Heiselberg, P.
ISBN (Print): 87-91606-36-5
BFI conference series: REHVA World Congress (5010061)
Main Research Area: Technical/natural sciences
Structures that Include a Semi-Outdoor Space: Part 1: Energy Performance

There are several examples of buildings that are partially or entirely covered by a transparent shield, such that a semi-outdoor space between the building and the shield is created. The purpose of the present study was to investigate the impact of the addition of a shield on the energy use of a building. Two case study buildings were examined: the EMBRACE dwelling, which has a climate shield on two of its sides and the "Dome of Visions (DoV)", in which a dwelling is enclosed in a domeshaped climate shield. Simulations were performed using IDA ICE software, where both buildings were simulated in two versions; with and without their climate shield. The results of the two versions were compared in terms of peak load and energy demand in the Copenhagen region, for three different cases; during the heating season, during the cooling season and during the cooling season with natural ventilation in the semi-outdoor space. In EMBRACE, the heating and cooling demand were only slightly affected by the addition of the climate shield. However, when implementing natural ventilation in the semi-outdoor space both the peak cooling load and the energy demand were reduced during the cooling season by 30.8% and 14.6% respectively. In DoV, the addition of the shield resulted in a reduced heating demand (-37.7%) but significantly higher cooling demand (109.8%), although with natural ventilation the peak cooling load and the energy demand were reduced, by 34.8% and 61.6% respectively, compared to the unshielded version of the building.

Subjective Evaluation of the Microenvironment Generated by a Hospital Bed with Localized Ventilation System

A novel method for local hospital bed ventilation, called HBIVCU (Hospital Bed with Integrated Ventilation and Cleansing Unit), was studied in a human subject experiment. The goal of this study was to identify human response to the microenvironment generated by a hospital bed with installed HBIVCU and to compare with human response to the microenvironment at a hospital bed without local ventilation. 32 participants took part in two experimental conditions - hospital bed with and without HBIVCU. The subjects evaluated the perceived air quality in the ventilated bed as better compared to that in the non-ventilated bed. The whole body thermal sensation (WTS) and acceptability votes were decreasing over time for the non-ventilated bed condition. Significant differences in the local thermal sensation LTS and the LTS acceptability votes between the two conditions could be found only for some body parts and time intervals. No draught was reported.
Successful Implementation of Energy Strategies in Local Communities through Strategic Navigation between Professions

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Aalborg University
Authors: Petersen, J. (Intern), Quitzau, M. (Ekstern)
Number of pages: 1
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Main Research Area: Technical/natural sciences
Links:
http://www.sustain.dtu.dk/

Bibliographical note
Sustain Abstract L-9
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The effects of bedroom air quality on sleep and next-day performance

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Section for Building Energy
Authors: Strøm-Tejsen, P. (Intern), Zukowska-Tejsen, D. (Intern), Wargocki, P. (Intern), Wyon, D. P. (Intern)
Number of pages: 8
Pages: 679–686
Publication date: 2016
Main Research Area: Technical/natural sciences

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Journal: Indoor Air
Volume: 26
Issue number: 5
ISSN (Print): 0905-6947
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.55
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 3.88
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 4.57
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
The effects of mixing air distribution and heat load arrangement on the performance of ceiling radiant panels under cooling mode of operation

The cooling power of radiant panels can be effected by the arrangement of heat loads and by the room air distribution system. This impact can be important because often the cooling output is the critical factor for the design and usability of radiant panels. In this study, the impact of heat load arrangement and air distribution generated in a room by linear slot diffuser, radial multi-nozzle diffuser and radial swirl induction unit on the cooling power of radiant panels was compared. The impact on the thermal environment was also studied. Measurements were carried out without and with supply air in a test chamber equipped with two ceiling radiant panels and air distribution units flush with the radiant panels. The heat load was generated through the walls and with heated cylinders. The cooling power of the radiant panels was increased with the studied air distribution methods. The increase was from 5% to 17% depending on the air distribution method and the heat load arrangement. The most significant effect of the heat load arrangement occured when heat loads are located unevenly and their convection flow turns or weakens the supply air jet flushing the radiant panels.
The Linkage of Urban and Energy Planning for Sustainable Cities: The Case of Denmark and Germany

The reduction of GHG emissions in buildings is a focus area of national energy policies in Europe, because buildings are responsible for a major share of the final energy consumption. It is at local scale where policies to increase the share of renewable energies and energy efficiency measures get implemented. Municipalities, as local authorities and responsible entity for land-use planning, have a direct influence on urban patterns and energy use, which makes them key actors in the transition towards sustainable cities. Hence, synchronizing urban planning with energy planning offers great potential to increase society’s energy-efficiency; this has a high significance to reach GHG-reduction targets. In this paper the actual linkage of urban planning and energy planning in Denmark and Germany was assessed; substantive barriers preventing their integration and driving factors that lead to successful transitions towards a holistic urban energy planning procedures were identified.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics
Authors: Petersen, J. (Intern)
Publication date: 2016

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Title of host publication: Proceedings of the 18th International Conference on Environmental Engineering and Urban Area
Main Research Area: Technical/natural sciences
Conference: 18th International Conference on Environmental Engineering and Urban Area, Lisbon, Portugal, 14/04/2016 - 14/04/2016
Energy planning, Urban planning, Renewable energies, Sustainable cities
Source: PublicationPreSubmission
Source-ID: 122357618
Publication: Research - peer-review › Article in proceedings – Annual report year: 2016

Theoretical analysis of the performance of different cooling strategies with the concept of cool exergy

The whole chains of exergy flows for different cooling systems were compared. The effects of cooling demand (internal vs. external solar shading), space cooling method (floor cooling vs. air cooling with ventilation system), and the availability of a nearby natural heat sink (intake air for the ventilation system being outdoor air vs. air from the crawl-space, and air-to-water heat pump vs. ground heat exchanger as cooling source) on system exergy performance were investigated. It is crucial to minimize the cooling demand because it is possible to use a wide range of heat sinks (ground, lake, sea-water, etc.) and indoor terminal units, only with a minimized demand. The water-based floor cooling system performed better than the air-based cooling system; when an air-to-water heat pump was used as the cooling source, the required exergy input was 28% smaller for the floor cooling system. The auxiliary exergy input of air-based systems was significantly larger than the water-based systems. The use of available cool exergy in the crawl-space resulted in 54% and 29% smaller exergy input to the power plant for the air-based and water-based cooling systems, respectively. For floor cooling, the exergy input to the power plant can be reduced by 90% and 93%, with the use of ground, and use of the ground and the air in the crawl-space, respectively. A new approach to exergy efficiency was introduced and used to prove that the exergy supply from the ground matches well with the low exergy demand of the floor cooling system.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Tokyo City University
Authors: Kazanci, O. B. (Intern), Shukuya, M. (Ekstern), Olesen, B. W. (Intern)
Pages: 102-113
Publication date: 2016
Main Research Area: Technical/natural sciences

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Journal: Building and Environment
Volume: 100
ISSN (Print): 0360-1323
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BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.51 SJR 2.015 SNIP 2.198
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 2.093 SNIP 2.49 CiteScore 4.37
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.938 SNIP 2.797 CiteScore 4.14
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.581 SNIP 2.602 CiteScore 3.57
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.331 SNIP 2.875 CiteScore 3.06
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.144 SNIP 2.255 CiteScore 2.76
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.235 SNIP 2.001
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.028 SNIP 1.865
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.924 SNIP 1.38
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.788 SNIP 1.778
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.03 SNIP 1.63
Scopus rating (2005): SJR 0.955 SNIP 1.225
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 0.548 SNIP 1.266
Scopus rating (2003): SJR 0.948 SNIP 0.921
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.998 SNIP 1.39
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.777 SNIP 1.098
Scopus rating (2000): SJR 0.526 SNIP 1.14
Scopus rating (1999): SJR 0.564 SNIP 1.175

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Electronic versions:
Theoretical_analysis_of_the_performance_manus.pdf. Embargo ended: 13/02/2018
DOIs:
10.1016/j.buildenv.2016.02.013
Source: PublicationPreSubmission
Thermal comfort and ventilation effectiveness in an office room with radiant floor cooling and displacement ventilation

The influence of displacement ventilation and a cooled floor on indoor climate in the cooling season were experimentally studied in a room representing an office with a shaded window, occupied by two simulated employees. The aim was to investigate whether the combination of these two systems can retain the favorable air and temperature distribution patterns and high ventilation effectiveness that are typically attained by displacement ventilation, while exploiting the energy conservation advantages of a high temperature cooling system. The tests were performed under a range of boundary conditions, varying the nominal air change rate from 4.5h⁻¹ down to 1.5h⁻¹. Contaminant removal and mean-age-of-air measurements were performed to characterize the ventilation effectiveness and air velocity; air and operative temperature profiles were measured, together with thermal manikin equivalent temperatures, to evaluate the thermal environment. The combined system was able to achieve good ventilation effectiveness close to a heat source, so that in the occupant’s breathing zone the ventilation effectiveness was significantly better than for ideal mixing, even at a nominal air change rate as low as 1.5h⁻¹. However, for a broad range of boundary conditions, decreasing the floor temperature resulted in vertical air temperature differences of up to 6K and vertical equivalent temperature differences of up to 8K for a seated person. Thus although the maximum draught rating at ankle level was 21% at the highest nominal air change rate of 4.5h⁻¹, even for an occupant sitting 1 meter in front of the supply diffuser, the local thermal discomfort occasioned by the excessive vertical temperature differences gives chilled ceilings the advantage over chilled floors for use with displacement ventilation.

General information

State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Slovak University of Technology, University of Padova
Authors: Krajcik, M. (Ekstern), Tomasi, R. (Ekstern), Simone, A. (Intern), Olesen, B. W. (Intern)
Number of pages: 11
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Pages: 317-327
Main Research Area: Technical/natural sciences

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Volume: 22
Issue number: 3
ISSN (Print): 2374-4731
Ratings:
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.01
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.514 SNIP 0.731
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.561 SNIP 0.891
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.544 SNIP 1.104
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.498 SNIP 0.742
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Thermal environment in simulated offices with convective and radiant cooling systems under cooling (summer) mode of operation

The thermal environment in a double office room and in a six-person meeting room obtained with chilled beam (CB), chilled beam with radiant panel (CBR), chilled ceiling with ceiling installed mixing ventilation (CCMV) and four desk partition-mounted local radiant cooling panels with mixing ventilation (MVRC) under summer (cooling) condition was compared. MVRC system was measured only for the office room case. CB provided convective cooling while the remaining three systems (CBR, CCMV and MVRC) provided combined radiant and convective cooling. Solar radiation, office equipment, lighting and occupants were simulated to obtain two different heat load conditions: 38 W/m² and 64 W/m² in the case of office room, and 71 W/m² and 86 W/m² in the case of meeting room. Air temperature, globe (operative) temperature, radiant asymmetry, air velocity and turbulent intensity were measured and draught rate calculated. Manikin-based equivalent temperature (MBET) was determined by using two thermal manikins to identify the impact of the local thermal conditions generated by the studied systems on occupants' thermal perception. The results revealed that the differences in the thermal conditions achieved with the four systems were not significant. CB and CBR provided slightly higher velocity level in the occupied zone. The operative temperature in the studied cases with chilled ceiling in operation with mixing ventilation was almost the same as the operative temperature obtained with the active chilled beam (i.e. only convective cooling). The heat load distribution played major role for the airflow pattern in all studied systems.

General information

State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Halton OY, Aalto University
Authors: Mustakallio, P. (Ekstern), Bolashikov, Z. D. (Intern), Kostov, K. (Ekstern), Melikov, A. K. (Intern), Kosonen, R. (Ekstern)
Number of pages: 10
Pages: 82-91
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Publication information
Journal: Building and Environment
Ultrafine particle exposure in Danish residencies
We measured ultrafine particle concentrations in 56 Danish residences, estimated the daily integrated exposure of the occupants and apportioned this exposure to source events. The residential daily integrated particle number (PN) exposure in the homes was substantial and source events, especially candle burning, cooking, toasting and unknown activities, were responsible on average for ~65% of the residential integrated exposure. Residents of another 60 homes were then asked to carry a backpack equipped with a GPS recorder and a portable monitor to measure real-time individual exposure over ~48 h. UFP exposure occurring in various microenvironments was estimated. The fractional contribution of each microenvironment to the daily integrated personal exposure corresponded to the fractions of the day the subjects spent in each microenvironment. The home environment accounted for 50% of the daily personal exposure, indoor environments other than home or vehicles contributed with ~40%, and being in transit or outdoors contributed 5% or less.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, University of Copenhagen, Lund University
Authors: Bekö, G. (Intern), Karottki, D. G. (Ekstern), Wierzbicka, A. (Ekstern), Toftum, J. (Intern), Loft, S. (Ekstern), Clausen, G. (Intern)
Number of pages: 2
Publication date: 2016

Electronic versions:
Beko_2016_IA_Ghent_CISBO_2_UFP.pdf

Uptake of chemicals from indoor air: Pathways and health effects
Building occupants are exposed to manufactured chemicals. Exposure in the indoor environment can occur via non-dietary ingestion (e.g. indoor dust), inhalation and dermal absorption including dermal uptake directly from air. The extent of dermal uptake from air has been previously studied for volatile organic compounds (VOC). Not much is however known about its role for semivolatile organics (SVOC) and therefore this exposure pathway is often neglected in exposure assessments. Dermal uptake received attention with regards to contact transfer from contaminated surfaces. Recent modeling efforts however indicate that direct uptake of certain semivolatile organic compounds from air may occur. Experimental verification of this hypothesis is emerging. Recent studies have demonstrated that dermal uptake of certain phthalates directly from air can be comparable to or larger than the corresponding intake from inhalation. Further experiments have been conducted with nicotine and the results are similar. Some of the SVOCs present indoors may have adverse health effects or are categorized as potential endocrine-disrupting compounds. It has been suggested that the health effects of a chemical may depend on the pathway of exposure. However, studies that investigate the health consequences of dermal uptake of SVOCs from air are lacking.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics
Authors: Bekö, G. (Intern)
Number of pages: 9
Publication date: 2016

Electronic versions:
Beko_2016_ICHES_Nagoya_WS3_Dermal_uptake.pdf
Validation of a numerical model of acoustic ceiling combined with TABS

Thermally-Active Building Systems (TABS) have proven to be an energy-efficient and economical cooling and heating solution for commercial buildings. However, acoustic comfort is often jeopardized in such buildings, due to the thermal requirements of the system. More knowledge is required to understand to which extent a layer of hanging sound absorbers will impede the heating and cooling performance of the system, and how this translates on the thermal comfort for the occupants.

In order to address these issues, this study focuses on validation of a new TRNSYS component (Type Ecophon Acoustic Elements) developed to simulate partially covered suspended ceilings such as hanging sound absorbers. The tool is validated by numerically modelling a set of similar experiments carried out in full-scale by a previous study. For this, a total of 12 scenarios from two case studies have been modelled, with varying suspended ceiling coverage ratios, type of suspended ceilings, internal heat gains and TABS water supply temperatures.

The results obtained from the simulations are very close to the experimental results. The first set of measurements analyzed the effect of the above-mentioned parameters in the heat flow from TABS; the difference between the numerical results and measurements is in the range of -6.9% to +5.2%. The second evaluates the impact on TABS cooling capacity coefficient and room temperatures. The simulated cases led to absolute differences +4.3% higher in average for the cooling capacity coefficient. The operative temperature in the room is particularly well estimated, with a maximum relative difference of +0.3°C in total of five scenarios.
Verification of Occupants' Behaviour Models in Residential Buildings

During the last decade, studies about stochastic models of occupants' behaviour in relation to control of the indoor environment have been published. Often the overall aim of these models is to enable more reliable predictions of building performance using building performance simulations (BPS). However, the validity of these models has only been sparsely tested.

In this talk three methods for evaluating the models' performance (listed below) will be described, discussed and exemplified using a dataset of window openings from Denmark.

1) Validation of state - TPR/FPR method
2) Validation of state transitions - Residuals method
3) Validation by simulation

The first two methods rely on a full dataset different to the one the models were derived from.

In the TPR/FPR method, the probability of an event is calculated using the model under evaluation. The probability is then compared to random numbers to determine if the event takes place or not. Finally, the simulated window position is compared to the measured ones and the True Positive Rate and False Positive Rate along with other metrics can be calculated and compared. The method evaluates the models abilities to predict the position of the window and the method works well if the model only relies on outdoor conditions. However, if the model under evaluation relies on variables that are affected by the window position (most indoor environmental variables), the method has inherent problems.

In the Residuals method the probabilities are compared directly to the measurements and no comparisons with random numbers are required. This has the benefit of avoiding feedback problems described above. The method evaluates the models abilities to predict the events rather than the position of the window. In the method, the model is used to calculate transition probabilities based on the dataset. In each time step, the probabilities are subtracted from the observed transitions, to find the residuals. Finally, the residuals can be averaged, and compared.

The validation by simulation relies on detailed Building Performance Simulations (BPS) using models under evaluation. In the method, different models of occupant behaviour are implemented in a BPS programme and detailed simulations are performed. The simulation results are compared to measurements in the simulated building to see which models best predicted the measurements. The method works under the assumption that any differences between measurements and simulation results are due to the occupant behaviour models' inaccuracies to make correct predictions. This assumption is only true if all other sources of uncertainty have been ruled out by careful calibration of the BPS model.

General information

State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics
Authors: Andersen, R. K. (Intern)
Number of pages: 1
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Main Research Area: Technical/natural sciences
Electronic versions:
Abstract_for_OB_16_symposium_aug_2016_version_2.pdf

Relations
Activities:
OB-16 International Symposium on Building Energy Performance and Occupant Behavior
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2017

Visualization of the structural changes in plywood and gypsum board during the growth of Chaetomium globosum and Stachybotrys chartarum

Fungal growth in indoor environments is associated with many negative health effects. Many studies focus on brown- and white-rot fungi and their effect on wood, but there is none that reveals the influence of soft-rot fungi, such as Stachybotrys spp. and Chaetomium spp., on the structure of building materials such as plywood and gypsum wallboard. This study focuses on using micro-computed tomography (microCT) to investigate changes of the structure of plywood and gypsum wallboard during fungal degradation by S. chartarum and C. globosum. Changes in the materials as a result of dampness and fungal growth were determined by measuring porosity and pore shape via microCT. The results show that the composition of the building material influenced the level of penetration by fungi as shown by scanning electron microscopy (SEM). Plywood appeared to be the most affected, with the penetration of moisture and fungi throughout the whole thickness of the sample. Conversely, fungi grew only on the top cardboard in the gypsum wallboard and they did not have significant influence on the gypsum wallboard structure. The majority of the observed changes in gypsum wallboard occurred due to moisture. This paper suggests that the mycelium distribution within building materials and the structural changes, caused by dampness and fungal growth, depend on the type of the material.
Advanced air distribution method combined with deodorant material for exposure reduction to bioeffluents contaminants in hospitals

The separate and combined effect of a ventilated mattress and acid-treated activated carbon fibre (ACF) fabric on reducing the exposure to body generated gaseous pollutants in hospital environment was studied. Full-scale experiments were performed in a climate chamber furnished as a single-bed hospital patient room at reduced background ventilation rate of 1.6 air changes per hour. The bed of the patient was equipped with the ventilated mattress (VM) having an exhaust opening from which bioeffluents generated from human body were sucked and discharged from the room. To enhance the pollutant removal, acid-treated activated carbon fibre material was used in some of the experiments in the form of patient’s cover. The simulated pollution source was ammonia gas released from the patient’s groins. The results show that when using the ventilated mattress the ammonia gas concentration in the room was significantly reduced compared to the concentration measured when the VM was not in operation. The concentration of ammonia gas in the room was 100% removed when the VM operating at 1.5 L/s and the ACF material used as a cover were used together.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Otsuma Women’s University
Authors: Bivolarova, M. P. (Intern), Mizutani, C. (Ekstern), Melikov, A. K. (Intern), Bolashikov, Z. D. (Intern)
Number of pages: 8
Publication date: 2015

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Local air distribution, Air cleaning, Indoor air quality (IAQ), Hospital environment
Electronic versions:
Paper_ID632.pdf
Publication: Research - peer-review › Article in proceedings – Annual report year: 2016

Aggregation of building energy demands for city-scale models

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Section for Building Energy, Centre for IT-Intelligent Energy Systems in Cities, Department of Management Engineering, Systems Analysis, DTU Climate Centre, Energy Systems Analysis, Section for Building Design
Authors: Gianniou, P. (Intern), Heller, A. (Intern), Nielsen, P. S. (Intern), Negendahl, K. (Intern), Rode, C. (Intern)
Number of pages: 9
Publication date: 2015

Host publication information
Title of host publication: Proceedings of Building Simulation 2015
Air distribution in a multi-occupant room with mixing or displacement ventilation with or without floor or ceiling heating

This study performed a comparative analysis of the air distribution in a multi-occupant room with mixing or displacement ventilation and the effect of adding floor or ceiling heating to each of them. The vertical distribution of indoor air temperature and velocity in the occupied zone and the horizontal distribution of indoor containment concentration in the breathing zone were measured for all six systems with a supply air temperature of 19.0°C and an air change rate of 4.2 h⁻¹. The results showed that the mean vertical air temperature difference in the occupied zone varied from 0.1°C to 0.6°C; the mean local turbulence intensity varied from 12.0% to 14.1% with mixing ventilation with or without floor or ceiling heating, and the corresponding values were 1.5°C to 2.5°C and 7.3% to 9.8% with displacement ventilation with or without floor or ceiling heating. Mean air distribution effectiveness varied from 0.93 to 1.0 for mixing ventilation and from 1.06 to 1.14 for displacement ventilation with or without floor or ceiling heating. The results are relevant to the design and control of mixing and displacement ventilation with or without floor or ceiling heating in a multi-occupant room.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Section for Indoor Climate and Building Physics, Xi'an Jiaotong University
Authors: Wu, X. (Ekstern), Fang, L. (Intern), Olesen, B. W. (Intern), Zhao, J. (Ekstern), Wang, F. (Ekstern)
Number of pages: 8
Pages: 1109-1116
Publication date: 2015
Main Research Area: Technical/natural sciences

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Web of Science (2016): Indexed yes
Scopus rating (2015): SJR 0.644 SNIP 0.888
Web of Science (2015): Indexed yes
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Web of Science (2014): Indexed yes
Scopus rating (2013): SJR 0.618 SNIP 0.89
Web of Science (2013): Indexed yes
Scopus rating (2012): SJR 0.587 SNIP 1.109
Web of Science (2012): Indexed yes
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Web of Science (2011): Indexed yes
Scopus rating (2010): SJR 1.027 SNIP 0.955
Web of Science (2010): Indexed yes
Scopus rating (2009): SJR 1.767 SNIP 1.187
Web of Science (2009): Indexed yes
Scopus rating (2008): SJR 0.866 SNIP 0.903
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.804 SNIP 1.625
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.907 SNIP 1.302
Air quality Performance of Ductless Personalized Ventilation in Conjunction with Displacement Ventilation: Impact of Walking Person

The present experiment evaluates the impact of air disturbances from a walking person on inhaled air by ductless personalized ventilation (DPV) with displacement ventilation (DV), when a seated occupant is the source of pollution: bio-effluents and exhaled air. The measurements took place in a full-scale office room with two side by side workstations. Each desk included a DPV, a personal computer and desk lamps. Two dressed, breathing thermal manikins were used as seated occupants. DV floorstanding air supply was installed at the wall facing the workstations. A real person was walking between the desks and the DV supply. Pollution from feet and exhaled air by one manikin was simulated with tracer gases. Room temperature of 26 °C and 90 L/s DV supply flow rate were kept constant. Measurements under numerous combinations of DPV operation modes and supply flow rates were performed. Tracer gas concentrations in inhaled air by the two manikins were measured. The DPV was not able to protect the exposed person from contaminants emitted from a sitting and polluting occupant when there were disturbances close to the DPV. However, using the DPV at the polluting manikin’s workstation resulted in better inhaled air quality for the polluting manikin.

General information

State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Technical University of Denmark
Authors: Bolashikov, Z. D. (Intern), Lu, P. (Ekstern), Melikov, A. K. (Intern), Tomasz, M. (Ekstern)
Number of pages: 8
Publication date: 2015

Host publication information

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Article number: 458
Main Research Area: Technical/natural sciences
Conference: Healthy Buildings Europe 2015, Eindhoven, Netherlands, 18/05/2015 - 18/05/2015
“Ductless” personalized ventilation, Exposure, Bio-effluents
Source: PublicationPreSubmission
Source-ID: 131108427
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

Air temperature investigation in microenvironment around a human body

The aim of this study is to investigate the temperature boundary layer around a human body in a quiescent indoor environment. The air temperature, mean in time and standard deviation of the temperature fluctuations around a breathing thermal manikin are examined in relation to the room temperature, body posture and human respiratory flow. To determine to what extent the experiments represent the realistic scenario, the additional experiments were performed with a real human subject. The results show that at a lower room air temperature (20°C), the fluctuations of air temperature increased close to the surface of the body. The large standard deviation of air temperature fluctuations, up to 1.2°C, was recorded in the region of the chest, and up to 2.9°C when the exhalation was applied. The manikin leaned backwards increased the air temperature in the breathing zone, which was opposite from the forward body inclination. Exhalation through the mouth created a steady air temperature drop with increased distance from the mouth without disturbing the region of the chest. Exhalation through the nose did not affect the air temperature in front of the chest due to physics of the jets flow from the nose. The additional carbon dioxide (CO₂) measurements showed that the exhaled air from the nose could penetrate the
region below the chest. Small discrepancies between the results obtained with the breathing thermal manikin and a real human subject suggest that the manikin can be used for accurate measurements of occupant's thermal microenvironment.

**General information**

State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Section for Indoor Climate and Building Physics, National University of Singapore
Authors: Licina, D. (Intern), Melikov, A. K. (Intern), Sekhar, C. (Ekstern), Tham, K. W. (Ekstern)
Number of pages: 9
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Main Research Area: Technical/natural sciences

**Publication information**

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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.51 SJR 2.015 SNIP 2.198
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 2.093 SNIP 2.49 CiteScore 4.37
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.938 SNIP 2.797 CiteScore 4.14
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.581 SNIP 2.602 CiteScore 3.57
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Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.331 SNIP 2.875 CiteScore 3.06
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.144 SNIP 2.255 CiteScore 2.76
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.235 SNIP 2.001
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.028 SNIP 1.865
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.924 SNIP 1.38
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.788 SNIP 1.778
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.03 SNIP 1.63
Scopus rating (2005): SJR 0.955 SNIP 1.225
Web of Science (2005): Indexed yes
A model to predict concentrations of DnBP metabolites in urine from a vapor-phase exposure

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, U.S. Environmental Protection Agency, Tsinghua University, Rutgers University, Institute for Prevention and Occupational Medicine of the German Social Accident Insurance, Fraunhofer Wilhelm-Klauditz-Institut (WKI), Missouri University of Science and Technology
Authors: Lorber, M. (Ekstern), Gong, M. (Ekstern), Weschler, C. (Ekstern), Bekö, G. (Intern), Koch, H. (Ekstern), Salthammer, T. (Ekstern), Schripp, T. (Ekstern), Toftum, J. (Intern), Morrison, G. (Ekstern), Zhang, Y. (Ekstern), Clausen, G. (Intern)
Publication date: 2015
Main Research Area: Technical/natural sciences
Electronic versions: Lorber_2015_ISES_Abstract_model_DnBP_in_urine_from_air.pdf
Source: PublicationPreSubmission
Source-ID: 119503258
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2015

A new simplified model to calculate surface temperature and heat transfer of radiant floor heating and cooling systems

In this paper, a new simplified model to calculate surface temperature and heat transfer of radiant floor heating and cooling system was proposed and established using the conduction shape factor. Measured data from references were used to validate the proposed model. The results showed that the maximum differences between the calculated surface temperature and heat transfer using the proposed model and the measured data were 0.8 ºC and 8.1 W/m² for radiant floor heating system when average water temperature between 40 ºC and 60 ºC. For the corresponding values were 0.3 ºC and 2.0 W/m² for radiant floor cooling systems when average water temperature between 10 ºC and 20 ºC.
Numerically simulated data in this study were also used to validate the proposed model. The results showed that the surface temperature and heat transfer of radiant floor calculated by the proposed model agreed very well with the numerically simulated data when average water temperature changing from 25 ºC to 45 ºC for radiant floor heating systems and from 10 ºC to 20 ºC for radiant floor cooling systems. Hence, the proposed model was validated to be applicable and was believed to be potentially beneficial for the design and control of radiant floor heating and cooling systems. © 2015 Elsevier B.V. All rights reserved.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Harbin Institute of Technology, Xi'an Jiaotong University
Authors: Wu, X. (Ekstern), Zhao, J. (Ekstern), Olesen, B. W. (Intern), Fang, L. (Intern), Wang, F. (Ekstern)
Number of pages: 9
Pages: 285-293
Publication date: 2015
Main Research Area: Technical/natural sciences
Application of users' light-switch stochastic models to dynamic energy simulation

The design of an innovative building should include building overall energy flows estimation. They are principally related to main six influencing factors (IEA-ECB Annex 53): climate, building envelope and equipment, operation and maintenance, occupant behaviour and indoor environment conditions. Consequently, energy-related occupant behaviour should be taken into account by energy simulation software. Previous researches (Bourgeois et al. 2006, Buso 2012, Fabi 2012) already revealed the differences in terms of energy loads between considering occupants' behaviour as stochastic processes rather than deterministic inputs, due to the uncertain nature of human behaviour. In this paper, new stochastic models of users' interaction with artificial lighting systems are developed and implemented in the energy simulation software IDA ICE. They were developed from field measurements in an office building in Prague. The aim is to evaluate the impact of a user's switching action over whole building energy consumption. Indeed, it is interesting not only to see the variance related to electric energy consumption, but the overall effect on a building's energy load.

General information
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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Politecnico di Torino
Authors: Camisassi, V. (Ekstern), Fabi, V. (Ekstern), Andersen, R. K. (Intern), Corgnati, S. (Ekstern)
Number of pages: 11
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Association between classroom ventilation mode and learning outcome in Danish schools

Associations between learning, ventilation mode, and other classroom characteristics were investigated with data from a Danish test scheme and two widespread cross-sectional studies examining air quality in Danish schools. An academic achievement indicator as a measure of the learning outcome was calculated from the scores of a standardized Danish test scheme adjusted for a socioeconomic reference index. Pupils in schools with balanced mechanical ventilation had significantly higher achievement indicators than pupils in schools with natural ventilation, where airing took place mostly by manual window opening. Also, the carbon dioxide concentration was lower in classrooms with balanced mechanical ventilation. There was no consistent association between the achievement indicators and the person specific room volume, construction/renovation year, or the occupancy. Measurements of carbon dioxide concentrations and temperatures in 820 classrooms in 389 schools were available. In 56% and 66% of the classrooms included in the two studies, the measured CO₂ concentration was higher than 1000ppm. The findings of this study add to the growing evidence that insufficient classroom ventilation have impacts on learning outcomes.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Section for Indoor Environment, Technical University of Denmark
Authors: Toftum, J. (Intern), Kjeldsen, B. U. (Intern), Wargocki, P. (Intern), Menà, H. R. (Ekstern), Hansen, E. M. (Ekstern), Clausen, G. (Intern)
Number of pages: 10
Pages: 494-503
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: Building and Environment
Building certification schemes and the quality of indoor environment

Building certification schemes create a new standard for the built environment reflecting the growing environmental consciousness and the need for “green buildings”. They are expected to signify an outstanding quality and excellence. Buildings, which receive a high degree of certification, are consequently presumed to guarantee the outstanding indoor environmental quality (IEQ). There still exists, however, scarcity of data supporting this postulation, especially as regards the ratings and perceptions of occupants of certified buildings. This PhD attempts to shed a light on this topic and supplement with new measuring data. It attempts additionally to formulate recommendations regarding future revisions of building certifications, so that the IEQ requirements, human needs and expectations are sufficiently addressed.

These objectives were attained initially by reviewing the scientific literature, providing information on the performance of building certification schemes in relation to IEQ and ratings of building occupants. Then, information was collected on IEQ in existing office buildings certified as green buildings with particular focus on the work performance indicators, acute health symptoms, and perceptions and comfort.

Information on IEQ in the existing buildings was collected through field campaigns. They comprised measurements in 6 office buildings in Singapore certified using the Green Mark (GM) Certification Scheme. The measurements were additionally carried out in 6 office buildings that are not certified, and do not qualify for GM certification. The study looked into seven dimensions in a holistic and longitudinal approach. A special on-line software was developed for collecting responses from building occupants. It integrates the questions regarding satisfaction, acute health symptoms, information on the conditions and parameters supporting and distracting from the efficient work, as well as the self-estimated performance and objectively measured performance using different tasks examining various cognitive skills. The data on absence rates was collected, too, and the range of environmental measurements performed.

Literature review showed that holistic and transversal IEQ studies comparing Green and Non-Green buildings are rare, with most of the evidence over-represented by post-occupancy surveys. Generally results show that green buildings outperform non-green for most of the IEQ parameters, with exception of acoustic, lighting, and glare. Results of measurements were modeled with statistical methods. They were then correlated with the measurements of IEQ parameters in the buildings. The results and analyses were specifically aiming in examining the differences between Green Mark and Non-Green Mark buildings. Physical measurements did not differ significantly between Green Mark and Non-Green Mark. Occupants’ satisfaction, importance and perceptions of IEQ parameters were observed to be better in GM buildings compared with the NGM buildings and the difference could be caused both by actual exposures and psychosocial factors. Air quality is the most important IEQ parameter for occupants in Green Mark buildings. Acoustical and visual privacy is problematic in Green Mark buildings. The odds of SBS symptoms in Green Mark are half of the odds in Non-Green Mark. Occupant self-assessment performance is better in GM buildings but no significant differences were observed for objective performance between occupants in both types of buildings. Annual sick-leave was lower in the Green Mark buildings; the difference was one day per year. In
conclusion, Green Mark buildings have generally a positive impact on occupants, compared with Non-Green Mark buildings. Improvements and future modifications of the building certification schemes are discussed. O.C.E.A.N (Organization, commitment, environment, aesthetics and natural) approach and a metric to integrate human satisfaction responses in certification schemes are recommended. Additionally, experiences collected during the fieldwork are used to upgrade the software for collection of subjective responses with an intent to use it for developing a common standard that can be used for gauging and benchmarking IEQ in buildings, as well as for examining the performance of buildings.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, National University of Singapore
Authors: Da Silva, N. A. F. (Intern), Wargocki, P. (Intern), Tham, K. W. (Ekstern)
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Building energy demand aggregation and simulation tools: a Danish case study
Nowadays, the minimization of energy consumption and the optimization of efficiency of the overall energy grid have been in the agenda of most national and international energy policies. At the same time, urbanization has put cities under the microscope towards achieving cost-effective energy savings due to their compact and highly dense form. Thus, accurate estimation of energy demand of cities is of high importance to policy-makers and energy planners. This calls for automated methods that can be easily expandable to higher levels of aggregation, ranging from clusters of buildings to neighbourhoods and cities. Buildings occupy a key place in the development of smart cities as they represent an important potential to integrate smart energy solutions. Building energy consumption affects significantly the performance of the entire energy network. Therefore, a realistic estimation of the aggregated building energy use will not only ensure security of supply but also enhance the stabilization of national energy balances.

In this study, the aggregation of building energy demand was investigated for a real case in Sønderborg, Denmark. Sixteen single-family houses -mainly built in the 1960s- were examined, all connected to the regional district heating network. The aggregation of building energy demands was carried out according to typologies, being represented by archetype buildings. These houses were modelled with dynamic energy simulation software and with a simplified simulation tool, which is based on monthly quasi-steady state calculations, using a visual parametric programming language (Grasshopper) coupled with a 3D design interface (Rhinoceros). The estimated heat demand of the examined houses from both simulation tools is compared to actual measured data of heat consumption. An assessment of the two different types of tools follows, which will indicate the suitability of each tool depending on the desired accuracy of results and on the purpose of analysis.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Section for Building Energy, Centre for IT-Intelligent Energy Systems in Cities
Authors: Gianniou, P. (Intern), Heller, A. (Intern), Rode, C. (Intern)
Number of pages: 6
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Main Research Area: Technical/natural sciences
Conference: CISBAT 2015, Lausanne, Switzerland, 09/09/2015 - 09/09/2015
Building energy, Heat demand, Archetypes, Energy Simulation Tools
Electronic versions:
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Source: PublicationPreSubmission
Can we establish relationship between outdoor air ventilation and health based on the published epidemiological data?

Appropriate exposure control is prerogative for reducing the burden of disease (BOD) due to inadequate air quality indoors (IAQ). Ventilation with outdoor air is one of the available exposure control methods and is widespread. It is often assumed that this method will bring tangible effects on health. This paper examines whether the available archival epidemiological evidence provides information on the link between outdoor air ventilation and health that can be used for regulative purposes, when ventilation requirements for non-industrial built environments are set. To achieve this goal, multidisciplinary review was carried out of the scientific literature on health and outdoor air ventilation in non-industrial indoor environments (not covered by previous reviews on this topic) and of major reviews on this topic. The results show, that effects on health were seen for wide range of ventilation rates from 6-7 L/s per person, which were the lowest ventilation rates, at which no effects on some health outcomes were observed in field studies, until 25-40 L/s per person, which were in some studies the highest ventilation rates needed so no effects on health outcomes were seen. The actual contaminant exposures at various levels of ventilation were no characterized. It was observed that available data have many limitations, such as insufficient statistical power, incomplete data on the strength of pollution sources, diversity and variability of ventilation rates, at which effects have been seen, no standardized duration of exposures and diversity of the outcomes, as well as different sensibility of populations exposed. The health-ventilation relationship cannot thus competently be established, also because it must be admitted that outdoor air ventilation is only indirectly related to health by modifying exposures affecting health. It is concluded, that currently available epidemiological data do not provide sound basis for outdoor air ventilation requirements that can be universally applicable in different public and residential buildings to protect against health risks. They show minimum rates at which some health outcomes can be avoided, but these may not be generalized for the entire population of buildings, and thus cannot be used for setting minimum standards and/or regulations. Consequently, ventilation should not be advocated as the only solution to modify exposures, and should be implemented together with, and preferably after, other methods of controlling exposures have been fully exploited.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, University of Milan
Authors: Carrer, P. (Ekstern), Wargocki, P. (Intern), Fanetti, A. (Ekstern)
Number of pages: 8
Pages: 62-69
Publication date: 2015

Host publication information
Title of host publication: Proceedings of the 11th International Conference on Industrial Ventilation
Volume: 1
Publisher: Tongji University
Main Research Area: Technical/natural sciences
Conference: 11th International Conference on Industrial Ventilation, Shanghai, China, 26/10/2015 - 26/10/2015
Electronic versions: T1_0050_v2.pdf
Source: FindIt
Source-ID: 2345974764
Publication: Research - peer-review › Article in proceedings – Annual report year: 2016

Case-study of thermo active building systems in Japanese climate
Thermo active building systems (TABS) have been applied in office buildings as a promising energy efficient solution in many European countries. The utilization of building thermal mass helps to provide high quality thermal environments with less energy consumption. However, the concept of TABS is entirely new in Japan. This paper introduces and evaluates TABS under Tokyo weather conditions to clarify the potential of use TABS in Japan. Cooling capacity of thermo active building systems used in an office building was evaluated by means of dynamic simulations. Two central rooms of the office were selected for the analysis. Six water control strategies were studied and two of those were found reasonable and suitable for TABS use in Tokyo. These two strategies are: free-cooling using underground heat exchanger combined with TABS and free-cooling with desiccant dehumidification system. For these two cases, the operative temperature was between 22-27 °C during 97 similar to 99% of the occupation time. The operative temperature drift was less than 4 °C per day. The pump miming time was 7 hours per day and the cooling power of the TABS was 36 W/m2 floor area. For those free-cooling cases, the average supply water temperature was 20 °C, which shows that free-cooling is achievable using underground heat exchangers even considering the temperature increase of the ground during cooling season.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Eindhoven University of Technology, University of Tokyo
Authors: Li, R. (Ekstern), Yoshidomi, T. (Ekstern), Ooka, R. (Ekstern), Olesen, B. W. (Intern)
Climate Change and Its Impact on the Operation and Maintenance of Buildings

State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Department of Management Engineering, Centre for Facilities Management, Systems Analysis, DTU Climate Centre, Gentofte Kommune
Authors: Cox, R. A. (Intern), Rode, C. (Intern), Nielsen, S. B. (Intern), Tarhan, S. (Ekstern)
Number of pages: 69
Publication date: 2015

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Series: B Y G D T U. Rapport
Number: 312
ISSN: 1601-2917
Main Research Area: Technical/natural sciences
Electronic versions:
Climate_change_and_its_impact.pdf
Source: PublicationPreSubmission
Source-ID: 122245456
Publication: Research › Ph.D. thesis – Annual report year: 2016

Comfort and performance impact of personal control over thermal environment in summer: Results from a laboratory study
Field studies suggest that the availability of adjustable thermostats, operable windows and other controls has a positive impact on comfort, the incidence of building related symptoms and productivity. This laboratory study was designed to further investigate how having or not having control over the thermal environment affects human responses to the indoor environment. The study was conducted in summer in a field laboratory that was kept at 28°C. A total of 23 subjects were exposed twice for about 2.5h. During the first session (A) subjects were able to fine-tune their local thermal environment at any given time with a personal desk fan with continuous, stepless adjustable control. During the second session (B) subjects still had the desk fans, but this time the fans were controlled from an adjacent room by the researchers who adjusted the individual air speed profiles so they were identical to those recorded during the first session. Thus, each subject was exposed to two customized conditions with identical exposure, only different from a psychological point of view. During the two sessions identical questionnaires and performance tests were used to evaluate subjects’ comfort, SBS symptom incidence and performance. As expected, perceived control over the environment was significantly higher during session A, but there were no differences in perceived comfort and SBS symptom intensity. Both self-assessed and objectively measured performance was significantly better during session B. About two-thirds of the subjects indicated to prefer the situation as during the first session when they themselves controlled the air movement.
Comparative analysis of modified PMV models and SET models to predict human thermal sensation in naturally ventilated buildings

In this paper, a comparative analysis was performed on the human thermal sensation estimated by modified predicted mean vote (PMV) models and modified standard effective temperature (SET) models in naturally ventilated buildings; the data were collected in field study. These prediction models were developed on the basis of the original PMV/SET models and consider the influence of occupants’ expectations and human adaptive functions, including the extended PMV/SET models and the adaptive PMV/SET models. The results showed that when the indoor air velocity ranged from 0 to 0.2m/s and from 0.2 to 0.8m/s, the expectancy factors for the extended PMV model and the extended SET model were from 0.770 to 0.974 and from 1.330 to 1.363, and the adaptive coefficients for the adaptive PMV model and the adaptive SET model were from 0.029 to 0.167 and from-0.213 to-0.195. In addition, the difference in thermal sensation between the measured and predicted values using the modified PMV models exceeded 25%, while the difference between the measured thermal sensation and the predicted thermal sensation using modified SET models was approximately less than 25%. It is concluded that the modified SET models can predict human thermal sensation more rationally and accurately compared with the modified PMV models in naturally ventilated buildings probably because air velocity has a strong effect on human thermal sensation in naturally ventilated buildings.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Xi’an University of Architecture and Technology
Authors: Gao, J. (Ekstern), Wang, Y. (Ekstern), Wargocki, P. (Intern)
Number of pages: 9
Pages: 200-208
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: Building and Environment
Volume: 92
ISSN (Print): 0360-1323
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.51 SJR 2.015 SNIP 2.198
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 2.093 SNIP 2.49 CiteScore 4.37
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.938 SNIP 2.797 CiteScore 4.14
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Exposure to ultrafine particles (UFP) may have adverse health effects. Central monitoring stations do not represent the personal exposure to UFP accurately. Few studies have previously focused on personal exposure to UFP. Sixty non-smoking residents living in Copenhagen, Denmark were asked to carry a backpack equipped with a portable monitor, continuously recording particle number concentrations (PN), in order to measure the real-time individual exposure over a period of similar to 48 h. A GPS logger was carried along with the particle monitor and allowed us to estimate the contribution of UFP exposure occurring in various microenvironments (residence, during active and passive transport, other indoor and outdoor environments) to the total daily exposure. On average, the fractional contribution of each microenvironment to the daily integrated personal exposure roughly corresponded to the fractions of the day the subjects spent in each microenvironment. The home environment accounted for 50% of the daily personal exposure. Indoor environments other than home or vehicles contributed with similar to 40%. The highest median UFP concentration was obtained during passive transport (vehicles). However, being in transit or outdoors contributed 5% or less to the daily exposure. Additionally, the subjects recorded in a diary the periods when they were at home. With this approach, 66% of the total daily exposure was attributable to the home environment. The subjects spent 28% more time at home according to the diary, compared to the GPS. These results may indicate limitations of using diaries, but also possible inaccuracy and miss-classification in the GPS data. (C) 2015 Elsevier Ltd. All rights reserved.
Coupling and quantifying resilience and sustainability in facilities management

Purpose – The purpose of this paper is to consider how to couple and quantify resilience and sustainability, where sustainability refers to not only environmental impact, but also economic and social impacts. The way a particular function of a building is provisioned may have significant repercussions beyond just resilience. The goal is to develop a decision support tool for facilities managers.

Design/methodology/approach – A risk framework is used to quantify both resilience and sustainability in monetary terms. The risk framework allows to couple resilience and sustainability, so that the provisioning of a particular building can be investigated with consideration of functional, environmental, economic and, possibly, social dimensions. Findings – The method of coupling and quantifying resilience and sustainability (CQRS) is illustrated with a simple example that highlights how very different conclusions can be drawn when considering only resilience or resilience and sustainability.

Research limitations/implications – The paper is based on a hypothetical example. The example also illustrates the difficulty in deriving the costs and probabilities associated with particular indicators. Practical implications – The method is generic, allowing the method to be customized for different user communities. Further research is needed to translate this theoretical framework to a practical tool for practitioners and to evaluate the CQRS method in practice.

Originality/value – The intention of this research is to fill the gap between the need for increasing sustainability and resilience of the built environment and the current practices in property maintenance and operation.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Department of Management Engineering, Centre for Facilities Management, Systems Analysis, DTU Climate Centre, Energy Systems Analysis
Authors: Cox, R. A. (Intern), Nielsen, S. B. (Intern), Rode, C. (Intern)
Pages: 314-331
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Facilities Management
Volume: 13
Issue number: 4
ISSN (Print): 1472-5967
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 1
BFI (2015): BFI-level 2
Coupling of phase change material with nighttime radiative cooling

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics
Authors: Pean, T. (Intern), Bourdakis, E. (Intern), Olesen, B. W. (Intern)
Number of pages: 1
Publication date: 2015

Host publication information
Title of host publication: Book of Abstracts. DTU's Sustain Conference 2015
Place of publication: Lyngby
Publisher: Technical University of Denmark (DTU)
Article number: E-8
Main Research Area: Technical/natural sciences
Conference: DTU Sustain Conference 2015, Lyngby, Denmark, 17/12/2015 - 17/12/2015
Electronic versions:
E8_DTU_Sustain_2015.pdf
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2015

Description of the passive air supply system based on ventilation windows supported by chimneys

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics
Authors: Cox, R. A. (Intern)
Number of pages: 39
Publication date: 2015

Publication information
Publisher: DTU Byg, Danmarks Tekniske Universitet
ISBN (Print): 9788777774330
Original language: English
Main Research Area: Technical/natural sciences
Electronic versions:
Technical_Report_090615.pdf
Publication: Research › Report – Annual report year: 2016

Bibliographical note
BYG R-342
Publication: Research › Report – Annual report year: 2016
Effectiveness of a personalized ventilation system in reducing personal exposure against directly released simulated cough droplets

The inhalation intake fraction was used as an indicator to compare effects of desktop personalized ventilation and mixing ventilation on personal exposure to directly released simulated cough droplets. A cough machine was used to simulate cough release from the front, back, and side of a thermal manikin at distances between 1 and 4m. Cough droplet concentration was measured with an aerosol spectrometer in the breathing zone of a thermal manikin. Particle image velocimetry was used to characterize the velocity field in the breathing zone. Desktop personalized ventilation substantially reduced the inhalation intake fraction compared to mixing ventilation for all investigated distances and orientations of the cough release. The results point out that the orientation between the cough source and the breathing zone of the exposed occupant is an important factor that substantially influences exposure. Exposure to cough droplets was reduced with increasing distance between cough source and exposed occupant.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, University of Maryland, National University of Singapore
Authors: Pantelic, J. (Ekstern), Tham, K. W. (Ekstern), Licina, D. (Intern)
Number of pages: 11
Pages: 683-693
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: Indoor Air
Volume: 25
Issue number: 6
ISSN (Print): 0905-6947
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.55
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 3.88
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 4.57
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 3.63
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 2.72
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 2.42
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Web of Science (2009): Indexed yes
Enhance total heat recovery for ventilation with flash evaporative cooling

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics
Authors: Fang, L. (Intern), Yuan, S. (Ekstern), Yang, J. (Ekstern)
Publication date: 2015

Host publication information
Title of host publication: Proceedings of Healthy Buildings 2015
BFI conference series: Healthy Buildings : The International Conference & Exhibition (5010979)
Main Research Area: Technical/natural sciences
Conference: Healthy Buildings Europe 2015, Eindhoven, Netherlands, 18/05/2015 - 18/05/2015
Publication: Research - peer-review › Article in proceedings – Annual report year: 2016

Er ventilation også velfærdsteknologi?

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics
Authors: Toftum, J. (Intern)
Number of pages: 1
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Main Research Area: Technical/natural sciences

Publication information
Journal: H V A C Magasinet
Volume: 51
Issue number: 11
ISSN (Print): 1603-6913
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
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Links:
http://ipaper.ipapercms.dk/TechMedia/HVACMagasinet/2015/11/
Source: PublicationPreSubmission
Experimental evaluation of enthalpy efficiency and gas-phase contaminant transfer in an enthalpy recovery unit with polymer membrane foils

Experimental studies were conducted in a laboratory setting to investigate the enthalpy efficiency and gas-phase contaminant transfer in a polymer membrane enthalpy recovery unit. One commercially available polymer membrane enthalpy recovery unit was used as a reference unit. Simulated indoor air and outdoor air by twin chambers was connected to the unit. Three chemical gases were dosed to the indoor exhaust air to mimic indoor air contaminants. Based on the measurements of temperature, humidity ratio, and contaminant concentrations of the indoor exhaust air and outdoor air supply upstream and downstream of the unit, the temperature efficiencies, humidity efficiencies, enthalpy efficiencies, and contaminant transfer ratios were calculated. The results showed that over 60% of enthalpy recovery efficiency could be achieved and that the contaminant transfer ratios were in the range of 5.4% to 9.0%. The enthalpy efficiency in cold-dry climate conditions was slightly higher than in hot-humid climate conditions. The contaminant transfer ratio were independent of any hygrothermal difference between indoor and outdoor air and was unrelated to its molecule size or water solubility. The conclusion indicated that the polymer membrane enthalpy recovery unit may be a viable choice for energy recovery in ventilation systems.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Tianjin University, Shanghai Research Institute of Building Sciences
Authors: Nie, J. (Intern), Yang, J. (Ekstern), Fang, L. (Intern), Kong, X. (Ekstern)
Number of pages: 10
Pages: 150-159
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: Science and Technology for the Built Environment
Volume: 21
Issue number: 2
ISSN (Print): 2374-474x
Ratings:
Web of Science (2018): Indexed yes
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 1.01
Web of Science (2016): Indexed yes
Scopus rating (2015): SJR 0.644 SNIP 0.888
Web of Science (2015): Indexed yes
Scopus rating (2014): SJR 0.578 SNIP 0.846
Web of Science (2014): Indexed yes
Scopus rating (2013): SJR 0.618 SNIP 0.89
Web of Science (2013): Indexed yes
Scopus rating (2012): SJR 0.587 SNIP 1.109
Web of Science (2012): Indexed yes
Scopus rating (2011): SJR 0.541 SNIP 0.74
Web of Science (2011): Indexed yes
Scopus rating (2010): SJR 1.027 SNIP 0.955
Web of Science (2010): Indexed yes
Scopus rating (2009): SJR 1.767 SNIP 1.187
Web of Science (2009): Indexed yes
Scopus rating (2008): SJR 0.866 SNIP 0.903
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.804 SNIP 1.625
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.907 SNIP 1.302
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.471 SNIP 1.257
Experimental Studies on Removal of Air-borne Haloanisoles by Photocatalytic Oxidation and Plasma Air Purifiers

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics
Authors: Fang, L. (Intern), Bermúdez, R. (Ekstern)
Publication date: 2015

Host publication information
Title of host publication: Proceedings of ISHVAC-COBEE 2015
Main Research Area: Technical/natural sciences
Conference: ISHVAC-COBEE 2015, Tianjin, China, 12/06/2015 - 12/06/2015
Publication: Research - peer-review › Article in proceedings – Annual report year: 2016

Experimental study of energy performance in low-temperature hydronic heating systems
Energy consumption, thermal environment and environmental impacts were analytically and experimentally studied for different types of heat emitters. The heat emitters studied were conventional radiator, ventilation radiator, and floor heating with medium-, low-, and very-low-temperature supply, respectively. The ventilation system in the lab room was a mechanical exhaust ventilation system that provided one air change per hour of fresh air through the opening in the external wall with a constant temperature of 5°C, which is the mean winter temperature in Copenhagen. The parameters studied in the climate chamber were supply and return water temperature from the heat emitters, indoor temperature, and heat emitter surface temperature. Experiments showed that the mean supply water temperature for floor heating was the lowest, i.e. 30°C, but it was close to the ventilation radiator, i.e. 33°C. The supply water temperature in all measurements for conventional radiator was significantly higher than ventilation radiator and floor heating; namely, 45°C. Experimental results indicated that the mean indoor temperature was close to the acceptable level of 22°C in all cases. For energy calculations, it was assumed that all heat emitters were connected to a ground-source heat pump. Analytical calculations showed that using ventilation radiator and floor heating instead of conventional radiator resulted in a saving of 17% and 22% in heat pump's electricity consumption, respectively. This would reduce the CO₂ emission from the building's heating system by 21% for the floor heating and by 18% for the ventilation radiator compared to the conventional radiator.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, KTH - Royal Institute of Technology
Authors: Hesaraki, A. (Ekstern), Bourdakis, E. (Intern), Ploskić, A. (Ekstern), Holmberg, S. (Ekstern)
Pages: 108-114
Publication date: 2015
Main Research Area: Technical/natural sciences

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Journal: Energy and Buildings
Volume: 109
ISSN (Print): 0378-7788
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BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
Energy performance, Experimental study, Floor heating, Low-temperature hydronic heating systems, Thermal environment, Ventilation radiator

DOIs:
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Field evaluation of performance of radiant heating/cooling ceiling panel system
As in many other countries in the world, Japan has witnessed an increased focus on low-energy buildings. For testing different engineering solutions for energy-efficient buildings, a low-energy building was built at the University of Tokyo as an experimental pilot project. In this building, a radiant heating/cooling ceiling panel system is used. However, no standard exists for the in situ performance evaluation of radiant heating/cooling ceiling systems; furthermore, no published database is available for comparison. Thus, this study aims to not only clarify the system performance but also to share our experience and our results for them to serve as a reference for other similar projects. Here, the system performance in relation to its heating/cooling capacity and thermal comfort has been evaluated. The heat transfer coefficient from water to room was 3.7 W/(m²K) and 4.8 W/(m²K) for heating and cooling cases, respectively. The upward heat flux from the panels was found to be as large as 30–40% of the water heating/cooling capacity; this would translate into heat loss in certain operating modes. Several proposals for reducing the upward heat flux were discussed. The measurements also showed that a category B thermal environment was obtained using the radiant ceiling heating/cooling system. © 2014 Elsevier B.V. All rights reserved.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Technical University of Denmark, University of Tokyo
Authors: Li, R. (Ekstern), Yoshidomi, T. (Ekstern), Ooka, R. (Ekstern), Olesen, B. W. (Intern)
Pages: 58–65
Publication date: 2015
Main Research Area: Technical/natural sciences

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Journal: Energy and Buildings
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Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 4.64 SJR 2.093 SNIP 1.965
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.088 SNIP 2.174 CiteScore 4.07
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.123 SNIP 2.936 CiteScore 4.21
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.897 SNIP 2.433 CiteScore 3.79
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.816 SNIP 2.737 CiteScore 3.36
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.506 SNIP 2.536 CiteScore 3.23
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.631 SNIP 2.081
Web of Science (2010): Indexed yes
Field measurements of perceived air quality and concentration of volatile organic compounds in four offices of the university building

Field measurements of perceived air quality were conducted in four refurbished offices at the Czech Technical University in Prague. The offices were refurbished as part of the research project Clear-up to serve as a field test facility. The present paper describes measurements conducted to investigate the perceived air quality, sensory pollution load and concentration of Volatile Organic Compounds (VOCs) in the offices. As the refurbishment comprised also installation of demand controlled ventilation (DCV), its influence on the perceived air quality was also tested. Measurements comprised the assessments of perceived air quality and objective measurements of operative temperature, relative humidity, CO₂ and VOCs concentrations. Results showed that the mean sensory pollution load in unoccupied offices was 0.09 ± 0.01 olf/m² (mean ± SEM). This falls into the category of a low-polluting building according to CEN Report CR 1752. The acceptability of the air quality was worst in unoccupied offices ventilated with minimum air change rate (0.4 h⁻¹). Application of DCV decreased the CO₂ concentration, but did not result in statistically significant improvement of perceived air quality.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Physics and Services, Section for Indoor Environment, Czech Technical University, European Commission
Authors: Kolarik, J. (Intern), Toftum, J. (Intern), Kabrhel, M. (Ekstern), Jordan, F. (Ekstern), Geiss, O. (Ekstern), Kabele, K. (Ekstern)
Number of pages: 8
Pages: 24
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: Indoor and Built Environment
Article number: 1048-1058
ISSN (Print): 1420-326X
Ratings:
BFI (2018): BFI-level 1
Field study of the indoor environment in a Danish prison

The indoor environment in a Danish prison was evaluated based on measurements made during the summer season of temperature, relative humidity and carbon dioxide, as well as through carefully conducted surveys among the inmates. The temperatures in the cells were high and well beyond common levels in Danish buildings. The mean CO₂ concentrations were generally low, but reached high maximum levels up to 5000 ppm. Thirty-one inmates responded to the questionnaire. They spent on average 19 h in the cell per day (range 12–23 h). Sixty-nine percent of the inmates expressed dissatisfaction with their general indoor environment and all responding inmates expressed dissatisfaction with the thermal climate. Dissatisfaction was mostly caused by a lack of airflow and air movement in the space as well as excessive direct sunlight from the windows. Security is a leading factor in the design of prisons, so a compromise must be found to ensure that the building can comply with minimum health and comfort standards. The findings of this study can be used as background for recommendations for renovation of prison buildings.
Horizontal temperature distribution in a plus-energy house: cooling season measurements
The present study is concerned with the air and operative temperatures at different locations in a detached, one-story, single family, plus-energy house. The house was located in Denmark and it has been used as a full-scale experimental facility with heated dummies to simulate occupants living in the house. The house had gone through a year-round measurement campaign from October 2013 to October 2014, where various physical parameters were measured. This study focuses on the cooling season (May to September 2014, both months included). The house was cooled by means of floor cooling (a dry radiant system) and was ventilated with a mechanical ventilation system (heat recovery on ventilation). Inside the house, there was a single space combining kitchen, living room and bedroom areas. The thermal comfort of the occupant(s) in this space could differ based on the location of the occupant, and control of indoor environment in this single space could be challenging. The measurement of horizontal temperature distribution could address these issues and provide a means of improvement, if necessary. The measurements showed that a uniform thermal indoor environment was achieved inside the house. The average operative temperature difference between the reference point (in the occupied zone) and other measurement points was 0.2 °C (0.4 °F) and the highest temperature difference compared to the reference point was 1.6 °C (2.9 °F) during the measurement period. It was observed that a thermostat on the East Wall would follow the temperature changes in the occupied zone closely and, thus, would provide a good indication of the thermal indoor environment to the control system.

Human body micro-environment: The benefits of controlling airflow interaction
This paper focuses on the micro-environment around a human body, and especially on its interaction with the surrounding environment. Research on the free convection flow generated by a human body (including the convective boundary layer around the body and the thermal plume above the body), its interaction with external invading flows and the resulting heat- and mass transfer, all of which are important for thermal comfort and inhaled air quality, is discussed. The benefit arising from control of the airflow interaction in the micro-environment, in terms of thermal comfort and inhaled air quality, is demonstrated by several methods that are applicable in practice.
Human convective boundary layer and its impact on personal exposure

People spend most of their time indoors and they are constantly exposed to pollution that affects their health, comfort and productivity. Due to strong economic and environmental pressures to reduce building energy consumption, low air velocity design is gaining popularity; hence buoyancy flows generated by heat sources are gaining more prominent influence in space airflow formation and on the indoor environment overall. In such spaces with low air supply velocity, air mixing is minimized and the pollution emitted from localized indoor sources is non-uniformly distributed. The large spatial differences in pollution concentration mean that personal exposure, rather than average space concentration, determines the risk of elevated exposure. Current room air distribution design practice does not take into account the air movement induced by the thermal flows from occupants, which often results in inaccurate exposure prediction. This highlights the importance of a detailed understanding of the complex air movements that take place in the vicinity of the human body and their impact on personal exposure.

The two objectives of the present work are: (i) to examine the extent to which the room air temperature, ventilation flow, body posture, clothing insulation/design, table positioning and chair design affect the airflow characteristics (velocity, turbulence and temperature) around the human body; and (ii) to examine the pollution distribution within the human convective boundary layer (CBL) and personal exposure to gaseous and particulate pollutants as a function of the factors that influence the human CBL, and of different locations of the pollution sources. In this work, the empirical results were obtained primarily by using a thermal manikin to simulate a human in the indoor environment.

In spaces with low air mixing, an increase of the ambient temperature from 20 to 26 °C widened the CBL flow in front of a seated manikin, but did not influence the shape of the CBL in front of a standing manikin. The same temperature increase caused a reduction of the peak velocity from 0.24 to 0.18 m/s in front of the seated manikin. Dressing the nude manikin in a thin-tight clothing ensemble reduced the peak velocity in the breathing zone by 17%, and by 40% for a thick-loose ensemble. A lack of hair on the head increased the peak velocity from 0.17 to 0.187 m/s. Apart from their thermal insulation, clothing and chair design had a minor influence on the velocity profile beyond 5 cm distance from the body.

Closing the gap between the table and the manikin reduced the peak velocity from 0.17 to 0.111 m/s. At a room air temperature of 23 °C, with the manikin leaning backwards the peak velocity was 0.185 m/s, which is 45% above the case with the manikin leaning forward.

The direction and magnitude of the surrounding airflows considerably influence the airflow distribution around the human body. Downward flow with a velocity of 0.175 m/s at a room air temperature of 23 °C did not influence the convective flow in the breathing zone, while the flow at 0.30 m/s affected the CBL at the nose level, reducing the peak velocity from 0.185 to 0.10 m/s. In order to completely break away the human CBL, downward flow had to be supplied with a velocity of 0.425 m/s. Transverse horizontal flow disturbed the CBL at the breathing zone even at 0.175 m/s. With a seated manikin exposed to airflow from below with a velocity of 0.30 and 0.425 m/s assisting the CBL, the peak velocity in the breathing zone was reduced and the flow pattern around the body was affected, compared to the assisting flow of 0.175 m/s or quiescent conditions. In this case, the airflow interaction was strongly affected by the presence of the chair. The results also show that Particle Image Velocimetry (PIV) and Pseudo Color Visualization (PCV) techniques can be adequately employed for the human CBL investigation.

The results show that reducing the room air temperature from 23 to 20 °C increased the fluctuations of air temperature close to the surface of the body. Large standard deviation of air temperature fluctuations, up to 1.2 °C, was measured in the region of the chest, and up to 2.9 °C when the exhalation was applied. Leaning the manikin backwards increased the air temperature and standard deviation of air temperature fluctuations in the breathing zone, while a forward body inclination had the opposite effect. Exhalation through the mouth created a steady temperature drop with increasing distance from the mouth, without disturbing conditions in the region of the chest. Exhalation through the nose did not affect the air temperature in front of the chest due to the physics of the jets flow from the nose. Only very small discrepancies between the results obtained with the breathing thermal manikin and a real human subject were found. This suggests that the thermal manikin can be used for accurate measurements of an occupant’s thermal microenvironment.

The results also suggest that a detailed understanding of the distribution of pollutants in the vicinity of a human body is essential for understanding exposure in spaces with low air mixing. The pollution source location had a considerable influence on the pollution concentrations measured in the breathing zone and on the extent to which the pollution spread to the surroundings. The highest breathing zone concentrations were measured when the pollution source was located at the chest, while there was negligible exposure to any the pollution emitted from the upper back or behind the chair. Based on the results obtained in a single plane, it was shown that a decrease in personal exposure to pollutants released from or around the human body increased the extent to which the pollution spread to the surroundings. Reduced room air temperature and backward body inclination both intensified the transport of pollution to the breathing zone and increased personal exposure. The front edge of a table positioned at zero distance from the human body reduced pollution/clean air transport to the breathing zone, but when it was positioned 10 cm from the body it increased the transport of pollution/clean air from beneath.

For accurate predictions of personal exposure, the characteristics of the CBL must be considered, as it can transport pollution around the human body. The best way to control and reduce personal exposure when the pollution originates at the feet is to employ transverse flow from in front and from the side, relative to the exposed occupant. Airflows from above opposing the CBL and from behind transverse to the CBL, create the most unfavourable velocity field that exhibits a non-
linear dependence between the supply airflow rate and personal exposure. Without a better understanding of the airflow patterns in a room the ventilation rate may therefore be increased in vain.

**General information**

State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics
Authors: Licina, D. (Intern), Melikov, A. K. (Intern), Sekhar, C. (Ekstern), Tham, K. (Ekstern)
Number of pages: 225
Publication date: 2015

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ISBN (Print): 978877774293
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Number: R-338
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Main Research Area: Technical/natural sciences
Electronic versions: Dusan_Licina_Til_orbit.pdf
Publication: Research › Ph.D. thesis – Annual report year: 2016

**Human convective boundary layer and its interaction with room ventilation flow**

This study investigates the interaction between the human convective boundary layer (CBL) and uniform airflow with different velocity and from different directions. Human body is resembled by a thermal manikin with complex body shape and surface temperature distribution as the skin temperature of an average person. Particle image velocimetry (PIV) and pseudocolor visualization (PCV) are applied to identify the flow around the manikin’s body. The findings show that the direction and magnitude of the surrounding airflows considerably influence the airflow distribution around the human body. Downward flow with velocity of 0.175 m/s does not influence the convective flow in the breathing zone, while flow at 0.30 m/s collides with the CBL at the nose level reducing the peak velocity from 0.185 to 0.10 m/s. Transverse horizontal flow disturbs the CBL at the breathing zone even at 0.175 m/s. A sitting manikin exposed to airflow from below with velocity of 0.30 and 0.425 m/s assisting the CBL reduces the peak velocity in the breathing zone and changes the flow pattern around the body, compared to the assisting flow of 0.175 m/s or quiescent conditions. In this case, the airflow interaction is strongly affected by the presence of the chair.

**General information**

State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, National University of Singapore
Authors: Licina, D. (Intern), Melikov, A. K. (Intern), Sekhar, C. (Ekstern), Tham, K. W. (Ekstern)
Number of pages: 15
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Publication date: 2015
Main Research Area: Technical/natural sciences

**Publication information**

Journal: Indoor Air
Volume: 25
Issue number: 1
ISSN (Print): 0905-6947
Ratings:

BFI (2018): BFI-level 2
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BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.55
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 3.88
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Convective boundary layer, Thermal manikin, Particle image velocimetry, Pseudocolor visualization, Ventilation flow, Airflow interaction

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IAQ Applications: Filtration and Air Cleaning: ASHRAE Guidance

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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics
Authors: Wargocki, P. (Intern)
Pages: 70-72
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Main Research Area: Technical/natural sciences

Publication information
Journal: A S H R A E Journal
Volume: 57
Issue number: 12
ISSN (Print): 0001-2491
Ratings:
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Web of Science (2018): Indexed yes
Indoor terminal units can be defined as the building elements that use different heat transfer mechanisms and media to emit and remove heat or moisture from indoor spaces (e.g., hydronic radiant heating and cooling systems, fan-coil units, active beams). Indoor temperature and humidity fields depend on the chosen terminal units.

Terminal units differ in their capabilities of addressing sensible and latent loads, methods of heat emission or removal, maximum heating and cooling capacities, medium of energy distribution, and local or total volume conditioning.

In the present study, operation characteristics, possibilities and limitations of different terminal units were specified. Considered terminal units were radiant heating and cooling systems, all-air systems (mixing, displacement, and personalized ventilation), passive and active beams. The results were summarized in a table, which aims at providing a
reference for terminal unit selection during the design phases of HVAC systems.

**General information**

State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics
Authors: Kazanci, O. B. (Intern), Olesen, B. W. (Intern)
Pages: 2427–2432
Publication date: 2015
Conference: 6th International Building Physics Conference (IBPC 2015), Torino, Italy, 14/06/2015 - 14/06/2015
Main Research Area: Technical/natural sciences

**Publication information**

Journal: Energy Procedia
Volume: 78
ISSN (Print): 1876-6102
Ratings:
- BFI (2018): BFI-level 1
- BFI (2017): BFI-level 1
- BFI (2016): BFI-level 1
- Scopus rating (2016): CiteScore 1.16 SJR 0.467 SNIP 0.586
- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 1
- Scopus rating (2015): SJR 0.365 SNIP 0.561 CiteScore 0.92
- BFI (2014): BFI-level 1
- Scopus rating (2014): SJR 0.433 SNIP 0.81 CiteScore 1.09
- BFI (2013): BFI-level 1
- Scopus rating (2013): SJR 0.425 SNIP 0.785 CiteScore 1.02
- ISI indexed (2013): ISI indexed no
- Web of Science (2013): Indexed yes
- Scopus rating (2012): SJR 0.425 SNIP 0.563 CiteScore 1.08
- ISI indexed (2012): ISI indexed no
- Web of Science (2012): Indexed yes
- Scopus rating (2011): SJR 0.918 SNIP 1.505 CiteScore 2.42
- ISI indexed (2011): ISI indexed no
- Scopus rating (2010): SJR 0.433 SNIP 0.957
- Web of Science (2009): Indexed yes

Original language: English
Categories: Indoor terminal unit, Temperature and humidity field, Radiant heating and cooling, Ventilation, Passive and active beams
Electronic versions:
- IEA_EBC_Annex_59.pdf
DOIs:
- 10.1016/j.egypro.2015.11.213

**Bibliographical note**

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**Impact of Cabin Ozone Concentrations on Passenger Reported Symptoms in Commercial Aircraft**

Due to elevated ozone concentrations at high altitudes, the adverse effect of ozone on air quality, human perception and health may be more pronounced in aircraft cabins. The association between ozone and passenger-reported symptoms has not been investigated under real conditions since smoking was banned on aircraft and ozone converters became more common. Indoor environmental parameters were measured at cruising altitude on 83 US domestic and international flights. Passengers completed a questionnaire about symptoms and satisfaction with the indoor air quality. Average ozone concentrations were relatively low (median: 9.5 ppb). On thirteen flights (16%) ozone levels exceeded 60 ppb, while the highest peak level reached 256 ppb for a single flight. The most commonly reported symptoms were dry mouth or lips (26%), dry eyes (22.1%) and nasal stuffiness (18.9%). 46% of passengers reported at least one symptom related to the eyes or mouth. A third of the passengers reported at least one upper respiratory symptom. Using multivariate logistic (individual symptoms) and linear (aggregated continuous symptom variables) regression, ozone was consistently associated with symptoms related to the eyes and certain upper respiratory endpoints. A concentration-response relationship was observed for nasal stuffiness and eye and upper respiratory symptom indicators. Average ozone levels, as opposed to peak concentrations, exhibited slightly weaker associations. Medium and long duration flights were
significantly associated with more symptoms compared to short flights. The relationship between ultrafine particles and ozone on flights without meal service was indicative of ozone-initiated chemistry.
Indeklimaet i danske skoler er fortsat udfordret

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics
Authors: Toftum, J. (Intern), Clausen, G. (Intern)
Pages: 18-20
Publication date: 2015
Main Research Area: Technical/natural sciences

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Journal: H V A C Magasinet
Volume: 51
Issue number: 2
ISSN (Print): 1603-6913
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: Danish
Links:
http://ipaper.ipapercms.dk/TechMedia/HVACMagasinet/2015/2/

Indoor air quality in passive and conventional new houses in Sweden
The indoor environment was evaluated in 20 new passive houses and 21 new conventionally built houses during the 2012/2013 and 2013/2014 heating seasons. Temperature, relative humidity (RH), the concentrations of NO₂, ozone, formaldehyde, volatile organic compounds (VOC) and viable microbiological flora were measured. Air exchange rates (AER) were estimated from the CO₂ concentrations measured in the bedrooms. The median AER was slightly higher in the passive houses than in the conventional ones (0.68h⁻¹ vs. 0.60h⁻¹). The median concentrations in the passive and the conventional buildings were 10 and 12μg/m³ for NO₂, 9.7 and 11μg/m³ for ozone, 11 and 16μg/m³ for formaldehyde, and 270 and 150μg/m³ for TVOC, respectively. Significant differences in the TVOC and formaldehyde concentrations between the two groups of buildings indicated substantial sources of TVOC present in the passive houses, while sources of formaldehyde may have been more pronounced in the conventional houses. In contrast to the passive houses, the indoor microbiological flora indicated possible mould or moisture problems in six (29%) of the conventionally built houses. When compared with the results previously reported for the Swedish housing stock, AERs and NO₂ concentrations were significantly higher in both groups of newly built buildings, while formaldehyde concentrations were significantly lower in the passive houses. TVOC concentrations were not significantly different from those reported for the housing stock, although the most abundant individual VOCs were present mostly at higher concentrations in the new buildings.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, University of Gothenburg, Swedish Environmental Research Institute, Chalmers University of Technology
Authors: Langer, S. (Ekstern), Bekö, G. (Intern), Bloom, E. (Ekstern), Widheden, A. (Ekstern), Ekberg, L. (Ekstern)
Pages: 92-100
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: Building and Environment
Volume: 93
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Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.51 SJR 2.015 SNIP 2.198
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 2.093 SNIP 2.49 CiteScore 4.37
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.938 SNIP 2.797 CiteScore 4.14
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.581 SNIP 2.602 CiteScore 3.57
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.331 SNIP 2.875 CiteScore 3.06
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.144 SNIP 2.255 CiteScore 2.76
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.235 SNIP 2.001
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.028 SNIP 1.865
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.924 SNIP 1.38
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.788 SNIP 1.778
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.03 SNIP 1.63
Scopus rating (2005): SJR 0.955 SNIP 1.225
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 0.548 SNIP 1.266
Scopus rating (2003): SJR 0.948 SNIP 0.921
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.998 SNIP 1.39
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.777 SNIP 1.098
Scopus rating (2000): SJR 0.526 SNIP 1.14
Scopus rating (1999): SJR 0.564 SNIP 1.175

Original language: English
Air exchange rate, Energy efficient houses, Formaldehyde, Indoor air quality, NO2, VOC
DOIs:
10.1016/j.buildenv.2015.02.004
Source: FindIt
Indoor environmental input parameters for the design and assessment of energy performance of buildings

The first international standard that dealt with all indoor environmental parameters (thermal comfort, air quality, lighting and acoustic) was published in 2007 as EN15251. This standard prescribed input parameters for design and assessment of energy performance of buildings and was a part of the set of standards developed to support the implementation of the Energy Performance of Buildings Directive in Europe. The standard has now been revised and issued for public comments with a new number: prEN16798-1.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Olesen, B. W. (Intern)
Pages: 17-23
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: REHVA Journal
ISSN (Print): 1307-3729
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ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: English
Electronic versions:
Indoor_Environmental_input_parameters_for_the_design_and_assessment_of_energy_performance_of_buildings.pdf
Source: PublicationPreSubmission
Source-ID: 106970623
Publication: Research - peer-review › Journal article – Annual report year: 2015

Influence of Indoor Environment and Occupant Behaviour on Energy Consumption in Passive House Apartments

In 2012 Køge Boligselskab built 9 building blocks totalling 126 passive house apartments. Their monitored space heating demand (SHD) has been a lot higher than the passive house requirements. The aim of this study was to identify why, and how it relates to indoor environment and occupant behaviour. The SHD and indoor environment was analysed and corrected and by performing a statistical analysis, different parameters' influence on SHD was determined. By simulating an apartment block, the effect of internal heat transfers between the apartments was determined. Furthermore, simulations were used to evaluate how the SHD was affected by different patterns of occupant behaviour. The monitoring indicated problems with overheating. However, the analysis suggested that the occupants actively chose these high temperatures. Simulations showed that internal heat flows could be up to 11.7 kWh/(m²a) per apartment. Furthermore, the results suggested that the indoor temperatures, weather conditions and occupants' window opening could explain the higher SHD.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Danish Technological Institute, Technical University of Denmark
Authors: Skød Søvsø, A. (Ekstern), Peuhkuri, R. (Intern), Andersen, R. K. (Intern)
Number of pages: 10
Publication date: 2015

Host publication information
Title of host publication: Proceedings of 7PHN Sustainable Cities and Buildings
Main Research Area: Technical/natural sciences
Conference: 7PHN Sustainable Cities and Buildings, Copenhagen, Denmark, 20/08/2015 - 20/08/2015
Space heating demand, Passive houses, Indoor environment, Occupant behaviour
Source: PublicationPreSubmission
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

Influence of measurement uncertainty on classification of thermal environment in buildings according to European Standard EN 15251

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Publication: Research - peer-review › Journal article – Annual report year: 2015

Influence of measurement uncertainty on classification of thermal environment in buildings according to European Standard EN 15251
European Standard EN 15 251 in its current version does not provide any guidance on how to handle uncertainty of long

term measurements of indoor environmental parameters used for classification of buildings. The objective of the study was
to analyse the uncertainty for field measurements of operative temperature and evaluate its effect on categorization of
thermal environment according to EN 15251. A data-set of field measurements of operative temperature four office
buildings situated in Denmark, Italy and Spain was used. Data for each building included approx. one year of continuous
measurements of operative temperature at two measuring points (south/south-west and north/northeast orientation).

Results of the present study suggest that measurement uncertainty needs to be considered during assessment of thermal
environment in existing buildings. When expanded standard uncertainty was taken into account in categorization of
thermal environment according to EN 15251, the difference in prevalence of exceeded category limits were up to 17.3%,
8.3% and 2% of occupied hours for category I, II and III respectively.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Energy, Section for Indoor Climate and Building Physics
Authors: Kolarik, J. (Intern), Olesen, B. W. (Intern)
Number of pages: 10
Publication date: 2015

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Title of host publication: Proceedings of 7PHN Sustainable Cities and Buildings
Main Research Area: Technical/natural sciences
Conference: 7PHN Sustainable Cities and Buildings, Copenhagen, Denmark, 20/08/2015 - 20/08/2015
Measurement uncertainty, Thermal environment, EN 15251, Operative temperature
Electronic versions:
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Source: PublicationPreSubmission
Source-ID: 118883930
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

Integrated smart infrastructures
General information
State: Published
Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Energy system operation and management, Department of Civil Engineering, Section for Indoor Climate and Building Physics, Zhejiang University
Authors: Østergaard, J. (Intern), Nørgård, P. B. (Intern), Wen, F. (Ekstern), Rode, C. (Intern)
Pages: 15-22
Publication date: 2015

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Title of host publication: DTU International Energy Report 2015: Energy systems integration for the transition to non-fossil energy systems
Publisher: Technical University of Denmark (DTU)
Editors: Hvidtfeldt Larsen, H., Sønderberg Petersen, L.
ISBN (Print): 978-87-550-3970-4
Main Research Area: Technical/natural sciences
Electronic versions:

Laminar airflow significantly reduced microbial air contamination during simulated total hip arthroplasty surgery in comparison to turbulent airflow

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Odense University Hospital, University Hospital Herlev, Fournais Energi APS, JRV A/S
Authors: Ravn, C. (Ekstern), Overgaard, A. (Ekstern), Knudsen, N. (Ekstern), Olsen, M. (Ekstern), Toftum, J. (Intern), Kemp, M. (Ekstern), Frich, L. (Ekstern), Overgaard, S. (Ekstern)
Load calculations of radiant cooling systems for sizing the plant

The aim of this study was, by using a building simulation software, to prove that a radiant cooling system should not be sized based on the maximum cooling load but at a lower value. For that reason six radiant cooling models were simulated with two control principles using 100%, 70% and 50% of the maximum cooling load. It was concluded that all tested systems were able to provide an acceptable thermal environment even when the 50% of the maximum cooling load was used. From all the simulated systems the one that performed the best under both control principles was the ESCS ceiling system. Finally it was proved that ventilation systems should be sized based on the maximum cooling load.
Measurements of Capture Efficiency of Range Hoods in Homes

A major source of pollutants in homes is cooking and as homes get tighter in the pursuit of lower energy use (particularly near zero energy), the concentration of cooking pollutants increases. The best way to remove cooking pollutants is to use a range hood above the cooking surface. Ideally, we want a range hood to use little energy and have high capture efficiency to minimize the required air flow to capture the cooking pollutants. Currently there are no standards for rating range hoods for capture efficiency. In this study, measurements of range hood capture efficiency were made in a tight kitchen-room built in a laboratory chamber, and a methodology for standardizing measurement of capture efficiency was developed. The results for a wall mounted range hood, showed that up to half of the cooking pollutants were not captured at a flow rate of 230 m³/h. A more detailed set of measurements mapped the pollution distribution in the room, and showed that the pollutants escape more at the sides of the cooktop. These preliminary results suggest that more measurements should be conducted investigating the capture efficiency at different pollutant source temperature, size and location, and for different range hood type and mounting height.

General information

State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Lawrence Berkeley National Laboratory
Authors: Simone, A. (Intern), Sherman, M. H. (Ekstern), Walker, I. S. (Ekstern), Singer, B. C. (Ekstern), Delp, W. (Ekstern), Stratton, J. C. (Ekstern)
Number of pages: 5
Publication date: 2015

Host publication information
Title of host publication: Proceedings of Healthy Buildings 2015 Europe
Editors: Loomans, M., Kulve, M. T.
Article number: 594
ISBN (Print): 978-90-386-3889-8
BFI conference series: Healthy Buildings : The International Conference & Exhibition (5010979)
Main Research Area: Technical/natural sciences
Conference: Healthy Buildings Europe 2015, Eindhoven, Netherlands, 18/05/2015 - 18/05/2015
Capture efficiency, Range hood, Ventilation, Homes
Source: PublicationPreSubmission
Source-ID: 110828895
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

Models for flexible operation of buildings in district energy system Nordhavn

General information

State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Section for Building Energy
Authors: Foteinaki, K. (Intern), Heller, A. (Intern), Rode, C. (Intern)
Number of pages: 1
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Publisher: Technical University of Denmark (DTU)
Article number: L-14
Main Research Area: Technical/natural sciences
Conference: DTU Sustain Conference 2015, Lyngby, Denmark, 17/12/2015 - 17/12/2015
Electronic versions: L14_DTU_Sustain_2015.pdf

Bibliographical note
Poster presentation
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2015
Night time cooling by ventilation or night sky radiation combined with in-room radiant cooling panels including phase change materials

Night sky radiative cooling technology using PhotoVoltaic/Thermal panels (PVT) and night time ventilation have been studied both by means of simulations and experiments to evaluate their potential and to validate the created simulation model used to describe it. An experimental setup has been constructed at the Technical University of Denmark, where the outside PVT panels are connected through a storage tank to in-room radiant ceiling panels. The radiant ceiling panels include phase change material (PCM) and embedded pipes for circulating water. Due to the phase change material it is possible to store the heat generated during the day from internal sources. Then during the night the panels can be cooled down again and regenerated. The possibility of cooling down the panels during the night with outside air was also studied. The night cooling power of the PVT panels ranged from 92 to 119 W/m² depending on the sky clearness. This cooling power was enough to remove the stored heat and regenerate the ceiling panels. The validation simulation model results related to PCM were close to the corresponding results extracted from the experiment, while the results related to the production of cold water through the night sky radiative cooling differed significantly. The possibility of night time ventilation was studied through simulations for three different latitudes. It was concluded that for Danish climatic conditions night time ventilation would also be able to regenerate the panels while its contribution is not sufficient in warmer South-European climates.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Technical University of Denmark
Authors: Bourdakis, E. (Intern), Olesen, B. W. (Intern), Grossule, F. (Ekstern)
Number of pages: 10
Publication date: 2015
Main Research Area: Technical/natural sciences
Electronic versions: Conference_Night_time_cooling_by_ventilation_or_night_sky_radiation_combined_with_in_room_radiant_cooling_panels_including_phase_change_materials.pdf
Source: PublicationPreSubmission
Source-ID: 127118908
Publication: Research - peer-review › Paper – Annual report year: 2016

Nighttime radiative cooling potential of unglazed and PV/T solar collectors: parametric and experimental analyses

Nighttime radiative cooling technology has been studied both by means of simulations and experiments, to evaluate its potential and to validate the existing theoretical models used to describe it. Photovoltaic/thermal panels (PV/T) and unglazed solar collectors have been chosen as case studies. An experimental setup has been constructed and tested during summer of 2014, at the Technical University of Denmark. The cooling performance (heat loss) has been measured simultaneously for both types of panels, installed side-by-side. The experimental results have been compared with the results from a commercial building simulation software and from theoretical calculations. All three methods showed good consistency in the cooling output. The cooling power ranged between 20 to 75 W/m² without a noticeable difference between the PV/Ts and the unglazed collectors, the outcome depending mainly on the sky clearness. The obtained values showed a good agreement with the ones found in the literature about solar panels or other kinds of heat sinks used for radiative cooling applications. The panels provided a cooling performance per night ranging between 0.2 and 0.9 kWh/m² of panel. The COP values (defined as the ratio between the obtained cooling and the energy used by the circulation pump) reached very high values, ranging from 19 to 59, which highlights the potential of this technology for energy savings for cooling purposes. Possible applications include cooling production for non-residential buildings such as offices under the Scandinavian climate, and, in addition, for residential buildings under Southern climates.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Technical University of Denmark
Authors: Pean, T. Q. (Intern), Gennari, L. (Ekstern), Olesen, B. W. (Intern), Kazanci, O. B. (Intern)
Number of pages: 8
Publication date: 2015

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Main Research Area: Technical/natural sciences
Occupant behaviour and robustness of building design

Occupant behaviour can cause major discrepancies between the designed and the real total energy use in buildings. A possible solution to reduce the differences between predictions and actual performances is designing robust buildings, i.e. buildings whose performances show little variations with alternating occupant behaviour patterns. The aim of this work was to investigate how alternating occupant behaviour patterns impact the performance of different envelope design solutions in terms of building robustness. Probabilistic models of occupants' window opening and use of shading were implemented in a dynamic building energy simulation tool (IDA ICE). The analysis was carried out by simulating 15 building envelope designs in different thermal zones of an Office Reference Building in 3 climates: Stockholm, Frankfurt and Athens. In general, robustness towards changes in occupants' behaviour increased with increasing thermal mass and with decreasing transparent area of the envelope. The importance of the robustness' evaluation is highlighted in this paper, in order to obtain optimized buildings' designs for more accurate and realistic energy predictions.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Politecnico di Torino
Authors: Buso, T. (Ekstern), Fabi, V. (Ekstern), Andersen, R. K. (Intern), Corgnati, S. P. (Ekstern)
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Web of Science (2015): Indexed yes
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BFI (2012): BFI-level 1
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ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Operative temperature drifts and occupant satisfaction with thermal environment in three office buildings using radiant heating/cooling system

The objective of this study was to analyse operative temperature drifts and occupant satisfaction with thermal environment in office buildings utilizing embedded radiant heating/cooling systems. Three office buildings were investigated: Town Hall in Viborg, Denmark (floor area 19400 m²), IDOM, Madrid, Spain (16000 m²), TiFS, Padua, Italy (2200 m²). Continuous measurements of operative temperature were conducted at four workplaces in each building for one year. Occupants’ satisfaction was assessed by internet based questionnaire. Results showed that mostly exceeded limits were those for 4-hour drift (0.8 K/h), which were exceeded at least in 2% and up to 52% of occupied time in investigated buildings. Limits for hourly and 2-hour drifts were exceeded in max. 2% of occupied time. Median values were in ranges of 0.12-0.29 K/h, 0.18-0.52 K/h and 0.27-0.84 K/h for 1, 2 and 4-hour drifts respectively. Occupants’ in all buildings were rather satisfied with temperature conditions. Median temperature satisfaction (0="Clearly satisfied" - 5="Clearly dissatisfied") was 2, 1 and 1 for Viborg, Madrid and Padua respectively. Temperature satisfaction slightly decreased when rate of temperature change increased, thus higher temperature drifts seemed to lead to higher dissatisfaction, however the collected data did not allow for robust statistical analysis.

General information
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Organisations: Department of Civil Engineering, Section for Building Energy, Section for Indoor Climate and Building Physics
Authors: Kolarik, J. (Intern), Toftum, J. (Intern), Olesen, B. W. (Intern)
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Operative temperature drift, Thermal comfort, Radiant heating/cooling
Electronic versions:
Optimization of municipal energy strategies: Are community energy profiles the key to a higher implementation rate of renewable energies?

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Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics
Authors: Petersen, J. (Intern)
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Electronic versions:
L16_DTU_Sustain_2015.pdf

Bibliographical note
Poster presentation

OPVent projektrapport – 2015: Resultater af OP Vent projektet

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Odense University Hospital, JRV A/S, Fournais Energi APS, Technical University of Denmark
Authors: Overgaard, A. (Ekstern), Overgaard, S. (Ekstern), Frich, L. H. (Ekstern), Ravn, C. (Ekstern), Olsen, M. (Ekstern), Knudsen, N. B. (Ekstern), Nielsen, J. (Ekstern), Toftum, J. (Intern), Clausen, G. (Intern), Nielsen, L. (Ekstern), Rosenbeck, K. (Ekstern)
Number of pages: 42
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Performance assessment of a ventilated mattress for pollution control of the bed microenvironment in healthcare facilities

A new method for minimizing the spread of bioeffluents emitted from hospitalized patients lying in beds was developed and studied. The method consists of a ventilated bed mattress that is able to exhaust the human bioeffluents at the area of the body where generated before spreading around in room. Full-scale experiments were conducted in a climate chamber furnished as a two-bed hospital patient room. A thermal manikin and two heated dummies were used to simulate two lying patients and a standing doctor. The bed with the thermal manikin had the ventilated mattress (VM). The tracer gases CO₂ and N₂O were used to mimic human bioeffluents released from the feet and armpits of the manikin, respectively. The concentration of the tracer gases was measured in six points including the breathing zone of the simulated occupants. The results show that the VM combined with mixing ventilation at 1.5 air changes per hour (ACH) proved to be more effective in reducing exposure to body contaminants compared to mixing ventilation alone at 3 ACH and 6 ACH. The findings also show that the lying position and the size of the local exhaust of the VM affect the efficiency of the mattress to exhaust bioeffluents.
Phthalate exposure through different pathways and allergic sensitization in preschool children with asthma, allergic rhinoconjunctivitis and atopic dermatitis

Studies in rodents indicate that phthalates can function as adjuvants, increasing the potency of allergens. Meanwhile, epidemiological studies have produced inconsistent findings regarding relationships between phthalate exposures and allergic disease in humans. The present study examined phthalate exposure and allergic sensitization in a large group of 3-5 year old children: 300 random controls and 200 cases with asthma, rhinoconjunctivitis or atopic dermatitis as reported in questionnaires. The children were clinically examined to confirm their health status. Blood samples were analyzed for IgE sensitization to 20 allergens. Adjusted logistic regressions were used to look for associations between phthalate exposure indicators (mass fractions in dust from children's homes and daycares, metabolites in urine, and estimated daily indoor intakes from dust ingestion, inhalation and dermal absorption) and sensitization and allergic disease. No direct associations were found between phthalate exposures and asthma, rhinoconjunctivitis or atopic dermatitis. However, among children with these diseases, there were significant associations between non-dietary exposures to DnBP, BBzP and DEHP in the indoor environment (mass fractions in dust or daily indoor intakes from dust ingestion, inhalation and dermal absorption) and allergic sensitization. Some exposure pathways were more strongly associated with sensitization than others, although the results are not conclusive and require confirmation. A number of the associations depended on accounting for a child's exposure in more than one environment (i.e., daycare facility as well as home). Significant associations were not observed between phthalate metabolites in urine, which reflected exposure from diet as well as indoor pathways, and allergic sensitization. (C) 2015 Elsevier Inc. All rights reserved.

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Physiological responses to exposure to carbon dioxide and human bioeffluents

Present paper describes physiological responses as a result of exposures to CO2 (between 500 ppm to 3,000 ppm) with and without bioeffluents. Twenty-five subjects participated. They were exposed in the climate chamber for 255 minutes in groups of five at a time. During exposure, they performed different cognitive tasks and assessed their comfort and acute health symptoms. Besides, the following were determined: heart rate, blood pressure, oxygen saturation of blood, respiration rate, minute ventilation rate, nasal peak flow, forced expiratory volume, and the end-tidal CO2 pressure.
Saliva samples were collected to analyze stress biomarkers. During exposure to CO2 with and without bioeffluents at 3,000 ppm, ETCO2 and minute ventilation rate were higher, while nasal peak flow decreased. These exposures caused also the increased heart rate during typing sessions. During exposures to CO2 with bioeffluents, the performance of Tsai-Partington test was reduced, and diastolic blood pressure and alpha-amylase increased after exposure compared with their levels before exposure, which may suggest higher arousal/stress. During exposure to CO2 without bioeffluents, the performance of Tsai-Partington test also was lower, which may suggest higher stress/arousal, too. However, no effects on blood pressure and alpha-amylase were seen for this exposure.

Radiant Heating and Cooling Systems. Part one
The use of radiant heating systems has several thousand years of history.1,2 The early stage of radiant system application was for heating purposes, where hot air from flue gas (cooking, fires) was circulated under floors or in walls. After the introduction of plastic piping water-based radiant heating and cooling with pipes embedded in room surfaces (floor, wall, and ceiling), the application increased significantly worldwide. Earlier application of radiant heating systems was mainly for residential buildings because of its comfort and free use of floor space without any obstruction from installations. For similar reasons, as well as possible peak load reduction and energy savings, radiant systems are being widely applied in commercial and industrial buildings.
Radiant Heating and Cooling Systems. Part two

Control of the heating and cooling system needs to be able to maintain the indoor temperatures within the comfort range under the varying internal loads and external climates. To maintain a stable thermal environment, the control system needs to maintain the balance between the heat gain/loss of the building and the supplied energy from the system. Several studies in the literature deal with control.(1-4)
Simple future weather files for estimating heating and cooling demand

Estimations of the future energy consumption of buildings are becoming increasingly important as a basis for energy management, energy renovation, investment planning, and for determining the feasibility of technologies and designs. Future weather scenarios, where the outdoor climate is usually represented by future weather files, are needed for estimating the future energy consumption. In many cases, however, the practitioner’s ability to conveniently provide an estimate of the future energy consumption is hindered by the lack of easily available future weather files. This is, in part,
due to the difficulties associated with generating high temporal resolution (hourly) estimates of future changes in air temperature. To address this issue, we investigate if, in the absence of high-resolution data, a weather file constructed from a coarse (annual) estimate of future air temperature change can provide useful estimates of future energy demand of a building. Experimental results based on both the degree-day method and dynamic simulations suggest that this is indeed the case. Specifically, heating demand estimates were found to be within a few per cent of one another, while estimates of cooling demand were slightly more varied. This variation was primarily due to the very few hours of cooling that were required in the region examined. Errors were found to be most likely when the air temperatures were close to the heating or cooling balance points, where the energy demand was modest and even relatively large errors might thus result in only modest absolute errors in energy demand.

**General information**

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Organisations: Department of Civil Engineering, Section for Indoor Environment, Department of Management Engineering, Systems Analysis, DTU Climate Centre, Energy Systems Analysis, Production and Service Management, Centre for Facilities Management
Authors: Cox, R. A. (Intern), Drews, M. (Intern), Rode, C. (Intern), Nielsen, S. B. (Intern)
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BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.144 SNIP 2.255 CiteScore 2.76
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.235 SNIP 2.001
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.028 SNIP 1.865
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
The main purpose of heating, cooling and ventilation systems is to provide a comfortable, healthy and productive indoor environment for the occupants. Indoor terminal units, which have a direct effect on the occupants comfort, can be defined as the building elements that use different heat transfer mechanisms and media to emit and remove heat or moisture from indoor spaces (e.g. hydronic radiant heating and cooling systems, fan-coil units, and active beams). The main differences between HVAC systems in Europe, North America and other parts of the world are often the indoor terminal units. Type of energy sources and energy generators are very much similar. This paper will present state-of the art-off energy efficient systems that will provide a good indoor environmental quality at a decreased energy use. Low Temperature Heating and High Temperature Cooling systems are an important requirement for increasing the energy efficiency of HVAC (heating, ventilation and air-conditioning) systems and for increasing the amount of renewable energy used. Especially these types of systems are getting increasing attention in Europe and North-America.

In the present study, operation characteristics, possibilities and limitations of different terminal units were specified. Considered terminal units were radiant heating and cooling systems, all-air systems (mixing, displacement, and personalized ventilation), passive and active beams.
Theoretical study on volatile organic compound removal and energy performance of a novel heat pump assisted solid desiccant cooling system

A theoretical model was established for predicting the volatile organic compound (VOC) removal and energy performance of a novel heat pump assisted solid desiccant cooling system (HP-SDC). The HP-SDC was proposed based on the combination of desiccant rotor with heat pump, and was designed for cooling, dehumidification and indoor air cleaning in normal office, commercial or residential buildings. The desiccant rotor was used for dehumidification and indoor air cleaning; the heat pump provided sensible cooling and regeneration heat for the desiccant rotor. The theoretical model consisted of two sub-models. One sub-model was used to simulate the heat, moisture and VOC transfer in the desiccant rotor; the other sub-model was used to predict the energy performance of the heat pump. Combining the two sub-models, the energy performance and VOC removal effect of the HP-SDC could be simulated and predicted. The theoretical model was validated by experimental data. Validating results showed that the model could be used to predict the performance of HP-SDC. The results also showed that the HP-SDC could clean air borne contaminants effectively and could provide an energy efficient choice for ventilation.
Thermal environment and air quality in office with personalized ventilation combined with chilled ceiling

The thermal environment and air quality conditions provided with combined system of chilled ceiling and personalized ventilation (PV) were studied in a simulated office room for two occupants. The proposed system was compared with total volume HVAC solutions used today, namely mixing ventilation and chilled ceiling combined with mixing ventilation. The objective of the study was to evaluate whether PV can be the only ventilation system in the rooms equipped with chilled ceiling. The room air temperature was 26°C in cases with traditional systems and 28°C when PV was used. PV supplied air with the temperature of 25°C. PV improved thermal conditions and was up to nearly 10 times more efficient in delivering clean air at workstations than mixing ventilation systems, which resulted in strong protection of occupants from the cross-infection. In the room space outside workstations no substantial differences in thermal environment were found between studied systems. The room air mixing with PV working alone was at the same level as with mixing ventilation. No substantial differences in contaminants’ concentration distribution and air-change effectiveness were found between the studied systems in the occupied zone outside workstations.
Thermal indoor environment and energy consumption in a plus-energy house: cooling season measurements

The present study is concerned with the thermal indoor environment and HVAC system energy consumption of a detached, one-story, single family, plus-energy house during a cooling season. The house was located in Denmark and it has been used as a full-scale experimental facility for one year. The house was cooled by a floor cooling system and was ventilated with a mechanical ventilation system. Different operative temperature set-points and different ventilation rates were tested. Operative temperature at a representative location inside the occupied zone was used as an indicator of the thermal indoor environment. For the energy consumption of the HVAC system, air-to-brine heat pump, mixing station and controller of the radiant floor, and the air handling unit were considered.

The measurements were analyzed based on the achieved indoor environment category (according to EN 15251:2007), overheating hours (according to DS 469:2013) and the energy consumption. Operation and switchover of the heating and cooling system during the transition periods (i.e. May and September) proved to be a challenge. Overheating was a significant problem. Decreasing the operative temperature set-point (of the floor cooling system) and increasing the ventilation rate provided a better thermal indoor environment but with increased energy consumption. The thermal indoor environment and energy performance of the house can be improved with decreased glazing area, increased thermal mass, installation of solar shading, adjustment of the orientation of the house, and natural ventilation.

General information

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Authors: Kazanci, O. B. (Intern), Olesen, B. W. (Intern)
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BFI (2014): BFI-level 1
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BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.425 SNIP 0.785 CiteScore 1.02
ISI indexed (2013): ISI indexed no
Web of Science (2013): Indexed yes
Scopus rating (2012): SJR 0.425 SNIP 0.563 CiteScore 1.08
ISI indexed (2012): ISI indexed no
Web of Science (2012): Indexed yes
Transdermal uptake of diethyl phthalate and di(n-butyl) phthalate directly from air: Experimental verification

Background: Fundamental considerations indicate that, for certain phthalate esters, dermal absorption from air is an uptake pathway that is comparable to or greater than inhalation. Yet this pathway has not been experimentally evaluated and has been largely overlooked when assessing uptake of phthalate esters. Objectives: This study investigated transdermal uptake, directly from air, of diethyl phthalate (DEP) and di(n-butyl) phthalate (DnBP) in humans. Methods: In a series of experiments, six human participants were exposed for 6 hr in a chamber containing deliberately elevated air concentrations of DEP and DnBP. The participants either wore a hood and breathed air with phthalate concentrations substantially below those in the chamber or did not wear a hood and breathed chamber air. All urinations were collected from initiation of exposure until 54 hr later. Metabolites of DEP and DnBP were measured in these samples and extrapolated to parent phthalate intakes, corrected for background and hood air exposures.

Results: For DEP, the median dermal uptake directly from air was 4.0 μg/(μg/m³ in air) compared with an inhalation intake of 3.8 μg/(μg/m³ in air). For DnBP, the median dermal uptake from air was 3.1 μg/(μg/m³ in air) compared with an intake of 3.9 μg/(μg/m³ in air).

Conclusions: This study shows that dermal uptake directly from air can be a meaningful exposure pathway for DEP and DnBP. For other semivolatile organic compounds (SVOCs) whose molecular weight and lipid/air partition coefficient are in the appropriate range, direct absorption from air is also anticipated to be significant.
Transport of gaseous pollutants by convective boundary layer around a human body

This study investigates the ability of the human convective boundary layer to transport pollution in a quiescent indoor environment. The impact of the source location in the vicinity of a human body is examined in relation to pollution distribution in the breathing zone and the thickness of the pollution boundary layer. The study, in addition, evaluates the effects of the room air temperature, table positioning, and seated body inclination. The human body is represented by a thermal manikin that has a body shape, size, and surface temperature that resemble those of a real person. The results show that the source location has a considerable influence on the breathing zone pollution concentrations and on the thickness of the pollution boundary layer. The highest breathing zone concentrations are achieved when the pollution is located at the chest, while there is negligible exposure for the pollution emitted at the upper back or behind the chair. The results also indicate that a decrease in personal exposure to pollutants released from or around the human body increases the extent to which the pollution spreads to the surroundings. Reducing the room air temperature or backward body inclination intensifies the transport of the pollution to the breathing zone and increases personal exposure. The front edge of a table positioned at zero distance from the human body can reduce the pollution transport to the breathing zone, or it can increase transport of the clean air from beneath if positioned at a 10-cm (0.33-ft) distance.

General information
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Organisations: Department of Civil Engineering, Section for Indoor Environment, National University of Singapore
Authors: Licina, D. (Intern), Melikov, A. K. (Intern), Sekhar, C. (Ekstern), Tham, K. W. (Ekstern)
Number of pages: 12
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Web of Science (2016): Indexed yes
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Web of Science (2015): Indexed yes
Scopus rating (2014): SJR 0.578 SNIP 0.846
Web of Science (2014): Indexed yes
Scopus rating (2013): SJR 0.618 SNIP 0.89
Web of Science (2013): Indexed yes
Scopus rating (2012): SJR 0.587 SNIP 1.109
Web of Science (2012): Indexed yes
Scopus rating (2011): SJR 0.541 SNIP 0.74
Web of Science (2011): Indexed yes
Scopus rating (2010): SJR 1.027 SNIP 0.955
Web of Science (2010): Indexed yes
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Web of Science (2009): Indexed yes
Scopus rating (2008): SJR 0.866 SNIP 0.903
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.804 SNIP 1.625
Use of visual CO₂ feedback as a retrofit solution for improving classroom air quality

Carbon dioxide (CO₂) sensors that provide a visual indication were installed in classrooms during normal school operation. During 2-week periods, teachers and students were instructed to open the windows in response to the visual CO₂ feedback in 1 week and open them, as they would normally do, without visual feedback, in the other week. In the heating season, two pairs of classrooms were monitored, one pair naturally and the other pair mechanically ventilated. In the cooling season, two pairs of naturally ventilated classrooms were monitored, one pair with split cooling in operation and the other pair with no cooling. Classrooms were matched by grade. Providing visual CO₂ feedback reduced CO₂ levels, as more windows were opened in this condition. This increased energy use for heating and reduced the cooling requirement in summertime. Split cooling reduced the frequency of window opening only when no visual CO₂ feedback was present.

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BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.55
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 3.88
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 4.57
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Using measured indoor environment parameters for calibration of building simulation model- a passive house case study

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Organisations: Department of Civil Engineering, Section for Building Energy, Section for Indoor Climate and Building Physics, Technical University of Denmark
Authors: Paliouras, P. (Ekstern), Matzaflaras, N. (Ekstern), Peuhkuri, R. H. (Intern), Kolarik, J. (Intern)
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Ventilationens betydning for indlæring i skoler

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Authors: Toftum, J. (Intern), Kjeldsen, B. U. (Intern), Wargocki, P. (Intern), Clausen, G. (Intern)
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Source: PublicationPreSubmission
Source-ID: 119503323
Publication: Communication › Journal article – Annual report year: 2015

Ventilation på operationsstuer og kontamineringsrisiko
Wearable Personal Exhaust Ventilation, WPEV: Improved Indoor Air Quality and Reduced Exposure to Air Exhaled from a Sick Doctor

Exposure reduction to exhaled air from a sick doctor wearing a personal exhaust unit incorporated in a headset-microphone was studied. Experiments were performed in a full-scale test room furnished as a double-bed hospital room with overhead ventilation at 3, 6, and 12 air changes per hour. Room air temperature was 22°C. A breathing thermal manikin with a body size and shape similar to the body of an average Scandinavian woman was used to mimic a “sick” doctor. The manikin was equipped with artificial lungs with a realistic breathing cycle (2.5-sec inhalation, 2.5-sec exhalation, and 1-sec pause) and a tidal flow rate of 6 L/min. A second thermal manikin and heated dummy were used to resemble lying patients. Exhaled air by the doctor was mixed with tracer gas to mimic pathogens. The wearable personal exhaust unit was positioned frontally by the mouth of the doctor at three distances: 0.02, 0.04, and 0.06 m. It was operated at 0.25 or 0.50 L/s under mixing background ventilation at three air changes per hour. The effect of the wearable exhaust unit geometry by modifying the exhaust surface, as well as the posture of the doctor, standing or seated, was also studied.
The use of the wearable personal exhaust resulted in cleaner air in the room compared to mixing alone at 12 air changes per hour, reducing the exposure of the two patients. The nozzle geometry and posture of the doctor affected the indoor exposure to exhaled air. The high potential to capture exhaled air makes the device efficient against airborne pathogens in densely occupied spaces.

**General information**

**State:** Published  
**Organisations:** Department of Civil Engineering, Section for Indoor Climate and Building Physics, Technical University of Denmark  
**Authors:** Bolashikov, Z. D. (Intern), Barova, M. (Ekstern), Melikov, A. K. (Intern)  
**Pages:** 1117–1125  
**Publication date:** 2015  
**Main Research Area:** Technical/natural sciences

**Publication information**

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**Volume:** 21  
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- Web of Science (2017): Indexed yes  
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- Web of Science (2016): Indexed yes  
- Scopus rating (2015): SJR 0.644 SNIP 0.888  
- Web of Science (2015): Indexed yes  
- Scopus rating (2014): SJR 0.578 SNIP 0.846  
- Web of Science (2014): Indexed yes  
- Scopus rating (2013): SJR 0.618 SNIP 0.89  
- Web of Science (2013): Indexed yes  
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- Web of Science (2012): Indexed yes  
- Scopus rating (2011): SJR 0.541 SNIP 0.74  
- Web of Science (2011): Indexed yes  
- Scopus rating (2010): SJR 1.027 SNIP 0.955  
- Web of Science (2010): Indexed yes  
- Scopus rating (2009): SJR 1.767 SNIP 1.187  
- Web of Science (2009): Indexed yes  
- Scopus rating (2008): SJR 0.866 SNIP 0.903  
- Web of Science (2008): Indexed yes  
- Scopus rating (2007): SJR 0.804 SNIP 1.625  
- Web of Science (2007): Indexed yes  
- Scopus rating (2006): SJR 0.907 SNIP 1.302  
- Web of Science (2006): Indexed yes  
- Scopus rating (2005): SJR 1.471 SNIP 1.257  
- Web of Science (2005): Indexed yes  
- Scopus rating (2004): SJR 1.209 SNIP 1.999  
- Scopus rating (2003): SJR 1.091 SNIP 1.28  
- Web of Science (2003): Indexed yes  
- Scopus rating (2002): SJR 0.938 SNIP 1.733  
- Web of Science (2002): Indexed yes  
- Scopus rating (2001): SJR 2.473 SNIP 2.259  
- Scopus rating (2000): SJR 0.712 SNIP 2.004  
- Scopus rating (1999): SJR 0.368 SNIP 0.778  

**Original language:** English  
**DOIs:**  
10.1080/23744731.2015.1091270
What are indoor air quality priorities for energy-efficient buildings?

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Technical University of Denmark
Authors: Wargocki, P. (Intern)
Number of pages: 4
Pages: 579-582
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: Indoor and Built Environment
Volume: 24
Issue number: 5
ISSN (Print): 1420-326X
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.97 SJR 0.55 SNIP 0.713
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.47 SNIP 0.612 CiteScore 0.82
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.595 SNIP 0.895 CiteScore 1.23
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 0.683 SNIP 1.102 CiteScore 1.71
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 0.541 SNIP 1.109 CiteScore 1.63
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 0.383 SNIP 0.85 CiteScore 1.59
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.618 SNIP 0.658
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.463 SNIP 0.819
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.363 SNIP 0.461
Scopus rating (2007): SJR 0.308 SNIP 0.52
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.341 SNIP 0.669
Scopus rating (2005): SJR 0.225 SNIP 0.372
Scopus rating (2004): SJR 0.269 SNIP 0.31
What does the scientific literature tell us about the ventilation-health relationship in public and residential buildings?

Objective of this paper is to examine whether the available epidemiological evidence provides information on the link between outdoor air ventilation rates and health, and whether it can be used for regulatory purposes when setting ventilation requirements for non-industrial built environments.

Effects on health were seen for a wide range of outdoor ventilation rates from 6 to 7 L/s per person, which were the lowest ventilation rates at which no effects on any health outcomes were observed in field studies, up to 25–40 L/s per person, which were in some studies the lowest outdoor ventilation rates at which no effects on health outcomes were seen. These data show that, in general, higher ventilation rates in many cases will reduce health outcomes, and that there are the minimum rates, at which some health outcomes can be avoided. But these data have many limitations, such as crude estimation of outdoor ventilation rates, diversity and variability of ventilation rates at which effects were seen, a diversity of outcomes (in case of health outcomes being mainly acute not chronic). Among other limitations there are incomplete data on the strength of pollution sources and exposures as well as a wide range of sensibility of the exposed populations.

The available data do not provide a sound basis for determining specific outdoor air ventilation rates that can be universally applicable in different public and residential buildings to protect against health risks. They cannot be used for regulative purposes, unless the required ventilation rates are related to actual exposures and are prescribed only when full advantage of other methods for controlling exposures has been taken.
Air and operative temperature measurements in a plus-energy house under different heating strategies

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Kazanci, O. B. (Intern), Olesen, B. W. (Intern)
Number of pages: 8
Pages: 312-319
Publication date: 2014

Host publication information
Title of host publication: Proceedings of ROOMVENT 2014, 13th SCANVAC International Conference on Air Distribution in Rooms
BFI conference series: International Conference on Air Distribution in Rooms (5010059)
Air cleaning efficiency of deodorant materials under dynamic conditions: effect of air flow rate

Unpleasant odor is a serious problem in hospitals and elderly facilities. One of the unpleasant odors is ammonia originating from human urine and sweat. The air cleaning efficiency of porous activated carbon fiber fabric which has been treated with acid, and porous activated carbon fiber fabric was evaluated as deodorant materials neutralising ammonia in air. The deodorant material efficiency was tested in a special experimental set-up consisting of a straight pipe section, an ammonia gas generator, a fan and a textile frame. The deodorant materials, placed in the pipe, were exposed to a flow of air mixed with ammonia gas at a concentration of 20 ppm and velocities of 0.05, 0.15, 0.3 and 1.2 m/s. The activated carbon fibers treated with acid had a high deodorizing effect for ammonia (0.8) at a velocity of 0.05 m/s. The deodorizing effect of this material decreased with the increase in the velocity. The porous activated carbon fiber fabric did not have a deodorant effect.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Otsuma Women’s University, Shinshu University
Authors: Mizutani, C. (Ekstern), Bivolarova, M. P. (Intern), Melikov, A. K. (Intern), Bolashikov, Z. D. (Intern), Sakoi, T. (Ekstern), Kajiwara, K. (Ekstern)
Pages: 745-749
Publication date: 2014

Host publication information
Title of host publication: Proceedings of Indoor Air 2014
Publisher: International Society of Indoor Air Quality and Climate
Main Research Area: Technical/natural sciences
Conference: 13th International Conference on Indoor Air Quality and Climate, Hong Kong, Hong Kong, 07/07/2014 - 07/07/2014
Source: PublicationPreSubmission
Source-ID: 101968847
Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

Air Distribution and Ventilation Effectiveness in a room with Floor/Ceiling Heating and Mixing/Displacement Ventilation

The present study investigated different combinations of floor/ceiling heating with mixing/displacement ventilation and their impacts on the indoor air distribution and ventilation effectiveness. Measurements were performed in a room during heating season in December. The results show that indoor vertical air temperature differences and air velocities for different hybrid systems are less than 3 C and 0.2 m/s when supply air temperature is 19 C, air change rate is 4.2 h⁻¹, and heated surface temperature of floor/ceiling heating system is 25 C. Ventilation effectiveness of mixing ventilation system combined with floor/ceiling heating systems is approximately equal to 1.0, and ventilation effectiveness of displacement ventilation system combined with floor/ceiling heating systems ranges from 1.0 to 1.2. The floor/ceiling heating systems combined with mixing ventilation system have more uniform indoor air distribution but smaller ventilation effectiveness compared with the floor/ceiling heating systems combined with displacement ventilation system. With regard to the building heat loss increased by non-uniform indoor air distribution and small ventilation effectiveness, there should be an optimal combination of floor/ceiling heating with mixing/displacement ventilation to have the minimal building heat loss. The present study investigated different combinations of floor/ceiling heating with mixing/displacement ventilation and their impacts on the indoor air distribution and ventilation effectiveness. Measurements were performed in a room during heating season in December. The results show that indoor vertical air temperature differences and air velocities for different hybrid systems are less than 3 C and 0.2 m/s when supply air temperature is 19 C, air change rate is 4.2 h⁻¹, and heated surface temperature of floor/ceiling heating system is 25 C. Ventilation effectiveness of mixing ventilation system combined with floor/ceiling heating systems is approximately equal to 1.0, and ventilation effectiveness of displacement ventilation system combined with floor/ceiling heating systems ranges from 1.0 to 1.2. The floor/ceiling heating systems combined with mixing ventilation system have more uniform indoor air distribution but smaller ventilation effectiveness compared with the floor/ceiling heating systems combined with displacement ventilation system. With regard to the building heat loss increased by non-uniform indoor air distribution and small ventilation effectiveness, there should be an optimal combination of floor/ceiling heating with mixing/displacement ventilation to have the minimal building heat loss.
Analyses of passive cooling strategies' effect on overheating in low-energy residential buildings in Danish climate

A model for estimating particle concentration indoors – based on information from occupants' questionnaires, indoor sources emission factors, outdoor concentration and building characteristics

Analyses of passive cooling strategies' effect on overheating in low-energy residential buildings in Danish climate
Analysis of a plus-energy house

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Technical University of Denmark
Authors: Andersen, M. (Ekstern), Schøtt, J. (Ekstern), Kazanci, O. B. (Intern), Olesen, B. W. (Intern)
Pages: 28-34
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Conference: 13th SCANVAC International Conference on Air Distribution in Rooms, São Paulo, Brazil, 19/10/2014 - 19/10/2014
BFI conference series: International Conference on Air Distribution in Rooms (5010059)
Main Research Area: Technical/natural sciences

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ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
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Analysis of a plus-energy house for improved building and HVAC system design

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Technical University of Denmark
Authors: Andersen, M. (Ekstern), Schøtt, J. (Ekstern), Kazanci, O. B. (Intern), Olesen, B. W. (Intern)
Number of pages: 8
Pages: 377-384
Publication date: 2014

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Title of host publication: Proceedings of ROOMVENT 2014, 13th SCANVAC International Conference on Air Distribution in Rooms
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Main Research Area: Technical/natural sciences
Conference: 13th SCANVAC International Conference on Air Distribution in Rooms, São Paulo, Brazil, 19/10/2014 - 19/10/2014
Electronic versions:
Analysis_of_a_plus_energy_house_for_improved_building_and_HVAC_system_design_ID_217_.pdf

Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

Analysis of the effect of passive strategies on a nearly zero Danish residential building by means of dynamic simulations

Increase of outdoors temperature, due to climate changes, results in warmer summers even in cold climate regions. Moreover the use of wider glazing surfaces leads to high amount of incoming solar radiation. As a consequence, the moving toward low energy buildings with the improved air tightness is raising the issue of overheating even in the middle seasons creating not negligible thermal discomfort. Through building simulation program, the effect of passive cooling strategies, such as solar shading and natural night-time ventilation, on a residential building under Copenhagen climate conditions. The main result is that a crossed use of both strategies leads to a cooling demand reduction (21 kWh/m2year)
that varies between 98%-100% depending on the building’s tightness. Behavioural actions of the occupants were also considered in the calculation of the cooling energy demand and their impact on the indoor environment. When an alternative mechanical ventilation system was considered to exploit the nighttime cooling potential, results show a more constant indoor air temperature performance, just below 26°C. Even though this temperature trend satisfied the design conditions and users’ safety, it isn’t that one required by the users (22-24°C by previous studies). This desired thermal indoor environment can be however obtained by exploiting windows opening during night.

An intervention study of the acoustical environment’s effects on teachers’ well-being

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, University of Padua
Authors: Avantaggiato, M. (Ekstern), Simone, A. (Intern), de Carli, M. (Ekstern), Olesen, B. W. (Intern)
Number of pages: 17
Publication date: 2014

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Title of host publication: Proceedings of 31st Annual AICARR Conference
Publisher: AICARR
Main Research Area: Technical/natural sciences
Conference: 31st Annual AICARR Conference, Padova, Italy, 05/06/2014
Source: PublicationPreSubmission
Source-ID: 103263879
Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

Association between Noise levels and CO₂ Concentrations in Classrooms

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, National Research Center for Working Environment, Akustik Aps, Danish Centre of Educational Environment
Authors: Kristiansen, J. (Ekstern), Lund, S. P. (Ekstern), Persson, R. (Ekstern), Toftum, J. (Intern), Møberg Nielsen, P. (Ekstern), Challi, R. (Ekstern)
Number of pages: 1
Publication date: 2014
Event: Abstract from 7th Forum Acusticum, Krakow, Poland.
Main Research Area: Technical/natural sciences
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2015

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BFI conference series: International Conference on Indoor Air Quality and Climate (5010063)
Main Research Area: Technical/natural sciences
Conference: 13th International Conference on Indoor Air Quality and Climate, Hong Kong, Hong Kong, 07/07/2014 - 07/07/2014
Acoustics, Schools, Ventilation, Monitoring, Air quality
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Bibliographical note
Topic (A9). Indoor air acoustics and lighting.
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015
Associations between selected allergens, phthalates, nicotine, polycyclic aromatic hydrocarbons, and bedroom ventilation and clinically confirmed asthma, rhinoconjunctivitis, and atopic dermatitis in preschool children

Previous studies, often using data from questionnaires, have reported associations between various characteristics of indoor environments and allergic disease. The aim of this study has been to investigate possible associations between objectively assessed indoor environmental factors and clinically confirmed asthma, rhinoconjunctivitis, and atopic dermatitis. The study is a cross-sectional case-control study of 500 children aged 3-5 years from Odense, Denmark. The 200 cases had at least two parentally reported allergic diseases, while the 300 controls were randomly selected from 2835 participating families. A single physician conducted clinical examinations of all 500 children. Children from the initially random control group with clinically confirmed allergic disease were subsequently excluded from the control group and admitted in the case group, leaving 242 in the healthy control group. For most children, specific IgE’s against various allergens were determined. In parallel, dust samples were collected and air change rates were measured in the children’s bedrooms. The dust samples were analyzed for phthalate esters, polycyclic aromatic hydrocarbons (PAH), nicotine, and various allergens. Among children diagnosed with asthma, concentrations of nicotine were higher (P
Cardiovascular and lung function in relation to outdoor and indoor exposure to fine and ultrafine particulate matter in middle-aged subjects

This cross-sectional study investigated the relationship between exposure to airborne indoor and outdoor particulate matter (PM) and cardiovascular and respiratory health in a population-based sample of 58 residences in Copenhagen, Denmark. Over a 2-day period indoor particle number concentrations (PNC, 10–300 nm) and PM$_{2.5}$ (aerodynamic diameter < 2.5 μm) were monitored for each of the residences in the living room, and outdoor PNC (10–280 nm), PM$_{2.5}$ and PM$_{10}$ (aerodynamic diameter < 10 μm) were monitored at an urban background station in Copenhagen. In the morning, after the 2-day monitoring period, we measured microvascular function (MVF) and lung function and collected blood samples for biomarkers related to inflammation, in 78 middle-aged residents. Bacteria, endotoxin and fungi were analyzed in material from electrostatic dust fall collectors placed in the residences for 4 weeks. Data were analyzed using linear regression with the generalized estimating equation approach. Statistically significant associations were found between indoor PNC, dominated by indoor use of candles, and lower lung function, the prediabetic marker HbA1c and systemic inflammatory markers observed as changes in leukocyte differential count and expression of adhesion markers on monocytes, whereas C-reactive protein was significantly associated with indoor PM$_{2.5}$. The presence of indoor endotoxin was associated with lower lung function and expression of adhesion markers on monocytes. An inverse association between outdoor PNC and MVF was also statistically significant. The study suggests that PNC in the outdoor environment may be associated with decreased MVF, while PNC, mainly driven by candle burning, and bioaerosols in the indoor environment may have a negative effect on lung function and markers of systemic inflammation and diabetes.
Cerebral blood flow, fatigue, mental effort, and task performance in offices with two different pollution loads

The effects of indoor air quality on symptoms, perceptions, task performance, cerebral blood flow, fatigue, and mental effort of individuals working in an office were investigated. Twenty-four right-handed Danish female subjects in an office were exposed in groups of two at a time to two air pollution levels created by placing or removing a pollution source (i.e. a used carpet) behind a screen. During the exposure, the subjects performed four different office tasks presented on a computer monitor. The tasks were performed at two paces: normal and maximum. When the pollution source was present, the air quality was perceived to be worse and more errors were made when subjects typed text at the maximum pace. No other changes in subjective responses, performance, or physiological measurements were associated with different exposures. Although cerebral blood flow and voice analysis did not detect any effects caused by modifying pollution exposure, they were well correlated with increased mental effort when the tasks were performed at maximum pace and subjectively reported fatigue, which increased during the course of exposure, respectively.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, University of the Sacred Heart, Waseda University
Authors: Nishihara, N. (Ekstern), Wargocki, P. (Intern), Tanabe, S. (Ekstern)
Pages: 153-164
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
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BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.51 SJR 2.015 SNIP 2.198
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 2.093 SNIP 2.49 CiteScore 4.37
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.938 SNIP 2.797 CiteScore 4.14
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.581 SNIP 2.602 CiteScore 3.57
Chaetomium and Stachybotrys in water-damaged buildings

Fungal growth occurs when parts of the building envelope get very wet due to unfortunate combinations of factors, e.g. thermal bridges/lack of ventilation, shoddy foundations/flooding or leaks in build-in pipes. Chaetomium and Stachybotrys are not as abundant as Penicillium and Aspergillus (Table 1), however, they may produce volatiles and microparticles that can cause health problems. They are common in wet walls constructed of wood fibre board (OSB/plywood) and gypsum board.

General information

State: Published
Organisations: Department of Systems Biology, Fungal Physiology and Biotechnology, Eucaryotic Molecular Cell Biology, Metabolomics Platform, Department of Civil Engineering, Section for Indoor Environment
Authors: Andersen, B. (Intern), Lewinska, A. M. (Intern), Nielsen, J. B. (Intern), Dosen, I. (Intern), Nielsen, K. F. (Intern), Peuhkuri, R. H. (Intern), Rode, C. (Intern), Clausen, G. (Intern), Thrane, U. (Intern)
Publication date: 2014
Event: Poster session presented at 10th International Mycological Congress, Bangkok, Thailand.
Main Research Area: Technical/natural sciences

Electronic versions:
Characterization of heat dynamics of an arctic low-energy house with floor heating

This paper presents grey-box modeling of the heat dynamics of an apartment in a highly insulated test building located in the Arctic. Data from a 16-day-long experiment is analyzed and used to fit lumped parameter models formulated as coupled stochastic differential equations. The output of the models is the measured indoor air temperature, and the models are fitted using maximum likelihood techniques with the software CTSM-R. Models are compared using likelihood-ratio tests and validated considering autocorrelation and periodograms of residuals. The fitted models facilitate description of both the fast responses to mechanical ventilation and solar radiation through a large window facade, and the slow responses to floor heating and outdoor temperature. To successfully describe the dynamics of the system, solar radiation is given special attention in modeling of both the physical system and the observational noise. The estimated physical parameters which include UA-value, total heat capacity, and time constants for the apartment are discussed. Simulations are performed to illustrate step and impulse responses of inputs.
**Classroom ventilation type and pupil learning**

**General information**

State: Published

Organisations: Department of Civil Engineering, Section for Indoor Environment, Deloitte, Technical University of Denmark

Authors: Kjeldsen, B. U. (Intern), Toftum, J. (Intern), Wargocki, P. (Intern), Menå, H. R. (Ekstern), Hansen, E. M. N. (Ekstern), Clausen, G. (Intern)

Publication date: 2014

**Host publication information**

Title of host publication: Proceedings of Indoor Air 2014

Publisher: International Society of Indoor Air Quality and Climate

Article number: HP0252

BFI conference series: International Conference on Indoor Air Quality and Climate (5010063)

Main Research Area: Technical/natural sciences

Conference: 13th International Conference on Indoor Air Quality and Climate, Hong Kong, Hong Kong, 07/07/2014 - 07/07/2014

Schools, CO2, Schoolwork, Performance

Electronic versions:

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**Bibliographical note**

Topic A6: Health and Indoor air epidemiology.

**Source:** PublicationPreSubmission

Source-ID: 104828868

Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

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**Comparison of mixing and displacement ventilation in a low energy office building during heating season**

The present study investigated the performance of mixing and displacement ventilation systems in a low energy office building during heating season. Measurements were performed with regard to air distribution and ventilation effectiveness. The results show that indoor air temperatures in occupied zone was 21.0°C for mixing ventilation and 20.8°C for displacement ventilation when supply air temperature was 19°C and air change rate was 4.2 h-. Vertical air temperature difference between the head level and the foot level were all less than 3°C and local air velocity were all less than 0.2m/s for both ventilation systems. In addition, local ventilation effectiveness ranged from 0.91 to 0.94 for mixing ventilation and from 1.03 to 1.17 for displacement ventilation. Distributions of vertical air temperature and velocity and horizontal contaminant concentration were more uniform for mixing ventilation compared to those for displacement ventilation. Due to the heat emission from equipments and occupants, heating system was not needed in the low energy office building in a mild winter. In such a situation, indoor thermal environment was still acceptable in terms of the general thermal comfort and the local thermal discomfort for a standard office worker.

**General information**

State: Published

Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics, Xi’an Jiaotong University, Harbin Institute of Technology

Authors: Fang, L. (Intern), Olesen, B. W. (Intern), Wu, X. (Ekstern), Wang, F. (Ekstern), Zhao, J. (Ekstern)

Pages: 492-499

Publication date: 2014

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Title of host publication: Proceedings of Indoor Air 2014

BFI conference series: International Conference on Indoor Air Quality and Climate (5010063)

Main Research Area: Technical/natural sciences

Conference: 13th International Conference on Indoor Air Quality and Climate, Hong Kong, Hong Kong, 07/07/2014 - 07/07/2014

Publication: Research - peer-review › Article in proceedings – Annual report year: 2015
Comparison of radiant and convective cooling of office room: effect of workstation layout

The impact of heat source location (room layout) on the thermal environment generated in a double office room with four cooling ventilation systems - overhead ventilation, chilled ceiling with overhead ventilation, active chilled beam and active chilled beam with radiant panels was measured and compared. The room was furnished with two workstations, two laptops and two thermal manikins resembling occupants. Two heat load levels, design (65 W/m²) and usual (39 W/m²), were generated by adding heat from warm panels simulating solar radiation. Two set-ups were studied: occupants sitting by the windows, and near the opposite wall. The room air temperature of 26 °C was kept constant. Air temperature, globe (operative) temperature, manikin based equivalent temperature and air velocities were all measured. All systems performed equally well and managed to keep the required thermal environment.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Technical University of Denmark, Halton OY, Uponor Corporation, Silesian University of Technology
Authors: Bolashikov, Z. D. (Intern), Melikov, A. K. (Intern), Rezgals, L. (Ekstern), Lipczynska, A. (Ekstern), Mustakallio, P. (Ekstern), Kosonen, R. (Ekstern), Aho, I. (Ekstern)
Number of pages: 8
Publication date: 2014

Host publication information
Title of host publication: Proceedings of Indoor Air 2014
Publisher: International Society of Indoor Air Quality and Climate
Article number: Paper ID 0875
BFI conference series: International Conference on Indoor Air Quality and Climate (5010063)
Main Research Area: Technical/natural sciences
Conference: 13th International Conference on Indoor Air Quality and Climate, Hong Kong, Hong Kong, 07/07/2014 - 07/07/2014
Electronic versions:
Comparison_of_radiant_and_convective_cooling.pdf
Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

Control of exposure to exhaled air from sick occupant with wearable personal exhaust unit

Exposure reduction to exhaled air from a sick doctor wearing personal exhaust unit incorporated in headset-microphone was studied. Experiments were performed in a full-scale test room furnished as a double-bed hospital room with overhead ventilation at 3, 6 and 12 ACH. Room air temperature was 22 °C. Breathing thermal manikin with realistic body and breathing cycle was used to mimic doctor. Second thermal manikin and heated dummy were used to resemble lying patients. Exhaled air by the doctor was mixed with tracer gas to mimic pathogens. The unit was positioned frontally by the mouth of the doctor at three different distances. It was operated at 0.25 or 0.50 L/s under mixing background ventilation at 3 ACH. The use of wearable personal exhaust resulted in cleaner air in the room compared to mixing alone at 12 ACH. The high potential to capture exhaled air makes the device efficient against airborne pathogens.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Technical University of Denmark
Authors: Bolashikov, Z. D. (Intern), Melikov, A. K. (Intern), Barova, M. I. (Ekstern)
Number of pages: 8
Publication date: 2014

Host publication information
Title of host publication: Proceedings of Indoor Air 2014
Publisher: International Society of Indoor Air Quality and Climate
Article number: Paper ID 0876
BFI conference series: International Conference on Indoor Air Quality and Climate (5010063)
Main Research Area: Technical/natural sciences
Conference: 13th International Conference on Indoor Air Quality and Climate, Hong Kong, Hong Kong, 07/07/2014 - 07/07/2014
Electronic versions:
Control_of_exposure_to_exhaled_air.pdf
Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

Convective Heat Transfer Coefficients of the Human Body under Forced Convection from Ceiling

The average convective heat transfer coefficient for a seated human body exposed to downward flow from above was determined. Thermal manikin with complex body shape and size of an average Scandinavian female was used. The surface temperature distribution of the manikin’s body was as the skin temperature distribution of an average person. The
measurements were performed in a room with controlled thermal environment. Air temperature was set at 26°C for cooling and at 20°C for heating. The radiant temperature asymmetry in horizontal and vertical direction was close to zero, i.e. mean radiant temperature was equal to the air temperature. The air velocity of the isothermal downward flow from the ceiling at height of 1.5 m above the floor (above the top of the head) was set in a range between still air and 0.73 m/s. Based on the analyses of the results relationships for determination of the convective heat transfer coefficient of the whole body (hc [W/(m²•K)]) was proposed: 

\[ hc = 4.088 + 6.592V^{1.715} \]

for a seated naked body at 20°C and 

\[ hc = 2.874 + 7.427V^{1.345} \]

for a seated naked body at 26°C. Differences in the convective heat transfer coefficient of the whole body in low air velocity range, \( V < 0.3 \) m/s, due to the natural convection were found. The results may be useful during design of air distribution in rooms, e.g. low impulse ventilation, diffuse ventilation, etc.

**General information**

**State:** Published

**Organisations:** Department of Civil Engineering, Section for Indoor Environment, Sugiyama Jogakuen University, Riga Technical University

**Authors:** Kurazumi, Y. (Ekstern), Rezgals, L. (Ekstern), Melikov, A. K. (Intern)

**Publication date:** 2014

**Main Research Area:** Technical/natural sciences

**Publication information**

**Journal:** Journal of Ergonomics

**Volume:** 4

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**ISI indexed (2013):** ISI indexed no

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**Bibliographical note**

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**Source:** PublicationPreSubmission

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**Publication:** Research - peer-review › Journal article – Annual report year: 2014

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**Cooling clothing utilizing water evaporation**

We developed cooling clothing that utilizes water evaporation to cool the human body and has a mechanism to control the cooling intensity. Clean water was supplied to the outer surface of the T-shirt of the cooling clothing, and a small fan was used to enhance evaporation on this outer surface. To prevent wet discomfort, the T-shirt was made of a polyester material having a water-repellent silicon coating on the inner surface. The chest, front upper arms, and nape of the neck were adopted as the cooling areas of the human body. We conducted human subject experiments in an office with air temperature ranging from 27.4 to 30.7 °C to establish a suitable water supply control method. A water supply control method that prevents water accumulation in the T-shirt and water dribbling was validated; this method is established based on the concept of the water evaporation capacity under the applied environment.

**General information**

**State:** Published

**Organisations:** Department of Civil Engineering, Section for Indoor Environment, Shinshu University

**Authors:** Sakoi, T. (Ekstern), Tominaga, N. (Ekstern), Melikov, A. K. (Intern), Kolenciková, S. (Intern)

**Number of pages:** 8

**Publication date:** 2014

**Host publication information**

**Title of host publication:** Proceedings of Indoor Air 2014

**Publisher:** International Society of Indoor Air Quality and Climate
Do Certified Buildings Enhance Indoor Environmental Quality and Performance of Office Work?

With the growth of sustainability consciousness, the awareness of stakeholders for high performance buildings has also increased. The concept of green buildings has appeared. Several voluntary environmental rating schemes for buildings were created. Their focus has been energy conservation and environmental impacts. The schemes use different credit system for various variables and different approaches to rate indoor environmental quality (IEQ) (Figure 1). It is interesting to examine, whether human related factors are properly addressed in the schemes, especially considering the potential effects on productivity and that an average employee cost can be >10-100 times higher than the rental operation and maintenance costs (Morrell, 2005; Persram et al., 2007). There is however lack of consistent and systematic data benchmarking benefits of green building, in particular as regards IEQ and the effects on humans. Health, comfort and work performance outcomes are more difficult to quantify than the effects on energy. As a result, it may be expected that credits for IEQ in the schemes be traded with other credits. If so, although claimed to have an outstanding IEQ as compared with conventional buildings (Lee, 2011), the green building do not have to necessarily meet this postulation. Quite limited numbers of credits for enhancing IEQ offered by the schemes will certainly not very much help that the high IEQ is guaranteed. The present paper surveyed literature on green buildings to examine whether there is any systematic evidence that these buildings outperform conventional buildings as regards IEQ either through actual IEQ measurements, subjective assessments made by occupants and/or objectively and self-estimated work performance.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Da Silva, N. A. F. (Intern), Wargocki, P. (Intern)
Number of pages: 3
Publication date: 2014

Host publication information
Title of host publication: Proceedings of Indoor Air 2014
Publisher: International Society of Indoor Air Quality and Climate
BFI conference series: International Conference on Indoor Air Quality and Climate (5010063)
Dynamisk varmeregnskab med fokus på indeklima i lejligheder

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Exergi
Authors: Wilke, G. (Ekstern), Andersen, R. K. (Intern)
Number of pages: 35
Publication date: 2014

Effect of individual and collective heat cost allocation on indoor environment in Danish apartments

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Andersen, R. K. (Intern), Andersen, S. (Intern), Olesen, B. W. (Intern)
Number of pages: 2
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Event: Abstract from Symposium on Occupant Behaviour, Nottingham, United Kingdom.
Main Research Area: Technical/natural sciences
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Effect of passive cooling strategies on overheating in low energy residential buildings for Danish climate

Climate changes have progressively produced an increase of outdoors temperature resulting in tangible warmer summers even in cold climate regions. An increased interest for passive cooling strategies is rising in order to overcome the newly low energy buildings’ overheating issue. The growing level of air-tightness plays in low-energy buildings a double-acting role: reduction of energy demand and lack of adequate infiltration rate. In particular, the last one combined with higher outside air temperatures brings these new concepts buildings to progressively experience higher indoor temperatures creating not negligible thermal discomfort.

In the present work the effect of passive strategies, such as solar shading and natural night-time ventilation, are evaluated through computer simulations. The analyses are performed for 1½-storey single-family house in Copenhagen’s climate. The main result is that a crossed use of both strategies leads to a cooling demand reduction that varies between 98%-100% depending on the building’s insulation.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, University of Padua
Authors: Simone, A. (Intern), Avantaggiato, M. (Ekstern), de Carli, M. (Ekstern), Olesen, B. W. (Intern)
Number of pages: 14
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Host publication information
Title of host publication: Proceedings of 8th Windsor Conference: Counting the Cost of Comfort in a changing world
Effect of thermostat and window opening occupant behavior models on energy use in homes

Existing dynamic energy simulation tools exceed the static dimension of the simplified methods through a better and more accurate prediction of energy use; however, their ability to predict real energy consumption is undermined by a weak representation of human interactions with the control of the indoor environment. The traditional approach to building dynamic simulation considers energy consumption as fully deterministic, taking into account standardized input parameters and using fixed and unrealistic schedules (lighting level, occupancy, ventilation rate, thermostat set-point). In contrast, in everyday practice occupants interact with the building plant system and building envelope in order to achieve desired indoor environmental conditions. In this study, occupant behavior in residential building was modelled accordingly to a probabilistic approach. A new methodology was developed to combine probabilistic user profiles for both window opening and thermostat set-point adjustments into one building energy model implemented in the dynamic simulation tool IDA Ice. The aim of the study was to compare mean values of the probabilistic distribution of the obtained results with a singular heating energy consumption value obtained by means of standard deterministic simulations. Major findings of this research demonstrated the weakness of standardized occupant behavior profile in energy simulation tools and the strengths of energy models based on measurements in fields and probabilistic modelling providing scenarios of occupant behavior in buildings.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Politecnico di Torino
Authors: D'Oca, S. (Ekstern), Fabi, V. (Ekstern), Corgnati, S. P. (Ekstern), Andersen, R. K. (Intern)
Number of pages: 12
Pages: 683-694
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Main Research Area: Technical/natural sciences

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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.56 SJR 0.784 SNIP 0.936
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.016 SNIP 1.154 CiteScore 1.74
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.827 SNIP 1.264 CiteScore 1.41
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.45 SNIP 0.649 CiteScore 0.77
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.444 SNIP 0.751 CiteScore 0.72
ISI indexed (2012): ISI indexed no
BFI (2011): BFI-level 2
Efficiency of deodorant materials for ammonia reduction in indoor air
A comparative study about the removability of ammonia gas in the air by activated carbon fiber (ACF) felt chemically treated with acid and a cotton fabric processed with iron phthalocyanine with copper (Cu) was performed in small-scale experiments. The test rig consisted of a heated plate and its purpose was to simulate surface body temperature of 34 °C. The textiles were tested at two levels of relative humidity of 25% and 80% and two air temperatures of 20 °C and 28 °C. During the experiments, the airflow supplied to the test rig was controlled at a low constant flow rate of 0.46 L/s. Results proved activated carbon fiber felt with acid to be highly efficient in removing ammonia gas. Air temperature did not have profound effect on ACF performance. However, efficiency of the carbon fiber felt decreased when relative humidity was raised from 20 to 80%.

Energy use and indoor environment in new and existing dwellings in Arctic climates
Buildings in Arctic climates require large amounts of heat to provide their occupants with a comfortable indoor environment. In recent years the intention to conserve energy has caused buildings in the Arctic (and worldwide) to become more insulated and airtight. The natural infiltration of buildings is being reduced to avoid heat loss and unpleasant air drafts, often without proper compensation. Many studies have shown that living in insufficiently ventilated spaces increases the risk for asthma and allergy symptoms. However, the indoor environment in Arctic dwellings has seldom been investigated. For energy and indoor environmental reasons it is advisable that new airtight buildings be equipped with mechanical ventilation systems with heat recovery. Nevertheless, these systems when exposed to the Arctic winter climate face the risk of frost formation, which may put the ventilation system out of order for long periods or potentially damage it. The main objectives of the work described in this thesis have been: A) to provide new knowledge about optimal operation and performance of low energy technologies in the Arctic and B) to map the indoor environmental quality in dwellings in the Arctic. The first part of this thesis provides an overview of three case studies undertaken in newly built residential buildings in Greenland and Alaska. It was found that ventilation systems in these buildings are either under or oversized which has a significant negative effect on their indoor air quality or energy use respectively. One of the evaluated buildings in Greenland had ventilation units that were not equipped with the frost protection and as a result, serious ice buildups appeared inside the heat exchangers. The prototype heat exchanger developed at the Technical University of Denmark and installed in the Low Energy House in Sisimiut had experienced an unnoticed malfunction for the first 3 years of operation. However, after repairing the heat exchanger it was capable of continuous operation without freezing and reached an average thermal effectiveness of 69 %. In Alaska, three out of four ventilation systems studied in
new homes used recirculation as a method of frost protection. This strategy allowed a continuous operation of the ventilation system; however, the fresh air supply was reduced significantly during winter months. The second part of the thesis presents a cross sectional study on indoor air quality performed in Sisimiut, Greenland. A questionnaire as part of the study found that over 30 % of respondents experience cold discomfort during winter months (i.e. cold floors, cold draft or too low indoor temperature), 35 % of the respondents reported frequent condensation on windows. Despite the cool summers 40 % of the respondents complained about summer overheating. It was also found that 34 % of the respondents smoke inside their homes. Additionally it was revealed that ventilation equipment is typically limited to fresh air openings on walls, mechanical exhausts from bathrooms (present in 63 % of the dwellings) and kitchen range hoods (installed in 82 % of the dwellings). Presence of balanced mechanical ventilation was not reported by any of the respondents. The questionnaire study was followed by summer and winter measurements in bedrooms of 79 dwellings selected among dwellings inhabited by the questionnaire respondents. The winter measurements indicate that 73 % of the monitored bedrooms experienced average additional moisture higher than 2.5 g/kg or average night CO2 concentration above 1000 ppm and 59 % of bedrooms had experienced both. This indicates that the majority of the monitored bedrooms were insufficiently ventilated. The problems with poor ventilation were more severe in newer buildings (build after 1990) due to tighter envelopes and unchanged ventilation strategies.

In conclusion, it is possible to provide dwellings in the Arctic with good indoor environment. However, this is largely dependent on the design of buildings and their ventilation systems. The ventilation should not rely on simple wall openings as they prove to be inefficient in providing continuous air change at a sufficient rate without creating thermal discomfort.
predict the behavior of DW and also helpful for developing a DW performance map for the further optimization of automatic control of the system. © 2014 Elsevier B.V. All rights reserved.

**General information**
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Tianjin University
Authors: Sheng, Y. (Ekstern), Zhang, Y. (Ekstern), Sun, Y. (Ekstern), Fang, L. (Intern), Nie, J. (Intern), Ma, L. (Ekstern)
Number of pages: 8
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Main Research Area: Technical/natural sciences

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Web of Science (2017): Indexed yes
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Scopus rating (2016): CiteScore 4.64 SJR 2.093 SNIP 1.965
Web of Science (2016): Indexed yes
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Scopus rating (2015): SJR 2.088 SNIP 2.174 CiteScore 4.07
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.123 SNIP 2.936 CiteScore 4.21
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.897 SNIP 2.433 CiteScore 3.79
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.816 SNIP 2.737 CiteScore 3.36
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.506 SNIP 2.536 CiteScore 3.23
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.631 SNIP 2.081
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.564 SNIP 1.79
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.624 SNIP 2.028
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.033 SNIP 1.718
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.411 SNIP 1.788
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.293 SNIP 1.277
Experimental Evaluation of a Total Heat Recovery Unit with Polymer Membrane Foils

A laboratory experimental study was conducted to investigate the energy performance of a total heat recovery unit using a polymer membranes heat exchanger. The study was conducted in twin climate chambers. One of the chambers simulated outdoor climate conditions and the other simulated the climate condition indoors. The airflows taken from the two chambers were connected into the total heat recovery unit and exchange heat in a polymer membrane foil heat exchanger installed inside the unit. The temperature and humidity of the air upstream and downstream of the heat exchanger were measured. Based on the measured temperature and humidity values, the temperature, humidity, and enthalpy efficiencies of the total heat recovery unit were calculated. The experiment was conducted in different combinations of outdoor climate conditions simulating warm and humid outdoor climates and air-conditioned indoor climate. The test was also conducted in isothermal conditions to observe the moisture transfer performance of the polymer membrane heat exchanger. The results of the experiment shows that total heat recovery equipment tested can recover up to 60% of the total heat from the ventilation air. Around 87% of the recovered total heat is latent heat that comes from the moisture transfer.

General information

State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Technical University of Denmark
Authors: Fang, L. (Intern), Yuan, S. (Ekstern), Nie, J. (Intern)
Pages: 235-242
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Conference: 8th International Symposium on Heating, Ventilation and Air Conditioning, Xi'an, China, 19/10/2013 - 19/10/2013

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Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

Experimental evaluation on energy performance of innovative clean air heat pump for indoor environment control in summer and winter seasons

Based on the air purification capacity of regenerative silica gel rotor, an innovative clean air heat pump (CAHP) was designed, developed and investigated through experimental studies. The CAHP integrated air purification,
dehumidification and heating/cooling in one unit. A prototype of the CAHP was developed. Laboratory experimental studies were conducted to investigate its energy performance under different outdoor climates including cold, mild-cold, mild-hot and extremely hot and humid climates. The energy performance of the CAHP was then evaluated by comparing with a conventional air source heat pump. The results showed that to keep same indoor air quality, the CAHP could save substantial amount of energy. For example, compared to the conventional air source heat pump, the CAHP could save up to 59%, 40%, 30% of electricity for ventilation and air conditioning in a test room in summer of Copenhagen, Milan and Colombo, and could save 5%, 13% of electricity for ventilation and heating in the test room in winter of Copenhagen, Milan.
Experimental investigation of the human convective boundary layer in a quiescent indoor environment

This study aims to characterize human convective boundary layer (CBL) in a quiescent indoor environment. The study has two objectives: first, to characterize the velocity field around the thermal manikin under two ambient temperatures and body postures; and secondly, the influence of clothing insulation/design, chair design, table positioning and seated body inclination on airflow characteristics in the breathing zone of a sitting manikin is examined. The increase of the ambient temperature from 20 to 26°C widens the CBL flow in front of the sitting manikin but do not influence the shape of the CBL in front of the standing manikin. The same temperature increase causes the reduction of the CBL mean peak velocity from 0.24 to 0.16m/s in front of the sitting manikin. Dressing the nude manikin with thin-tight clothing ensemble reduces the peak velocity in the breathing zone from 0.205m/s by 17%, and by 40% for thick-loose ensemble. Removing the wig increases the peak velocity from 0.17 to 0.187m/s. Clothing and chair design have a minor influence on the velocity profile beyond 5cm distance from the body. Closing the gap between the table and the manikin reduces the peak velocity from 0.17 to 0.111m/s. Manikin leaned backwards induces the peak velocity of 0.185m/s, which is 45% above the case when manikin is leaned forward. PIV measurements complemented with Pseudo color visualization (PCV) technique provide a good synergy between quantitative and qualitative airflow characteristics and can be adequately employed for the CBL investigation. © 2014 Elsevier Ltd.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, University of Maryland, National University of Singapore
Authors: Licina, D. (Intern), Pantelic, J. (Ekstern), Melikov, A. K. (Intern), Sekhar, C. (Ekstern), Tham, K. W. (Ekstern)
Pages: 79-91
Publication date: 2014
Main Research Area: Technical/natural sciences

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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.51 SJR 2.015 SNIP 2.198
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Experimental study on energy performance of clean air heat pump

An innovative clean air heat pump (CAHP) was designed and developed based on the air purification capacity of regenerative silica gel rotor. The clean air heat pump integrated air purification, dehumidification and cooling in one unit. A prototype of the clean air heat pump was developed to investigate its energy performance. Energy consumption of the prototype of CAHP was measured in laboratory at different climate conditions including mild-cold, mildhot and extremely hot and humid climates. The energy saving potential of the clean air heat pump compared to a conventional ventilation and air-conditioning system was calculated. The experimental results showed that the clean air heat pump saved substantial amount of energy compared to the conventional system. For example, the CAHP can save up to 59% of electricity in Copenhagen, up to 40% of electricity in Milan and up to 30% of electricity in Colombo in summer compared to...
the conventional ventilation and air-conditioning system that are commonly used in those regions.

**General information**
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics
Authors: Fang, L. (Intern), Nie, J. (Intern), Olesen, B. W. (Intern)
Pages: 609-616
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BFI conference series: International Conference on Indoor Air Quality and Climate (5010063)
Main Research Area: Technical/natural sciences
Conference: 13th International Conference on Indoor Air Quality and Climate, Hong Kong, Hong Kong, 07/07/2014 - 07/07/2014
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

**Experimental study on human exposure to occupant generated pollutants in rooms with ductless personalized ventilation**
The performance of “ductless” personalized ventilation in conjunction with displacement ventilation with regard to exposure to different body bioeffluents was studied. Experiments were performed in a full-scale room furnished as a double office. Room air temperature was kept at 26 °C. Two breathing thermal manikins were used to simulate occupants. Tracer gases were used to simulate human bioeffluents (feet, groins, armpits and exhaled air) released from one manikin, simulating polluting occupant. The second manikin simulated exposed occupant. Different combinations of supply flow rates and operation modes for the ductless personalized and displacement ventilation were tested. The location of the bioeffluent source affected the spread of body bioeffluents in the space. The ductless personalized ventilation provided cleaner air to both occupants than displacement ventilation alone. Occupants using the “ductless” system will perceive the supplied air quality as superior compared to displacement ventilation alone.

**General information**
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Technical University of Denmark
Authors: Melikov, A. K. (Intern), Bolashikov, Z. D. (Intern), Lu, P. (Ekstern)
Publication date: 2014

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Title of host publication: Proceedings of Indoor Air 2014
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Article number: Paper ID 0866
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**Experimental study on mass transfer of contaminants through an enthalpy recovery unit with polymer membrane foils**
Laboratory experimental studies were conducted to investigate the mass transfer of contaminants through a total heat recovery unit with polymer membranes foils. The studies were conducted in twin climate chambers which simulated outdoor and indoor thermal climates. One manufactured total heat recovery unit with polymer membrane foils was used as refeering unit in this study. The experiments were conducted with different outdoor thermal climates e.g. warm-humid and cold-dry climates; isothermal and non isothermal as well as equal humidity and non equal humidity with indoor climate. Three chemical gases were used to simulate air contaminants. The concentrations of dosed contaminants in the supply and exhaust air upstream and downstream of the total heat recovery unit were measured with Multi-Gas Monitor Innova 1316 in real time. Experiment results showed that 5% to 9% of dosed contaminants could transfer from exhaust air to supply air through the enthalpy recovery unit. The mass transfer efficiency of contaminants was independent of the hygro-thermal differences between indoor and outdoor climate conditions. The mass transfer ratio of the chemical contaminants in the total heat recovery unit tested was little to do with their molecule sizes and water solubility. The contaminants transfer of 5-9% in the total heat recovery unit tested is to be investigated further to determine the reasons e.g. due to air leakage in the unit or due to diffusion of the contaminants through the polymer membrane or due to both reasons. The results indicated that polymer membrane foils may be a choice for producing total heat recovering equipment in ventilation systems.

**General information**
State: Published
Guidelines For Health-Based Ventilation In Europe

The burden of disease (BoD) associated with major air exposures indoors in 26 European countries was recently accounted for loss of two million healthy life years annually expressed as disability adjusted life years (DALYs) (Jantunen et al., 2011). The development of health-based ventilation guidelines has been recommended as one of the strategic priorities to reduce this BoD (de Oliveira-Fernandes et al., 2009), also because the current ventilation standards in Europe provide different categories of comfort, not health, as the main criteria for designing ventilation requirements (EN 13779, 2007). HealthVent project was granted by the European Commission through the Second Programme of Community Action in the Field of Health 2008-2013 to develop the principles of such guidelines. This paper describes the results of this project.

Hospital bed ventilation: impact of operation mode on exposure

Full-scale measurements were performed in a climate chamber set as a two-bed hospital room with overhead ventilation. Air temperature was kept constant at 22 °C. Two breathing thermal manikins were used to mimic a sick patient lying sideways in one of the beds and a doctor. A thermal dummy mimicked a second patient lying in the other bed. The doctor stood up 0.55 m from the bed facing the sick patient. Two pairs of localized ventilation units were attached near the heads of both patients alongside the beds to capture, clean and release the captured exhaled air from the lying patients. When the bed units were not operated the room was ventilated at 3, 6 or 12 ACH. The background ventilation was kept at 3 ACH when the units were used. The ‘sick patient’ was exhaling through the mouth and inhaling from the nose. Tracer gas (R 134a) was mixed with the exhaled air to mimic airborne droplets and droplet nuclei of less than 3 μm aerodynamic diameter. Two modes of operation of the bed incorporated ventilation unit were tested: releasing the cleaned air upwards (pull mode) or supplying it sideways over the lying patient (“push and pull” mode). The strategy to exhaust pollutants close to release proved to be efficient. The bed incorporated ventilation unit was effective in capturing the air exhaled by the sick lying patient and performed significantly better than the overhead ventilation at 12 ACH. The exposure for the doctor and the second patient was further reduced when the bed incorporated ventilation unit was operated in the “push and pull” mode compared to the pull mode.
Human perception of indoor environment generated by chilled ceiling combined with mixing ventilation or localised chilled beam under cooling mode

Experiments with 24 subjects were performed to study and compare the human perception of the indoor environment under summer conditions generated by a chilled ceiling combined with overhead mixing ventilation and localised chilled beam. The experiments were performed in an experimental chamber (4.2 m x 5.4 m x 3.1 m) equipped as an office with two workstations. One of the workstations (with a laptop) was by the window and the other in the opposite side of the room. Five heated radiant water panels were used to simulate direct solar gains from windows (404 W). Five electrical foils were used to simulate direct solar load on the floor (270 W). The total heat load in the room was 56 W/m². The air temperature around the workstation by the window was kept either 26 or 28 °C. The supplied air by the overhead mixing ventilation and the primary supply air of the localised chilled beam was kept at 13 L/s and 16 °C. The localised chilled beam was installed over the workstation placed by the simulated window. During the experiment the subjects were delegated control over the primary flow rate supplied by the localised chilled beam. The whole exposure lasted 2 hours with 30 min of acclimatisation before the experiment. Every person spent in total 90 minutes at the workstation by the windows (three sets of 30 min), 10 min at the other workstation and 20 min away from the workstations performing office work at increased activity (1.4 Met). The primary airflow rate supplied by the chilled beam was reduced to 6 L/s during the 20 min period of physical activity, when the occupant was not at the desk with the localised chilled beam, resulting in increase of the air temperature in the room. Subjects used questionnaires to answer on thermal sensation and acceptability, perceived air quality, air movement and SBS symptoms. Under 26 °C the localised chilled beam provided more local cooling compared to the chilled ceiling. The opposite trend between the two systems was noticed at 28 °C. However the local thermal acceptability votes were similar for the two systems. Majority of the occupants did not wish change in the air movement at WS1 at 26 °C. With the chilled ceiling more subjects complained of not sufficient air movement especially at 28 °C. Most of the subjects tended to use the localised chilled beam at the maximum flow rate available, i.e. 13 L/s.

General information
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Publication date: 2014

Human response to individually controlled micro environment generated with localized chilled beam

Indoor environment in a single-office room created by a localised chilled beam with individual control of the primary air flow was studied. Response of 24 human subjects when exposed to the environment generated by the chilled beam was collected via questionnaires under a 2-hour exposure including different work tasks at three locations in the room. Response of the subjects to the environment generated with a chilled ceiling combined with mixing air distribution was used for comparison. The air temperature in the room was kept at 26 or 28 °C. Results show no significant difference in the overall and local thermal sensation reported by the subjects with the two systems. Both systems were equally
acceptable. At 26°C the individual control of the localised chilled beam lead to higher acceptability of the work environment. At 28°C the acceptability decreased with the two systems. It was not acceptable with the localized chilled beam.

Human Response to Personalized Ventilation Combined with Chilled Ceiling

Personalized ventilation (PV) improves inhaled air quality, because it provides fresh air to each workstation and directly to occupant’s breathing zone. Previous research was focused on combining PV with additional total volume air distribution, i.e. mixing ventilation or displacement ventilation, which was responsible for keeping the design air temperature conditions in the occupied zone. Removing room sensible heat load with radiant cooling systems enables reduction of required supply airflow rates which can make it possible to use the PV as a single ventilation system in the room. Furthermore, the use of radiant ceiling cooling will provide operative temperature lower than the air temperature and will improve further occupants’ thermal comfort at warm environment. Therefore combining PV with chilled ceiling may be an effective way to provide thermal comfort in rooms at temperature higher than the recommended in the standards upper temperature limit of 26°C. In this paper response of 24 human subjects to a PV combined with chilled ceiling system (CCPV) is compared with the response to mixing ventilation combined with chilled ceiling (CCMV). Participants were provided with control of direction and flow rate of the air supplied from the PV. Air quality and thermal comfort perceived by subjects were studied during 3-h. exposures. Room air temperature was kept at 26°C and 28°C. Supplied air temperature (by PV and mixing ventilation) was 3 K lower than room air temperature. Average supply/return water temperature for chilled ceiling was 15.5/16.8°C at room air temperature of 26°C and 19.5/20.6°C at 28°C. During the experiment the subjects were performing typical office tasks at workstations with computers. Exposure included also increased activity level office work for a period of 25 min. At the workstation PV provided overall thermal sensation close to neutral, whereas thermal sensation above neutral was reported during the exposure with CCMV. In the room away from the workstations the thermal sensation and its’ acceptability was similar with both systems. Immediately after the increased activity period subjects’ thermal sensation ranged between warm and hot. After returning to the workstations the use of PV helped subjects to improve their thermal sensation much faster (5 min) compared to the CCMV (30 min). Air at workstation was perceived as more fresh with CCPV than with CCMV. Percentage of dissatisfied with air quality was lower in the cases with CCPV system compared to CCMV. Both studied systems created similar thermal and air quality conditions in the occupied zone outside of the workstations.
Impact of personalized ventilation combined with chilled ceiling on eye irritation symptoms

Personalized ventilation (PV) improves inhaled air quality, because it provides fresh air to each workstation and directly to occupant’s breathing zone. The PV alone can be used for room ventilation when applied in conjunction with ceiling radiant cooling system, which removes sensible heat loads from the space. Combining PV with chilled ceiling may be an effective way to provide thermal comfort in rooms at air temperature higher than the recommended in the standards upper limit of 26°C (category II), because the operative temperature will be lower. However, combination of high air temperature, elevated air movement toward face and increased radiant cooling may have impact on the eye symptoms. Twenty four human subjects participated in experiments with PV combined with chilled ceiling system (CCPV) and with mixing ventilation (MV) combined with chilled ceiling (CCMV). In the experiments with PV participants were provided with control of supplied air flow rate and direction. Room air temperature was kept at 26°C and 28°C. Relative humidity in the chamber was not controlled but was monitored and it varied between 20% and 30% during the experiments. Supplied air temperature (by PV and MV) was 3 K lower than room air temperature. Average supply/return water temperature for
chilled ceiling was 15.5/16.8°C at room air temperature of 26°C and 19.5/20.6°C at 28°C. The total exposure time was 3 h (with 0.5-h. acclimatization period). During the experiment subjects performed typical office tasks at workstations with computers. Exposure included also a higher activity level office work for a period of 25 min outside computer workstations. The influence of the environment on eye symptoms was assessed by subjective votes and objective measurements. Subjects reported on the eye irritation and the intensity of eye dryness 6 times throughout each experiment. Eye tear film samples were taken at the beginning and the end of the exposure. The blinking rate was analysed in the beginning and at the end of exposures. The preliminary results of the analyses reveal that the environment subjects were exposed to had an impact on their subjective and physiological response.

General information
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Improved inhaled air quality at reduced ventilation rate by control of airflow interaction at the breathing zone with lobed jets
Inhaled air quality at a reduced supply of clean air was studied by controlling the airflow interaction at the breathing zone of a person using lobed jets as part of personalized ventilation (PV). Experiments were performed in a full-scale test room at 23°C (73.4°F) with a breathing thermal manikin seated at a workstation, with realistic free-convection flow around the body and a normal breathing cycle. The air in the room was mixed with tracer gas R134a. Clean air was supplied isothermally from three nozzles with circular, four-leafed clover, and six-edged star openings of 0.025 m (0.08 ft) equivalent diameter. The nozzles were positioned frontally at the face within the boundary layer and centered to the mouth. The enhancement of inhaled air quality by changing the initial velocity (0.2-0.6 m/s, 0.66-1.97 fps) and the distance from the mouth (0.02-0.06 m, 0.07-0.20 ft) was studied. The control over the interaction between the inserted jets and the free convection flow was efficient. Over 80% clean PV air was measured in inhalation. The worst performing nozzle was the four-leafed clover: its best performance yielded 23% clean air inhalation, at the shortest distance and the highest velocity. The other lobed nozzle, the six-edged star, performed similarly to the circular nozzle. © 2014 Taylor and Francis Group, LLC.

General information
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Organisations: Department of Civil Engineering, Section for Indoor Environment, Universite de La Rochelle, Universitatea Tehnica de Constructii Bucuresti, Danish Building Research Institute
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Improvement of thermal comfort by cooling clothing in warm climate

We developed cooling clothing that utilizes water evaporation and can adjust the cooling intensity according to the user’s preference. The continuous cooling effect is supported by a small supply of clean water, and wet discomfort is prevented by using a textile with waterrepellent silicon coating on the inner surface. We conducted experiments with human subjects in climate chambers maintained at 30 °C and RH 50% to compare the effectiveness of the cooling clothing with that of other convective cooling devices. The use of cooling clothing with a convective cooling device improved the subjects’ thermal comfort compared to convective cooling alone. The supply of a small amount of water allowed the cooling clothing to provide a continuous cooling effect, whereas the effect of convective cooling alone decreased as sweat dried. However, the controllability of the cooling clothing needs to be improved.
Indoor environment in bedrooms in 79 Greenlandic households

The climate in Greenland is cold which means that living inside the heated space requires quite some energy. To avoid large heat losses and cold discomfort, building envelopes are often sealed, which reduces natural infiltration. The combination of reduced infiltration and lack of mechanical ventilation results in low air change and thus elevated concentrations of indoor pollutants. In cold Arctic regions where people spend most of their time during long winters indoors is the effect of poor indoor air quality (IAQ) on occupants' health and comfort considerable. A cross sectional study in 79 dwellings was performed in the town of Sisimiut. The aim was to investigate the indoor climate in Greenlandic dwellings. Temperature, relative humidity (RH) and CO2 concentration were measured in several rooms in each dwelling. This paper presents the results from measurements in bedrooms. CO2 concentrations above 1000 ppm and difference in absolute humidity between indoor and outdoor air above 2.5 g/kg as indicators of insufficient ventilation were found in 73% of the bedrooms. The situation was significantly worse dwellings build after 1990. Although the average winter additional moisture was higher than 2.5 g/kg, the RH was low (mean RH = 26%). In summer, 19% of all bedroom temperatures were above 26 °C despite the low outside temperatures. To avoid possible escalation of health problems related to IAQ in the future and to increase comfort of the occupants, properly designed ventilation systems should be introduced in Greenland.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Physics and Services, Section for Indoor Environment
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Indoor environment in Swedish passive houses

The purpose of this study was to evaluate the indoor air quality (IAQ) in newly built low energy houses. Measurements were performed in 22 passive houses and 21 conventional buildings during 2012-2013 and 2013-2014 heating seasons. The measured parameters were temperature, relative humidity, concentration of CO2, NO2, formaldehyde, volatile organic compounds, and live microbiological flora. Air exchange rates (AER) were determined from the concentration-time profiles of CO2. The median AER was slightly higher in the passive houses than in conventional buildings (0.66 h⁻¹ vs. 0.60 h⁻¹). The median concentrations in passive houses and conventional buildings were 9.7 and 11 μg/m³, respectively, for NO2, 12 and 16 μg/m³ for formaldehyde, and 230 and 145 μg/m³ for TVOC. The indoor microbiological flora did not differ, with a few exceptions, from outdoors. The IAQ in the passive buildings was judged to be relatively good with regard to the parameters measured in this study.

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Interaction of convective flow generated by human body with room ventilation flow: impact on transport of pollution to the breathing zone

This study aims to investigate the interaction between the human convective boundary layer (CBL) and uniform airflow from two directions and with different velocities. The study has two objectives: first, to characterize the velocity field in the breathing zone of a thermal manikin under its interaction with opposing flow from above and assisting flow from below; and secondly, implication of such a flow interaction on the particle transport from the feet to the breathing zone is examined. The results reveal that the human body heat transports the pollution to the breathing zone and increases concentration by factor of 5.5. Downward flow of 0.175 m/s does not change airflow patterns and pollutant concentration in the breathing zone, while the velocity of 0.425 m/s offsets the thermal plume and minimizes the concentration. Since the downward flow at 0.30 m/s collides with the CBL at the forehead level, it prolongs particle dwell time and consequently, increases the concentration in the breathing zone by 106%. Adding the assisting flow dilutes the pollution and reduces the concentration compared to case of a pure CBL. Findings that the assisting flow of 0.30 m/s and above reduces the velocity in the breathing zone due to the blocking effect of the chair suggest that furniture should be carefully considered in numerical results predictions and optimal air distribution.

General information
State: Published
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Investigating peoples’ preferences of automated indoor climate control facilities

State: Published
Organisations: Department of Civil Engineering, Section for Building Physics and Services, Section for Indoor Environment, Technical University of Munich
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Number of pages: 3
Publication date: 2014

Investigation of the Indoor Environment in a Passive House Apartment Building Heated by Ventilation Air

Experience has shown that appropriate design of very low energy dwellings can be a large challenge and that the final design may result in insufficient heating in winter and overheating in summer. The 126 certified Passive House apartments (Ravnsborghusene) in Køge, Denmark are a low energy building project finished medio 2012. The design challenge was met with a concept of air heating that is individually controlled in every room. It also applies external solar shading. This study used indoor climate measurements and dynamic simulations in one of these apartment buildings to evaluate thermal comfort and the performance of the air heating system and solar shading. Thermal comfort category B according to ISO 7730 was obtained in the building during field measurements, indicating that the air heating system was able to maintain comfort conditions in winter, when the outdoor temperature had been unusual low for a longer period. The dynamic simulations also indicated that air heating during winter can provide a comfortable thermal environment. Dynamic simulations also demonstrated that during summer, apartments with automatic external solar screens had no serious overheating, whereas in apartments with south oriented windows, static shadings by the balcony overhangs and low ventilation rates, resulted in excessive hours of overheating.

State: Published
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Number of pages: 8
Publication date: 2014
ISIAQ Academy Awards 2014

The 13th International Conference on Indoor Air Quality and Climate (Indoor Air 2014) was convened in Hong Kong during the week of 7–12 July 2014. Professor Yuguo Li served as the Conference President. One of many highlights was the presentation of awards from the ISIAQ Academy of Fellows, which occurred during the opening plenary session. These awards celebrate high achievements in the indoor air sciences. As described in an earlier editorial (Nazaroff, 2012a), the ISIAQ Academy of Fellows has its origins in the creation of the International Academy of Indoor Air Sciences in 1991. In 2005, that organization was reconstituted as a part of the International Society of Indoor Air Quality and Climate (ISIAQ). The ISIAQ Academy of Fellows is an international, multidisciplinary, scientific, honorific organization established to promote scholarship in the indoor environment and building sciences. The awards program, which is featured at all Indoor Air conferences, is a core activity of the Academy.

General information
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BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 3.63
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Web of Science (2013): Indexed yes
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ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Latex paint as a delivery vehicle for diethylphthalate and di-n-butylphthalate: Predictable boundary layer concentrations and emission rates

The description of emission processes of volatile and semi-volatile organic compounds (VOCs and SVOCs) from building products requires a detailed understanding of the material and the air flow conditions at the surface boundary. The mass flux between the surface of the material and air depends on the mass transfer coefficient ($h_m$) through the boundary layer, the gas phase concentration of the target compound immediately adjacent to the material ($y_0$), and the gas-phase concentration in bulk air ($y(t)$). In the present study emission experiments were performed in two chambers of quite different sizes (0.25 m$^3$ and 55 m$^3$), and, in the larger chamber, at two different temperatures (23 °C and 30 °C). The emitting material was latex wall paint that had been doped with two plasticizers, diethylphthalate (DEP) and di-n-...
butylphthalate (DnBP). The phthalate content in the paint was varied in the small chamber experiment to evaluate the impact of the initial concentration in the bulk material (C0) on the emission rate. Boundary layer theory was applied to calculate hm for the specific phthalates from the Sherwood number (Sh) and the diffusion coefficient (Dair). Then \( y_0 \) was determined based on the bulk gas-phase concentration at steady state(y). For both, DEP and DnBP, the \( y_0 \) obtained was lower than the respective saturation vapor pressure (Ps). Furthermore, for both phthalates in latex paint, the material/air partition coefficient (CO/y0) was close in value to the octanol/air partition coefficient (Koa). This study provides a basis for designing phthalate emitting reference materials that mimic the emission behavior of common building materials.

**General information**
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- Web of Science (2016): Indexed yes
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- Scopus rating (2014): SJR 1.635 SNIP 1.847 CiteScore 4.2
- Web of Science (2014): Indexed yes
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- BFI (2012): BFI-level 2
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- Web of Science (2012): Indexed yes
- BFI (2011): BFI-level 2
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- Web of Science (2010): Indexed yes
- BFI (2009): BFI-level 1
- Scopus rating (2009): SJR 1.571 SNIP 1.602
- BFI (2008): BFI-level 2
- Scopus rating (2008): SJR 1.463 SNIP 1.501
- Web of Science (2008): Indexed yes
- Scopus rating (2007): SJR 1.407 SNIP 1.491
- Web of Science (2007): Indexed yes
Leverage of Behavioural Patterns of Window Opening and Heating Set Point Adjustments on Energy Consumption and Thermal Comfort in Residential Buildings

The current trend in reduction in energy use in buildings is oriented towards sustainable measures and techniques aimed to energy need restraint. Even so, studies have underlined large differences in energy consumption in similar buildings, suggesting strong influence of occupant behaviour. Variability due to occupants’ interactions within buildings is therefore organic. Nevertheless, it is worth noting a lack of knowledge and study of the parameters influencing users’ behaviour and their way of life. Existing dynamic energy simulation tools exceed the static size of the simplified methods through a better and more accurate prediction of energy use; however, they are still unable to replicate the actual dynamics that govern energy uses within buildings. Furthermore, occupant behaviour is currently described by static profiles, based on assumptions and average values of typical behaviour, which do not necessarily reflect reality accurately. The pursuit of a comfort condition in indoor environment is a result of complex correlation between different parameters and users’ personal sensitivity. As a consequence, a need for always more accurate statistical occupant behaviour models, considering different behavioural patterns and preferences among indoor environmental quality, is arising. Final goal of this research is to simulate, in a more accurate way, the variation in actual energy consumption due to human interaction within buildings. In this effort, the study has highlighted which combination of users’ behavioural pattern consists the most energy-saver or energy-waster behaviour in residential buildings.

General information
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Number of pages: 9
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Publication date: 2014
Literature Survey on the Effects of Pure Carbon Dioxide on Health, Comfort and Performance

Carbon dioxide (CO₂) is one of the components of the earth atmosphere. It is also a significant human metabolite. It is colourless and odourless gas. The background levels of CO₂ in ambient air are about 350-400 ppm. Its concentration in buildings can be an order of magnitude higher reaching even 4,000-4,500 ppm (Menå and Larsen, 2010). The indoor levels of CO₂ depend mainly on human occupancy (CO₂ producing processes) and the frequency of air renewal (outdoor air exchange rate). Since studies of Pettenkofer in the 19th century, the levels of indoor CO₂ have been used as an indicator of air quality in buildings (Pettenkofer, 1858), as well as quantity and effectiveness of ventilation in the presence of people; the levels above 1,000 ppm have been generally considered to cause unacceptable air quality; the levels above 2,000 ppm are considered as the levels requiring actionable decisions. The 8-hour permissible occupational exposure level to CO₂ is set at 5,000 ppm (ACGIH, 2011). Although in many studies CO₂ has been related with health symptoms, comfort and performance of office work and schoolwork, it in itself has traditionally been assumed innocuous at the typical levels indoors; in these studies, CO₂ was merely a proxy for elevated exposure levels to air pollutants, and an indicator of inadequate outdoor air ventilation and poor indoor air quality. Two recent experiments suggest however that the exposure to pure CO₂ at the levels typically occurring indoors and lower than the levels prescribed as permissible by the occupational standards can have negative effects on some aspects of human performance, in particular on tasks requiring concentration (Kajtar et al., 2006) and on tasks, in which decision should be taken (Satish et al., 2012). The present paper reports the results of the literature survey aimed to summarize the published evidence on the effects of pure CO₂ on humans and, if possible, to suggest the underlying mechanisms.

General information
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Carbon dioxide, Health, Comfort, Performance, Review
Source: PublicationPreSubmission
Source-ID: 105243729
Publication date: 2015
Local cooling of the human body using ventilated mattress in hospitals

A series of experiments were conducted in order to examine the cooling of the human body in bed equipped with a ventilated mattress (VM). The experiments were performed in a climate chamber (4.65 m width x 5.3 m length x 2.6 m height) which was air-conditioned by mixing ventilation system. A thermal manikin lying in the bed with the VM was used to simulate a person. The surface temperature and heat loss of the thermal manikin were controlled to correspond to those of an average person in a state of thermal comfort. The local cooling effect of the VM was studied at room air temperatures of 23, 26 and 30 °C. The performance of the VM was tested when VM was operating at different air flow rates (1.5, 3, 4.5 and 6 L/s). The impact of body covering on the cooling effect from the VM was also studied. The performance of the cooling method was evaluated based on comparison of the segmental and whole body equivalent temperature (teq) with those determined at the reference temperature of 23 °C or when at the same room temperature with VM not in operation. The obtained results reveal that the body segments in contact with the VM were cooled, especially the back side and the back. The cooling effect increased with the increase of the airflow rate through the VM. These results suggest that in warm environment the VM may improve thermal comfort of people lying in bed. The use of the VM may lead to energy saving by operating the background ventilation system at elevated set point for the room temperature or by use of natural ventilation. However the non-uniform body cooling may cause local thermal discomfort. This needs to be further studied in human subject experiments.

General information
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

Low temperature heating and high temperature cooling in buildings

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Kazanci, O. B. (Intern)
Pages: 26-32
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
Journal: H V A C Magasinet
Issue number: 6
ISSN (Print): 1603-6913
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: English
Electronic versions:
HVAC_artikel.pdf
Source: PublicationPreSubmission
Source-ID: 92547736
Publication: Communication › Journal article – Annual report year: 2014

Luftkvalitet og søvn
Measurement of water vapour transport through a porous non-hygrosopic material in a temperature gradient

This was an experiment to identify the driving potential for water vapour diffusion through porous materials in a temperature gradient. The specimen of mineral fibre insulation was placed between a space with controlled temperature and relative humidity and a space with a controlled, higher temperature, and a measured but not controlled relative humidity (RH). This assembly was allowed to reach equilibrium with no vapour movement between the spaces, as tested by a constant RH on each side and by zero flux of water vapour measured in the cold side chamber. The RH and temperature values were converted to partial vapour pressure and to vapour concentration in g/m³. The concentrations proved to be more equal on either side of the specimen than the partial vapour pressures. This supports an argument that it is concentration difference that drives diffusion of gases. Isothermal diffusion cannot be tested experimentally in this way, but it is reasonable to assume that concentration is the driving potential. The close equality of the concentrations makes it unnecessary to invoke temperature difference as a third possible potential for driving diffusion.
Novel approach for evaluation of air change rate in naturally ventilated occupied spaces based on metabolic CO2 time variation

IAQ in many residential buildings relies on non-organized natural ventilation. Accurate evaluation of air change rate (ACR) in this situation is difficult due to the nature of the phenomenon - intermittent infiltration-exfiltration periods of mass exchange between the room air and the outdoor air at low rate. This paper describes a new approach for ACR evaluation in naturally ventilated occupied spaces. Actual metabolic CO2 time variation record in an interval of time is compared with the computed variation of metabolic CO2 for the same time interval under reference conditions: sleeping occupants, air-tight space, constant indoor pressure and temperature. The proposed approach for ACR evaluation can be applied to time intervals with any length, even with varying parameters of both indoor and outdoor air, in which metabolic CO2 generation rate is known and constant. This approach makes possible evaluation of very low ACH.

Novel bed integrated ventilation method for hospital patient rooms

This study presents a novel method for advanced ventilation of hospital wards leading to improved air quality at reduced ventilation rate. The idea is to evacuate the bio-effluents generated from patients’ body by local exhaustion before being spread in the room. This concept was realized by using a mattress having a suction opening from which bio-effluents generated from human body are exhausted. Experiments were conducted in a full-scale two-bed hospital room mock-up, 4.7 x 5.3 x 2.6 m3 (W x L x H). Only one of the patients’ beds was equipped with the ventilated mattress. The room was air conditioned via mixing total volume ventilation system supplying air through a ceiling mounted diffuser. All experiments were performed at room air temperature of 23ºC. A thermal manikin was used to simulate a polluting patient on the bed equipped with the ventilated mattress. Two heated dummies were used to simulate an exposed patient and a doctor. Bio-effluents from the body were exhausted via tracer gases released from manikin’s armpits, groin region and feet.

Contaminants’ distribution in the occupied zone was analyzed. The performance of the ventilated mattress was assessed based on pollution concentration in the breathing zone of the exposed patient and the doctor. Various experiments were performed at three background ventilation rates, namely 27, 55 and 109 L/s (1.5, 3 and 6 air change rates, ACH). Two openings in the mattress, located at the feet and the pelvic region, were used to exhaust the air through the mattress at 1.5 L/s. The obtained results showed that the use of the advanced ventilation together with background ventilation rate of 1.5 ACH significantly improved the air quality in the room compared to the air quality in the case of 6 ACH background ventilation only.
Occupant body movement and seat occupancy rate for design of desk micro-environment

Occupant's body movement and seat occupancy rate are some of the factors important for optimal design of desk micro-environment, including personalized ventilation. A system for identification and recording occupant’s presence and body movement at the desk was designed. The detection system consisted of set of five infrared detectors and a non-contact laser distance meter. The system was used in an office building. In total 11 occupants participated in the survey. Each occupant was monitored during one standard working day. Occupants spent approximately 70% of the working time at the desk. In average occupants left the desk 4.6 times during the day and stayed away in average for 20 min. The average distance between the PC monitor and the occupant body was 0.63 m and changed mainly from 0.48 m to 0.72 m. 78% of the time the length of occupants' body movement to the left/right direction was less than 0.225 m, with maximum span of the whole interval up to 0.75 m. In average the frequency of body position change was 4.9 times per minute, with minimum frequency of 0.6 times per minute and maximum frequency of 11.9 times per minute. The collected data are discussed and requirements for optimal design of desk micro-environment are suggested.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Elpramo s.r.o.
Authors: Melikov, A. K. (Intern), Pokora, P. (Ekstern)
Publication date: 2014
Occupant Time Period of Thermal Adaption to Change of Outdoor Air Temperature in Naturally Ventilated Buildings

The present work proposed a method to determine time period of thermal adaption of occupants in naturally ventilated building, based on the relationship between their neutral temperatures and running mean outdoor air temperature. Based on the data of the field investigation, the subjects' time period of thermal adaption was obtained with the proposed method. The result revealed that the subjects needed to take 4.25 days to fully adapt to a step-change in outdoor air temperature. The time period of thermal adaption for the occupants in five European countries was also calculated and compared with the value of the subjects in this study. The comparison shows that the occupants in China had a shorter time period of thermal adaption than European occupants, which means that Chinese occupants can adapt to a new outdoor climate condition faster.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Shanghai Jiao Tong University
Authors: liu, W. (Intern), Wargocki, P. (Intern), Xiong, J. (Ekstern)
Number of pages: 11
Publication date: 2014

Host publication information
Title of host publication: Proceedings of 8th Windsor Conference: Counting the Cost of Comfort in a changing world
Publisher: Network for Comfort and Energy Use in Buildings
Main Research Area: Technical/natural sciences
Conference: 8th Windsor Conference, London, United Kingdom, 10/04/2014 - 10/04/2014
Thermal adaption, Time period, Neutral temperature, Running mean temperature
Electronic versions:
W14036_Liu_1.doc
Source: PublicationPreSubmission
Source-ID: 105243742
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

Offset of warm sensation by local air flow: Chinese and Danish preference

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Tsinghua University, University of Padua
Authors: Yu, J. (Ekstern), Simone, A. (Intern), Levorato, G. (Ekstern), Zhu, Y. (Ekstern), Olesen, B. W. (Intern)
Number of pages: 4
Publication date: 2014

Host publication information
Title of host publication: Proceedings of Indoor Air 2014
Publisher: International Society of Indoor Air Quality and Climate
BFI conference series: International Conference on Indoor Air Quality and Climate (5010063)
Main Research Area: Technical/natural sciences
Conference: 13th International Conference on Indoor Air Quality and Climate, Hong Kong, Hong Kong, 07/07/2014 - 07/07/2014
Electronic versions:
Offset_of_warm_sensation.pdf
Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

Optimization analysis of high temperature heat pump coupling to desiccant wheel air conditioning system
The high temperature heat pump and desiccant wheel (HTHP&DW) system can make full use of heat released from the condenser of heat pump for DW regeneration without additional heat. In this study, DW operation in the HTHP&DW system was investigated experimentally, and the optimization analysis of HTHP&DW system was carried out. The performance of DW had influence on the dehumidification (evaluated by dehumidification and regeneration effectiveness) and cooling load (evaluated by thermal and adiabatic effectiveness). The results show that the enthalpy increase occurred in all the experiments. Compared to the isosteric heat, heat accumulation in the desiccant and matrix material and heat leakage from regeneration side to process side have greater influence on the adiabatic effectiveness. Higher regeneration temperature leads to lower adiabatic effectiveness that increases more cooling load of the system. When the regeneration temperature is 63°C, the maximal dehumidification effectiveness is 35.4% and the satisfied adiabatic effectiveness is 88%, which contributes to the optimal balance between dehumidification and cooling. © 2014 Tianjin University and Springer-Verlag Berlin Heidelberg.
Outdoor air dominates burden of disease from indoor exposures

Both indoor and outdoor sources of air pollution have significant public health impacts in Europe. Based on quantitative modelling of the burden of disease the outdoor sources dominate the impacts by a clear margin.
Performance of ductless personalized ventilation in conjunction with displacement ventilation: Physical environment and human response

The performance of ductless personalized ventilation (DPV) in conjunction with displacement ventilation was studied and compared with displacement ventilation alone and mixing ventilation. Thirty subjects were exposed in a climate chamber to environmental conditions representing three levels of indoor air temperature (23, 26 and 29 °C) and three levels of temperature difference between indoor air temperature and supply air temperature: 3, 5 or 6 K below room temperature. During a 1 h exposure the subjects answered questions with regard to thermal comfort, perceived air quality and general perception of the environment. The subjects could control the position of the DPV supply diffuser and the personalized air flow (air velocity). The use of DPV improved perceived air quality and thermal comfort compared to displacement ventilation alone. At 26 °C and 29 °C the percentage dissatisfied with air movement decreased with DPV compared to corresponding conditions with displacement ventilation alone and reached the same level as mixing or displacement ventilation at 23 °C. Subjects were able to control the volume and speed of the personalized air flow in order to avoid eye irritation. However, increased eye dryness sensation was reported by 30% of subjects. The personalized air flow selected by nearly 80% of the subjects at 26 °C was between 10 and 20 l/s corresponding to the target air velocity of 1.2–1.7 m/s. At 29 °C almost 90% of subjects chose a personalized air flow between 15 and 20 l/s (1.5–1.7 m/s).

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Technical University of Denmark
Authors: Dalewski, M. (Intern), Melikov, A. K. (Intern), Vesely, M. (Ekstern)
Number of pages: 11
Pages: 354-364
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
Journal: Building and Environment
Volume: 81
ISSN (Print): 0360-1323
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.51 SJR 2.015 SNIP 2.198
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 2.093 SNIP 2.49 CiteScore 4.37
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.938 SNIP 2.797 CiteScore 4.14
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.581 SNIP 2.602 CiteScore 3.57
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.331 SNIP 2.875 CiteScore 3.06
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.144 SNIP 2.255 CiteScore 2.76
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Performance of personalized ventilation combined with chilled ceiling in an office room: inhaled air quality and contaminant distribution

In a simulated two persons’ office room inhaled air quality and contaminant distribution provided with personalized ventilation combined with chilled ceiling, mixing ventilation only, chilled ceiling with mixing ventilation and chilled ceiling with mixing and personalized ventilation was studied. Breathing thermal manikins were used to resemble two occupants at workstations. Room air temperature was kept at 26°C and 28°C. Personalized ventilation supplied air at 25°C. Supplied total flow rate ranged from 26 to 82 L/s. Heat gains of 66-72 W/m² were simulated. Tracer gases simulated pollution from people (exhaled air, bioeffluents) and building materials (wall painting).

Personalized ventilation combined with chilled ceiling ensured highest air quality at the workstation under all conditions. Pollutant concentration in the occupied zone away from the workstations did not differ substantially between the tested systems. Chilled ceiling combined with personalized ventilation working as the only air supplying system may be optimal solution in many buildings.
Performance of radiant cooling ceiling combined with personalized ventilation in an office room: identification of thermal conditions

The paper compares thermal environment conditions created by four HVAC systems: mixing ventilation, chilled ceiling combined with mixing ventilation, chilled ceiling with mixing ventilation and personalized ventilation, and chilled ceiling combined with personalized ventilation only. Measurements were performed in a test room arranged as an office with 2 workstations and 2 seating occupants resembled by thermal manikins. Heat gain of 66–72 W/m² was simulated in the room (occupants, computers, lighting, solar gain). The air temperature in the chamber was maintained at 26°C and 28°C. Personalized ventilation supplied air at non-isothermal condition with temperature of 25°C. Results showed that the compared methods generated almost the same thermal environment in the occupied zone. However at the workstations the personalized ventilation combined with chilled ceiling provided more cooling and decreased the radiant temperature asymmetry created by the simulated warm window surface. Chilled ceiling combined with PV alone may be applied successfully in practice.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Silesian University of Technology
Authors: Lipczynska, A. (Ekstern), Kaczmarczyk, J. (Ekstern), Melikov, A. K. (Intern)
Publication date: 2014

Personal exposure to cough released droplets in quiescent environment and ventilated spaces

This study shows the results of an experimental investigation of personal exposure to cough released droplets. Human body is resembled by a thermal manikin with a body shape and surface temperature distribution of a real person. The objective of the study is to examine personal exposure of the manikin exposed to cough released droplets in a calm indoor environment and under uniform air patterns relative to a human body. The findings show that human body orientation relative to the direction and magnitude of invading flow from the surroundings considerably modifies personal exposure. Surrounding uniform flows is most of the scenarios decrease the exposure to cough droplets, however not in all scenarios. Study results show that understanding of the air patterns should be prioritized in ventilation design practice.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Eidgenössische Technische Hochschule , National University of Singapore
Authors: Licina, D. (Intern), Melikov, A. K. (Intern), Pantelic, J. (Ekstern), Sekhar, C. (Ekstern), Tham, K. W. (Ekstern)
Pages: 174 – 181
Publication date: 2014

Host publication information
Title of host publication: Proceedings of ROOMVENT 2014, 13th SCANVAC International Conference on Air Distribution in Rooms
BFI conference series: International Conference on Air Distribution in Rooms (5010059)
Main Research Area: Technical/natural sciences
Conference: 13th SCANVAC International Conference on Air Distribution in Rooms, São Paulo, Brazil, 19/10/2014 - 19/10/2014
Electronic versions:
Personal_exposure_to_cough_released_droplets.pdf
Phthalate metabolites in urine and asthma, allergic rhinoconjunctivitis and atopic dermatitis in preschool children

Phthalate esters are among the most ubiquitous of indoor pollutants and have been associated with various adverse health effects. In the present study we assessed the cross-sectional association between eight different phthalate metabolites in urine and allergic disease in young children. As part of the Danish Indoor Environment and Children's Health study, urine samples were collected from 440 children aged 3-5 years, of whom 222 were healthy controls, 68 were clinically diagnosed with asthma, 76 with rhinoconjunctivitis and 81 with atopic dermatitis (disease subgroups are not mutually exclusive; some children had more than one disease). There were no statistically significant differences in the urine concentrations of phthalate metabolites between cases and healthy controls with the exception of MnBP and MECPP, which were higher in healthy controls compared with the asthma case group. In the crude analysis MnBP and MiBP were negatively associated with asthma. In the analysis adjusted for multiple factors, only a weak positive association between MEP in urine and atopic dermatitis was found; there were no positive associations between any phthalate metabolites in urine and either asthma or rhinoconjunctivitis. These findings appear to contradict earlier studies. Differences may be due to higher exposures to certain phthalates (e.g., BBzP) via non-dietary pathways in earlier studies, phthalates serving as surrogates for an agent associated with asthma (e.g., PVC flooring) in previous studies but not the present study or altered cleaning habits and the use of "allergy friendly" products by parents of children with allergic disease in the current study in contrast to studies conducted earlier.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Odense University Hospital, Swedish Environmental Research Institute, SP Technical Research Institute of Sweden, Aarhus University, University of Southern Denmark
Authors: Callesen, M. (Ekstern), Bekö, G. (Intern), Weschler, C. J. (Intern), Langer, S. (Ekstern), Brive, L. (Ekstern), Clausen, G. (Intern), Toftum, J. (Intern), Sigsgaard, T. (Ekstern), Høst, A. (Ekstern), Jensen, T. K. (Ekstern)
Pages: 645-652
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
Journal: International Journal of Hygiene and Environmental Health
Volume: 217
Issue number: 6
ISSN (Print): 1438-4639
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.22 SJR 1.338 SNIP 1.435
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.45 SNIP 1.276 CiteScore 3.84
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.315 SNIP 1.671 CiteScore 3.61
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.173 SNIP 1.428 CiteScore 3.3
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.512 SNIP 1.625 CiteScore 3.62
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.21 SNIP 1.359 CiteScore 3.02
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.236 SNIP 1.453
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.869 SNIP 1.193
BFI (2008): BFI-level 1
Seasonal differences in human responses to increasing temperatures

Experiments were conducted in late summer and winter with 80 young and elderly Danish subjects exposed for 3.5 hours in a climate chamber to the temperature increasing from 24°C to 35.2°C at a rate of 3.7K/h. Psychological and physiological measurements were performed during exposure and subjects assessed comfort and acute health symptoms. Thermal sensation increased with increasing chamber temperature and did not differ during late summer and winter exposures. Skin temperature increased with increasing temperature and was slightly but significantly higher in the late summer in the first half of exposure. Core temperature started to increase, when the chamber temperature reached about 28°C, earlier in winter than in the late summer. Thermal environment was assessed to be slightly less acceptable in winter only until chamber temperature reached about 28°C; acceptability systematically decreased with increasing temperature. Difficulty to concentrate increased with increased temperature and the self-estimated ability to perform work decreased; subjects reported being sleepier. Severity of headache and difficulty to concentrate was in winter slightly but systematically higher, subjects reporting also to be sleepier. Heart rate slightly increased during exposure, and SpO2 and ETCO2 began to decrease while core temperature started to increase. Performance of Tsai-partington test and addition test improved during exposures due to learning though lesser in winter. Results show negative effects of the temperature ramp, being somewhat higher in winter than in the late summer.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Section for Building Physics and Services, Tohoku University, Karlsruhe Institute of Technology KIT
Authors: Kitazawa, S. (Ekstern), Andersen, R. K. (Intern), Wargocki, P. (Intern), Kolarik, J. (Intern), Schweiker, M. (Ekstern)
Number of pages: 8
Publication date: 2014

Host publication information
Title of host publication: Proceedings of Indoor Air 2014
Publisher: International Society for Indoor Air Quality and Climate (ISIAQ)
BFI conference series: International Conference on Indoor Air Quality and Climate (5010063)
Main Research Area: Technical/natural sciences
Conference: 13th International Conference on Indoor Air Quality and Climate, Hong Kong, Hong Kong, 07/07/2014 - 07/07/2014
Thermal comfort, Warmth, Performance, Physiological reaction, Symptoms

Bibliographical note
Topic A7: Thermal comfort
Source: PublicationPreSubmission
Source-ID: 97325013
Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

Socioeconomic and health impacts among the elderly of their dwelling environment

General information
State: Published
Socio-Economic Consequences of Improved Indoor Air Quality in Danish Primary Schools

This paper reports an attempt to estimate the socio-economic effects of upgrading the indoor air quality in Danish schools to the level of Swedish schools. The OECD “PISA” score is used to quantify the effects together with the Danish Rational Economic Agent Model (DREAM). The following effects are taken into consideration: a) increased PISA score increases productivity; b) increased PISA score reduces the duration of primary education; c) improved indoor air quality reduces absenteeism in teachers. The results show that improved air quality in Danish schools could result in an increase in the Gross Domestic Product (GDP) of €173 million per annum, and in the public finances of €37 million per annum.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Velux A/S, Slotsholm A/S
Authors: Wargocki, P. (Intern), Foldbjerg, P. (Ekstern), Eriksen, K. E. (Ekstern), Eriksen Videbæk, L. (Ekstern)
Number of pages: 6
Publication date: 2014
Host publication information
Title of host publication: Proceedings of Indoor Air 2014
Publisher: International Society of Indoor Air Quality and Climate
Main Research Area: Technical/natural sciences
Conference: 13th International Conference on Indoor Air Quality and Climate, Hong Kong, Hong Kong, 07/07/2014 - 07/07/2014
Socio-Economics, Schools, IAQ, Productivity
Source: PublicationPreSubmission
Source-ID: 105175987
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

Survey of Indoor Air Quality in the University of Alaska

In cold climates living inside the heated space requires considerable amounts of heat. With the intention to decrease the heating demand, people are insulating their homes and make them more air tight. With the natural infiltration being brought close to zero there has been an increase of a new problem which is poor indoor air quality (IAQ). During summer 2012 four student homes were built in Fairbanks, Alaska as a part of Sustainable Village project. The aim of this project is to promote sustainable ways of living in the Arctic and to study new technologies and their applicability in the cold north. This paper presents the results of an IAQ survey performed in the homes during two weeks in December 2012. During this survey the air temperature, relative humidity (RH) and CO2 concentration were measured in all occupied bedrooms along with monitoring of the ventilation units. The results have shown noticeable differences in IAQ between the four houses caused by different technical solutions. The ventilation rates were reduced by occupants or by frost protecting strategy of the ventilation units and the RH inside the living space was often very low. It is assumed that by introducing more advanced controls of the HVAC systems, better defrosting strategy and moisture recovery from the exhaust air the IAQ can be improved with minimum extra energy demand.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Physics and Services, Section for Indoor Environment, Cold Climate Housing Research Center
Authors: Kotol, M. (Intern), Craven, C. (Ekstern), Rode, C. (Intern)
Number of pages: 710-717
Publication date: 2014
Sustainable Heating, Cooling and Ventilation of a Plus-Energy House via Photovoltaic/Thermal Panels

Present work addresses the HVAC and energy concerns of the Technical University of Denmark's house, Fold, for the competition Solar Decathlon Europe 2012. Various innovative solutions are investigated; photovoltaic/thermal (PV/T) panels, utilization of ground as a heat source/sink and phase change materials (PCM).

The development of a building integrated photovoltaic/thermal (BIPV/T) system and its performance evaluation compared to a PV installation built of the same photovoltaic cells are also presented. Annual results show that having the combined PV/T system is more beneficial compared to having two separate systems.

PV/T panels enable the house to perform as a plus-energy house. PV/T also yields to a solar fraction of 63% and 31% for Madrid and Copenhagen, respectively.

The ground heat exchanger acts as the heat sink/source of the house. Free cooling enables the same cooling effect to be delivered with 8% of the energy consumption of a representative chiller.

The major part of sensible heating and cooling is done via embedded pipes in the floor and ceiling. Ventilation is used to control the humidity and to remove sensory and chemical pollution.

A combination of embedded pipes and PCM was simulated. Results show energy savings up to 30%, for cooling season in Madrid.
This study is an outcome of Elforsk, project number 344-060, Bæredygtige Energi-Plus huse (Sustainable plus-energy houses).

The focus of this report is to document the approach and the results of different analyses concerning a plus-energy, single family house. The house was designed for an international student competition, Solar Decathlon Europe 2012 and after the competition it was used as a full-scale experimental facility for one year. During this period, different heating and cooling strategies were tested and the performance of the house regarding the thermal indoor environment and energy was monitored.

This report is structured as follows. Chapter 1 presents the project and briefly explains the different phases of the project. The details of the house’s construction and its HVAC system are explained in Chapter 2, along with the energy efficiency measures and innovations. Chapter 3 introduces the investigations carried out in detail, with respect to different phases of the project. The investigations presented are divided into four phases: design phase and pre-competition period, competition period, year-round measurements in Denmark, and improvement suggestions for building and HVAC system.

The results of the investigations, measurements, and the experiences from one year of operation are presented in Chapter 4. Chapter 5 presents the main conclusions derived from the project and Chapter 6 presents a look into future research. In Appendix A, all publications and dissemination activities over the course of the project are presented. In Appendix B, the measured parameters and the measuring equipment are given.

**Sustainable Plus-energy Houses: Final Report**

This study is an outcome of Elforsk, project number 344-060, Bæredygtige Energi-Plus huse (Sustainable plus-energy houses).

The focus of this report is to document the approach and the results of different analyses concerning a plus-energy, single family house. The house was designed for an international student competition, Solar Decathlon Europe 2012 and after the competition it was used as a full-scale experimental facility for one year. During this period, different heating and cooling strategies were tested and the performance of the house regarding the thermal indoor environment and energy was monitored.

This report is structured as follows. Chapter 1 presents the project and briefly explains the different phases of the project. The details of the house’s construction and its HVAC system are explained in Chapter 2, along with the energy efficiency measures and innovations. Chapter 3 introduces the investigations carried out in detail, with respect to different phases of the project. The investigations presented are divided into four phases: design phase and pre-competition period, competition period, year-round measurements in Denmark, and improvement suggestions for building and HVAC system.

The results of the investigations, measurements, and the experiences from one year of operation are presented in Chapter 4. Chapter 5 presents the main conclusions derived from the project and Chapter 6 presents a look into future research. In Appendix A, all publications and dissemination activities over the course of the project are presented. In Appendix B, the measured parameters and the measuring equipment are given.
**Sustainable resilience in property maintenance: encountering changing weather conditions**

**Purpose:** The purpose of the study is to develop a methodological approach for project management to integrate sustainability and resilience planning in property maintenance as an incremental strategy for upgrading existing properties to meet new standards for sustainable and climate resilient buildings.

**Background:** Current maintenance practice is focused on the technical standard of buildings, with little consideration of sustainability and resilience. There is a need to develop tools for incorporating sustainable resilience into maintenance planning.

**Approach:** The study is primarily theoretical, developing the concept of sustainable resilience for changing weather conditions.

**Results:** The paper suggests a decision support methodology that quantifies sustainable resilience for the analytical stages of property maintenance planning.

**Practical Implications:** The methodology is generic and expected users are FM organisations with responsibility of property maintenance, and consultants offering property management planning as a service.

**Research limitations:** The methodology is conceptual and has not been tested. However the concept is to be further developed in dialogue between the authors, the Danish local authority Gentofte Properties and other potential users.

**Originality/value:** The paper suggests a new methodology to explicitly integrate sustainability and resilience planning in property maintenance planning.

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**The Adaptive Thermal Comfort model may not always predict thermal effects on performance**

A letter to the editor is presented in response to the article "Progress in thermal comfort research over the last twenty years," by R.J. de Dear and colleagues.

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**General information**

State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Technical University of Denmark
Authors: Kazanci, O. B. (Intern), Olesen, B. W. (Intern)
Number of pages: 50
Publication date: 2014

**Publication information**

Publisher: Technical University of Denmark, Department of Civil Engineering
Original language: English
Main Research Area: Technical/natural sciences
Plus-energy house, Low temperature heating, High temperature cooling, Ground heat exchanger, Ground coupled heat pump, Photovoltaic/thermal
Electronic versions:
Sustainable_Plus_energy_Houses.pdf
Source: PublicationPreSubmission
Source-ID: 103961575
Publication: Research › Report – Annual report year: 2014
The effect of air quality on sleep

The effect of air quality on sleep was examined for occupants of 14 identical single-occupancy dormitory rooms. The subjects, half women, were exposed to two conditions (open/closed window), each for one week, resulting in night-time average CO2 levels of 660 and 2585 ppm, and air temperatures of 24.7 and 23.9°C, respectively. Sleep was assessed from movement data recorded on wristwatch-type actigraphs and from online morning questionnaires, including the Groningen Sleep Quality scale, questions about the sleep environment, next-day well-being, SBS symptoms, and two tests of mental performance. Although no significant effects on the sleep quality scale or on next-day performance could be shown, there were significant and positive effects of a higher ventilation rate (open window) on the actigraph measured sleep latency and on the subjects’ assessment of the freshness of the air, their ability to fall asleep and nasal dryness. There was a negative effect on reported lip dryness.

General information

State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Silesian University of Technology
Authors: Strøm-Tejsen, P. (Intern), Wargocki, P. (Intern), Wyon, D. P. (Intern), Kondracka, A. (Ekstern)
Number of pages: 8
Publication date: 2014

Host publication information
Title of host publication: Proceedings of the 13th International Conference on Indoor Air Quality and Climate - Indoor Air 2014
Publisher: International Society for Indoor Air Quality and Climate (ISIAQ)
Article number: HA0506
BFI conference series: International Conference on Indoor Air Quality and Climate (5010063)
Main Research Area: Technical/natural sciences
Conference: 13th International Conference on Indoor Air Quality and Climate, Hong Kong, Hong Kong, 07/07/2014 - 07/07/2014
Electronic versions:
EFFECT_OF_AIR_QUALITY_ON_SLEEP.pdf

Relations
Activities:
13th International Conference on Indoor Air Quality and Climate
Projects:
The effect of air quality on sleep
Source: PublicationPreSubmission
Source-ID: 99356771
Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

The effect of CO2 controlled bedroom ventilation on sleep and next-day performance

Both sleep and good indoor air quality are generally considered to be important for human health and well-being. In the present study, sleep quality and next-day performance were measured in identical single-occupancy dormitory rooms located in a quiet area North of Copenhagen. The 16 international students participating as subjects, half of them women, were sleeping in their own rooms and maintained their habitual life style, with a few restrictions on alcohol and caffeine consumption. The subjects were exposed to two conditions, each for one week, with one high and one low rate of ventilation, resulting in average CO2 levels of around 835 and 2395 ppm, respectively. A fan controlled by a CO2 sensor was used to supply outside air to establish the condition with low CO2 level. In the condition with high CO2 concentration the fan was switched off. The subjects were instructed to adjust the electric heater that was installed below the window to ensure thermal comfort and average room temperature did not differ between conditions. The indoor environment was assessed based on online morning questionnaires and physical measurements of room air temperature, relative humidity and CO2 concentration. The subjects’ sleep quality and next-day performance were assessed from subjective responses that were obtained by using visual analogue scales and the Groningen Sleep Quality scale, from one test of logical thinking, one diagnostic test of cue-utilisation, and in terms of movement data recorded on wristwatch-type actigraphs. The results show positive effects of a higher ventilation rate on the subjectively assessed freshness of the air, on the subjects’ mental state and their feeling of being rested. There was also a significant and positive effect on the sleep efficiency measured by the actigraphs and the expected significant and positive effect on performance. However, there were some negative effects of the higher ventilation rate on the rated intensity of mouth dryness and skin dryness.
The effects of radiant cooling versus convective cooling on human eye tear film stability and blinking rate

The effect of indoor temperature, radiant and convective cooling on tear film stability and eye blink frequency was examined. 24 human subjects were exposed to the non-uniform environment generated by localised chilled beam and a chilled ceiling combined with overhead mixing ventilation. The subjects participated in four two-hour experiments. The room air temperature was kept at 26 °C or 28 °C. Tear film samples were collected after 30 min of acclimatisation and at the end of the exposures. Eye blinking frequency was analysed for the first and last 15 min of each exposure. The tear film stability decreased as the temperature increased. The highest number of subjects with unchanged or improved tear film quality was observed with the localised chilled beam at 26 °C. A trend was found between subjects who reported eye irritation and had a bad tear film quality.

The influence of outdoor thermal environment on young Japanese females

The influence of short wave solar radiation appears to be strong outdoors in summer, and the influence of airflow appears to be strong outdoors in winter. The purpose of this paper was to clarify the influence of the outdoor environment on young Japanese females. This research shows the relationship between the physiological and psychological responses of humans and the enhanced conduction-corrected modified effective temperature (ETFe). Subjective experiments were conducted in an outdoor environment. Subjects were exposed to the thermal environment in a standing posture. Air temperature, humidity, air velocity, short wave solar radiation, long wave radiation, ground surface temperature, sky factor, and the green solid angle were measured. The temperatures of skin exposed to the atmosphere and in contact with the ground were measured. Thermal sensation and thermal comfort were measured by means of rating the whole-body thermal sensation (cold-hot) and the whole body thermal comfort (comfortable-uncomfortable) on a linear scale. Linear
rating scales are given for the hot (100) and cold (0), and comfortable (100) and uncomfortable (0) directions only. Arbitrary values of 0 and 100 were assigned to each endpoint, the reported values read in, and the entire length converted into a numerical value with an arbitrary scale of 100 to give a linear rating scale. The ETFe considered to report a neither hot nor cold, thermally neutral sensation of 50 was 35.9 °C, with 32.3 °C and 42.9 °C, respectively, corresponding to the low and high temperature ends of the ETFe considered to report a neither comfortable nor uncomfortable comfort value of 50. The mean skin temperature considered to report a neither hot nor cold, thermally neutral sensation of 50 was 33.3 °C, with 31.0 °C and 34.3 °C, respectively, corresponding to the low and high temperature ends of the mean skin temperature considered to report a neither comfortable nor uncomfortable comfort value of 50. The acceptability raised the mean skin temperature even for thermal environment conditions in which ETFe was high. © 2013 ISB.
Thermal comfort: Design and assessment for energy saving

Thermal comfort is one of the most important aspects of the indoor environmental quality due to its effects on well-being, people's performance and building energy requirements. Its attainment is not an easy task requiring advanced design and operation of building and HVAC systems, taking into account all parameters involved. Even though thermal comfort fundamentals are consolidated topics for more than forty years, often designers seem to ignore or apply them in a wrong way. Design input values from standards are often considered as universal values rather than recommended values to be used under specific conditions. At operation level, only few variables are taken into account with unpredictable effects on the assessment of comfort indices. In this paper, the main criteria for the design and assessment of thermal comfort are discussed in order to help building and HVAC systems designers and operators to navigate the complex and varied world of standards in the field of thermal environment for improving indoor environmental quality and energy saving. The examples discussed in the paper will also be useful for the standardization, leading to harmonized documents more readable for all users.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Universita di Salerno, Università degli Studi di Napoli Federico II
Authors: d'Ambrosio Alfano, F. R. (Ekstern), Olesen, B. W. (Intern), Palella, B. I. (Ekstern), Riccio, G. (Ekstern)
Number of pages: 11
Pages: 326-336
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
Journal: Energy and Buildings
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ISSN (Print): 0378-7788
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 4.64 SJR 2.093 SNIP 1.965
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.088 SNIP 2.174 CiteScore 4.07
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.123 SNIP 2.936 CiteScore 4.21
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Thermal comfort assessment of Danish occupants exposed to warm environments and preferred local air movement

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Tsinghua University, University of Padua
Authors: Simone, A. (Intern), Yu, J. (Ekstern), Levorato, G. (Ekstern), Olesen, B. W. (Intern), Zhu, Y. (Ekstern)
Number of pages: 8
Publication date: 2014

Host publication information
Title of host publication: Proceedings of Indoor Air 2014
Publisher: International Society of Indoor Air Quality and Climate
BFI conference series: International Conference on Indoor Air Quality and Climate (5010063)
Main Research Area: Technical/natural sciences
Thermal effects on human performance in office environment measured by integrating task speed and accuracy

We have proposed a method in which the speed and accuracy can be integrated into one metric of human performance. This was achieved by designing a performance task in which the subjects receive feedback on their performance by informing them whether they have committed errors, and if did, they can only proceed when the errors are corrected. Traditionally, the tasks are presented without giving this feedback and thus the speed and accuracy are treated separately. The method was examined in a subjective experiment with thermal environment as the prototypical example. During exposure in an office, 12 subjects performed tasks under two thermal conditions (neutral & warm) repeatedly. The tasks were presented with and without feedback on errors committed, as outlined above. The results indicate that there was a greater decrease in task performance due to thermal discomfort when feedback was given, compared to the performance of tasks presented without feedback.

General Information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Technical University of Denmark, Shanghai Jiao Tong University
Authors: Lan, L. (Ekstern), Wargocki, P. (Intern), Lian, Z. (Ekstern)
Pages: 490-495
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
Journal: Applied Ergonomics
Volume: 45
Issue number: 3
ISSN (Print): 0003-6870
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.18 SJR 0.875 SNIP 1.662
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.243 SNIP 1.997 CiteScore 2.4
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.98 SNIP 2.328 CiteScore 2.32
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 0.89 SNIP 1.99 CiteScore 2.18
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.057 SNIP 2.603 CiteScore 2.22
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 0.86 SNIP 1.749 CiteScore 1.94
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 0.776 SNIP 1.777
Thermo Active Building Systems – Using Building Mass To Heat and Cool

Using the thermal storage capacity of the concrete slabs between each floor in multistory buildings to heat or cool is a trend that began in the early 1990s in Switzerland.1,2 Pipes carrying water for heating and cooling are embedded in the center of the concrete slab. In central Europe (Germany, Austria, Netherlands, etc.), this type of system has been installed in a significant number of new office buildings since the late 1990s. The trend is spreading to other parts of the world (the rest of Europe, North America and Asia).

Thermo active building systems (TABS) are primarily used for cooling multistory buildings. By activating the building mass, there is a direct heating-cooling effect. Also, because of the thermal mass, the peak load will be reduced and some of the cooling load will be transferred beyond the time of occupancy. Because these systems for cooling operate at water temperatures close to room temperature, they increase the efficiency of heat pumps, ground heat exchangers and other systems using renewable energy sources.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Olesen, B. W. (Intern)
Pages: 30-34
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
Journal: Ecolibrium
Issue number: August
ISSN (Print): 1447-042X
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: English
Source: PublicationPreSubmission
Source-ID: 101857195
Publication: Research - peer-review › Journal article – Annual report year: 2014

Transport of gaseous pollutants around a human body in quiescent indoor environment

“Well-mixed” assumption often leads to inadequate prediction of the human exposure. In spaces that operate with a low air velocity, local airflows generated by occupants play predominant role for pollutant transport. The present study investigates the ability of a human convective boundary layer (CBL) to transport the pollution in quiescent indoor
environment. A human body is resembled by a thermal manikin with a body shape and surface temperature distribution of a real person. The objective of the study is to examine the impact of the pollutant location around the human body on the pollution concentration levels in the breathing zone. The results show that the location of the pollution source has a considerable influence of the breathing zone concentrations. This is contributed to the human CBL, as it pulls the pollution emitted close to the human body and transports it to the breathing zone. For different pollutant location studied, the highest breathing zone concentrations are achieved when the pollution is located at the chest, while there is zero exposure for the pollutants emitted from the upper back or behind the chair. The results suggest that understanding of the air patterns around the human body should be recognized in ventilation design practice.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Technical University of Denmark, National University of Singapore
Authors: Licina, D. (Intern), Melikov, A. K. (Intern), Mioduszewski, P. (Ekstern), Sekhar, C. (Ekstern), Tham, K. W. (Ekstern)
Pages: 182–189
Publication date: 2014

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Title of host publication: Proceedings of ROOMVENT 2014, 13th SCANVAC International Conference on Air Distribution in Rooms
BFI conference series: International Conference on Air Distribution in Rooms (5010059)
Main Research Area: Technical/natural sciences
Conference: 13th SCANVAC International Conference on Air Distribution in Rooms, São Paulo, Brazil, 19/10/2014 - 19/10/2014
Electronic versions:
Transport_of_gaseous_pollutants.pdf
Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

Ultrafine particles in 60 danish homes: measurements in the homes and personal monitoring

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, University of Copenhagen, Lund University
Authors: Bekö, G. (Intern), Kjeldsen, B. U. (Intern), Olsen, Y. (Ekstern), Wierzbicka, A. (Ekstern), Karottki, D. G. (Ekstern), Toftum, J. (Intern), Loft, S. (Ekstern), Clausen, G. (Intern)
Number of pages: 3
Publication date: 2014

Host publication information
Title of host publication: Proceedings of Indoor Air 2014
Publisher: International Society of Indoor Air Quality and Climate
Article number: HP0182
BFI conference series: International Conference on Indoor Air Quality and Climate (5010063)
Main Research Area: Technical/natural sciences
Conference: 13th International Conference on Indoor Air Quality and Climate, Hong Kong, Hong Kong, 07/07/2014 - 07/07/2014
Particle number concentration, Integrated exposure, Residential environment, Personal exposure

Bibliographical note
Topic C3: Nanoparticles in indoor environment.
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

Vascular and lung function related to ultrafine and fine particles exposure assessed by personal and indoor monitoring: a cross-sectional study

Background: Exposure to ambient air particulate matter (PM) has been linked to decline in pulmonary function and cardiovascular events possibly through inflammation. Little is known about individual exposure to ultrafine particles (UFP) inside and outside modern homes and associated health-related effects. Methods: Associations between vascular and lung function, inflammation markers and exposure in terms of particle number concentration (PNC; d = 10-300 nm) were studied in a cross-sectional design with personal and home indoor monitoring in the Western Copenhagen Area, Denmark. During 48-h, PNC and PM2.5 were monitored in living rooms of 60 homes with 81 non-smoking subjects (30-75 years old), 59 of whom carried personal monitors both when at home and away from home. We measured lung function in terms of the FEV1/FVC ratio, microvascular function (MVF) and pulse amplitude by digital artery tonometry, blood pressure and biomarkers of inflammation including C-reactive protein, and leukocyte counts with subdivision in neutrophils, eosinophils, monocytes, and lymphocytes in blood. Results: PNC from personal and stationary home
monitoring showed weak correlation (r = 0.15, p = 0.24). Personal UFP exposure away from home was significantly inversely associated with MVF (1.3% decline per interquartile range, 95% confidence interval: 0.1-2.5%) and pulse amplitude and positively associated with leukocyte and neutrophil counts. The leukocyte and neutrophil counts were also positively and pulse amplitude negatively associated with total personal PNC. Indoor PNC and PM2.5 showed positive association with blood pressure and inverse association with eosinophil counts. Conclusions: The inverse association between personal exposure away from home and MVF is consistent with adverse health effects of UFP from sources outside the home and might be related to increased inflammation indicated by leukocyte counts, whereas UFP from sources in the home could have less effect.
Ventilation System Type and the Resulting Classroom Temperature and Air Quality During Heating Season
The present study investigated how different ventilation system types influence classroom temperature and air quality. Five classrooms were selected in the same school. They were ventilated by manually operable windows, manually operable windows with exhaust fan, automatically operable windows with and without exhaust fan and by mechanical ventilation system. Temperature, relative humidity, carbon dioxide (CO₂) concentration and opening of windows were continuously monitored for one month during heating season in 2012. Classroom with manually operable windows had the highest carbon dioxide concentration levels so that the estimated ventilation rate was the lowest compared with the classrooms ventilated with other systems. Temperatures were slightly lower in classroom ventilated by manually operable windows with exhaust fan. Windows were opened seldom even in the classroom ventilated by manually operable windows. Classrooms with automatically operable windows and exhaust fan and with mechanical ventilation systems achieved the best thermal environment and air quality during heating season among all classrooms examined.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Xi'an University of Architecture and Technology
Authors: Gao, J. (Intern), Wargocki, P. (Intern), Wang, Y. (Ekstern)
Number of pages: 12
Pages: 203-214
Publication date: 2014

Host publication information
Title of host publication: Proceedings of the 8th International Symposium on Heating, Ventilation and Air Conditioning
Volume: 1
Publisher: Springer

Series: Lecture Notes in Electrical Engineering
Volume: 261
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BFI conference series: International Symposium on Heating, Ventilating and Air Conditioning (5010058)
Main Research Area: Technical/natural sciences
Conference: 8th International Symposium on Heating, Ventilation and Air Conditioning, Xi'An, China, 19/10/2013 - 19/10/2013
Classroom, Ventilation system type, Temperature, Carbon dioxide concentration, Ventilation rate
DOIs:
10.1007/978-3-642-39584-0_23
Source: FindIt
Source-ID: 268816734
Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

Ventilation system type, classroom environmental quality and pupils' perceptions and symptoms
The present study investigated indoor climate and window opening behaviour by pupils, as well as their perceptions and symptoms in classrooms with different types of ventilation systems. Four classrooms were selected in the same school in suburban Denmark. Classroom ventilation was achieved either by manually operable windows, or by automatically operable windows with and without an exhaust fan in operation, or by a balanced mechanical ventilation system. Indoor air temperature, relative humidity, carbon dioxide (CO₂) concentration and window opening were continuously monitored for one month in non-heating and heating seasons; CO₂ concentration was used to estimate average classroom ventilation rates. At the end of each measuring period, the pupils were asked to report their perceptions of the indoor environment and their acute health-related symptoms. The classroom in which ventilation was achieved by manually operable windows had the highest air temperatures and CO₂ concentrations during both non-heating and heating season; the estimated average air-change rate was lowest in this classroom. The classroom with mechanical ventilation had the highest estimated average air-change rate. Windows were frequently opened in all four classrooms in the non-heating season but very seldom in the heating season. Automatic operation of the windows had a marked effect on CO₂ concentration and...
classroom temperature in the heating season. Perceptions of the indoor environment were more positive in the classroom that was ventilated by automatically operable windows with an exhaust fan in operation: fewer symptoms were reported in this classroom compared with classrooms with other systems. Present results and approach can be used as the basis for rational selection of systems that ensure adequate classroom ventilation. © 2014 Elsevier Ltd.

**General information**

State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Xi’an University of Architecture and Technology
Authors: Gao, J. (Intern), Wargocki, P. (Intern), Wang, Y. (Ekstern)
Pages: 46-57
Publication date: 2014
Main Research Area: Technical/natural sciences

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ISSN (Print): 0360-1323
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.51 SJR 2.015 SNIP 2.198
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 2.093 SNIP 2.49 CiteScore 4.37
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.938 SNIP 2.797 CiteScore 4.14
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.581 SNIP 2.602 CiteScore 3.57
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.331 SNIP 2.875 CiteScore 3.06
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.144 SNIP 2.255 CiteScore 2.76
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.235 SNIP 2.001
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.028 SNIP 1.865
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.924 SNIP 1.38
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.788 SNIP 1.778
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.03 SNIP 1.63
Scopus rating (2005): SJR 0.955 SNIP 1.225
This paper reviews and discusses various sustainable materials utilizing waste products with the focus on their properties having an impact on the indoor environmental conditions and indoor air quality (IAQ). Materials included in the review are selected considering the following aspects: sustainability, cradle to cradle perspective, application, their impact on indoor environment and human well-being. The attempt of the paper is to cover a wide spectrum of information so to provide better understanding of waste utilization in construction industry.

**Waste-based materials; capability, application and impact on indoor environment – literature review**

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Section for Building Physics and Services
Authors: Krejcirikova, B. (Intern), Rode, C. (Intern), Kolarik, J. (Intern), Wargocki, P. (Intern), Peuhkuri, R. H. (Intern)
Number of pages: 8
Publication date: 2014

Host publication information
Title of host publication: Proceedings of Indoor Air 2014
Publisher: International Society for Indoor Air Quality and Climate (ISIAQ)
Main Research Area: Technical/natural sciences
Conference: 13th International Conference on Indoor Air Quality and Climate, Hong Kong, Hong Kong, 07/07/2014 - 07/07/2014
Building materials, Waste utilization, Environmental impact, Indoor air quality

Bibliographical note
Topic C5: Environmental impact of buildings
Source: PublicationPreSubmission
Source-ID: 97325061
Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

**ZeroWaste BYG: Hygro-thermal conditions and pollutant emissions from ZeroWaste materials and their effects on humans**

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Section for Building Physics and Services
Authors: Krejcirikova, B. (Intern), Rode, C. (Intern), Wargocki, P. (Intern), Peuhkuri, R. H. (Intern), Kolarik, J. (Intern)
Number of pages: 1
Publication date: 2014

Host publication information
Title of host publication: Abstract Book - DTU Sustain Conference 2014
Place of publication: Kgs. Lyngby
Publisher: Technical University of Denmark (DTU)
Main Research Area: Technical/natural sciences
Conference: DTU Sustain Conference 2014, Lyngby, Denmark, 17/12/2014 - 17/12/2014
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2014
ZeroWaste BYG: Redesigning construction materials towards zero waste society
The ZeroWaste research group (www.zerowaste.byg.dtu.dk) at the Department of Civil Engineering was established in 2012 and covers the broad range of expertise required for turning waste materials into attractive, new materials. Members of the group have developed methods for removal of heavy metals and phosphorous from waste incineration, sewage sludge and other bio ashes [1], providing the basis to make these ash types an attractive, new material for the building sector. The amount of waste increases and it is both difficult and expensive to handle many waste types as e.g. different ashes. At the same time there are fewer natural resources and the general consumption increases. We wish to utilize alternative and new ash types as raw material in concrete, similarly to what was previously seen with fly ash from coal combustion and microsilica, which were both transformed from problematic waste to valuable raw material. The physical-chemical characteristics of fly ash, such as large uniformity coefficient, clay-sized particles and rich in some metal elements and salts, show the possibility of being a raw material also for bricks and lightweight aggregates. In the future we expect increasing political pressure to change the status of different ashes from waste to raw material and that export for disposal will be no longer be allowed. We wish to influence the consequences from this new situation. In principle some of the ashes can be used already, but the huge variation in ash characteristics and lack of knowledge in the construction industry on the qualities some of the ashes can give the concrete and clay materials means that they are not used today.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Section for Structural Engineering, Section for Indoor Environment, Section for Building Physics and Services
Number of pages: 1
Publication date: 2014

Advanced air distribution for minimizing airborne cross-infection in aircraft cabins
The performance of personalized ventilation combined with local exhaust at each seat was studied for the purpose of minimizing airborne cross-infection in spaces whose occupants are sedentary, such as transportation environments. Experiments were carried out in a simulated aircraft cabin section (3 rows, 21 seats). One breathing thermal manikin simulated an infected passenger as a source of pollution, and a second breathing manikin simulated an exposed passenger. The personalized ventilation supplied clean air at 6 or 10 L/s (12.7 or 21.2 cfm) from in front of each manikin’s face. Air was withdrawn at a rate of 6 or 10 L/s (12.7 or (21.2 cfm) by the local exhaust system, which consisted of two exhaust terminals, one on each side of the head of the infected manikin. The cabin was ventilated with 180 L/s (381 cfm) of fresh air. Freon was mixed with the air exhaled by the infected manikin to simulate airborne pathogens. The airflow from the personalized supply outlet pushed the contaminated exhaled air backward, where it was exhausted before it had mixed with cabin air. This resulted in a substantial decrease of the tracer gas concentration in the air inhaled by the exposed manikin and in the air exhausted from the cabin.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Technical University of Denmark
Authors: Melikov, A. K. (Intern), Dzhartov, V. (Ekstern)
Number of pages: 8
Pages: 926-933
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: HVAC & R Research
Volume: 19
Issue number: 8
ISSN (Print): 2374-4731
Ratings:
BFI (2018): BFI-level 1
A methodology for modelling energy-related human behaviour: Application to window opening behaviour in residential buildings
An energy simulation of a building is a mathematical representation of its physical behaviour considering all the thermal, lighting, acoustics aspects. However, a simulation cannot precisely replicate a real construction because all the simulations are based on a number of key assumptions that affect the results accuracy. Above all, the real energy performance can be affected by the actual behaviour of the building occupants. Thus, there are great benefits to be derived from improving models that simulate the behaviour of human beings within the context of engineered complex systems. The occupant behaviour related to the building control potentialities is a very complex process that has been studied only in the last years with some focuses related to natural ventilation (window opening behaviour), space heating energy demand (in particular the adjustments in the temperature set-point) and natural light (focusing on window blinds adjustments). In this paper, a methodology is presented to model the user behaviour in the context of real energy use and applied to a case study. The methodology, based on a medium/long-term monitoring, is aimed at shifting towards a probabilistic approach for modelling the human behaviour related to the control of indoor environment. The procedure is applied at models of occupants’ interactions with windows (opening and closing behaviour). Models of occupants’ window opening behaviour were inferred based on measurements and implemented in a simulation program. Simulation results were given as probability distributions of energy consumption and indoor environmental quality depending on user behaviour.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Technical University of Denmark, Polytechnic University of Turin
Authors: Fabi, V. (Ekstern), Andersen, R. K. (Intern), Corgnati, S. P. (Ekstern), Olesen, B. W. (Intern)
Pages: 415-427
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: Building Simulation
Volume: 6
Issue number: 4
ISSN (Print): 1996-3599
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.56 SJR 0.784 SNIP 0.936
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.016 SNIP 1.154 CiteScore 1.74
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.827 SNIP 1.264 CiteScore 1.41
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.45 SNIP 0.649 CiteScore 0.77
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.444 SNIP 0.751 CiteScore 0.72
ISI indexed (2012): ISI indexed no
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 0.373 SNIP 0.858 CiteScore 0.95
ISI indexed (2011): ISI indexed no
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 0.364 SNIP 0.699
BFI (2009): BFI-level 2
BFI (2008): BFI-level 1
Original language: English
Occupant behaviour, Energy modelling, Building energy performance, Probabilistic approach
A nodal model to predict vertical temperature distribution in a room with floor heating and displacement ventilation

In this paper, the development of a nodal model that predicts vertical temperature distribution in a typical office room with floor heating and displacement ventilation (FHDV) is described. The vertical air flow distribution is first determined according to the principle of displacement ventilation, taking into account the effects of the cold external envelope and those of the warm floor surface. The vertical temperature distribution can then be predicted by the proposed model, which identifies four temperature nodes at different heights above the floor. The vertical temperature distribution can be calculated by solving energy balance equations for each node, using boundary parameters as inputs. The predictions agree quite well with experimentally measured data for floor surface temperatures between 25 and 28 °C, supply air temperatures between 14 and 18 °C and air change rates from 3.1 to 4.5. The proposed vertical temperature distribution can be used in the design and analysis of hybrid systems with floor heating and displacement ventilation.
A novel human body exergy consumption formula to determine indoor thermal conditions for optimal human performance in office buildings

In this paper, a novel human body exergy consumption formula was derived strictly according to Gagge's two-node thermal transfer model. The human body exergy consumption calculated by the formula was compared with values calculated using Shukuya's formula for a typical office environment. The results show that human body exergy consumption calculated by either of these formulas reaches a minimum under the same thermal condition. It is shown that this is in accordance with expectation. The relation between human performance and human body exergy consumption was studied by analyzing the data obtained in simulated office environments in winter. The results show that human body exergy consumption and human performance are inversely as operative temperature changes from 17 to 28°C or human thermal sensation changes from −1.0 to +1.4, and that optimum thermal comfort cannot be expected to lead to optimal human performance, as has so often been assumed. According to the second law of thermodynamics, it makes sense that optimal human performance coincides with minimum human body exergy consumption and that this should occur under thermal conditions in which human thermal sensation is close to “slightly cool”.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Harbin Institute of Technology
Authors: Wu, X. (Intern), Zhao, J. (Ekstern), Olesen, B. W. (Intern), Fang, L. (Intern)
Pages: 48-55
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: Energy and Buildings
Volume: 56
ISSN (Print): 0378-7788
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
**Bæredygtig opvarmning, køling og ventilation af et plusenerghus**

**General information**
- **State:** Published
- **Organisations:** Department of Civil Engineering, Section for Indoor Environment, Department of Management Engineering
- **Authors:** Olesen, B. W. (Intern), Kazanci, O. B. (Intern)
- **Pages:** 20-26
- **Publication date:** 2013
- **Main Research Area:** Technical/natural sciences

**Publication information**
- **Journal:** H V A C Magasinet
- **Issue number:** 7
- **ISSN (Print):** 1603-6913
- **Ratings:**
  - ISI indexed (2013): ISI indexed no
  - ISI indexed (2012): ISI indexed no
  - ISI indexed (2011): ISI indexed no
- **Original language:** Danish
- **Electronic versions:**
  - prod21375441087630.SDE2012_i_HVAC.pdf
  - Source: dtu
  - Source-ID: n:oai:DTIC-ART:dkart/388989566::30190
- **Publication:** Communication › Journal article – Annual report year: 2013

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**Children's Phthalate Intakes and Resultant Cumulative Exposures Estimated from Urine Compared with Estimates from Dust Ingestion, Inhalation and Dermal Absorption in Their Homes and Daycare Centers.**

Total daily intakes of diethyl phthalate (DEP), di(n-butyl) phthalate (DnBP), di(isobutyl) phthalate (DiBP), butyl benzyl phthalate (BBzP) and di(2-ethylhexyl) phthalate (DEHP) were calculated from phthalate metabolite levels measured in the urine of 431 Danish children between 3 and 6 years of age. For each child the intake attributable to exposures in the indoor environment via dust ingestion, inhalation and dermal absorption were estimated from the phthalate levels in the dust collected from the child's home and daycare center. Based on the urine samples, DEHP had the highest total daily intake (median: 4.42 µg/d/kg-bw) and BBzP the lowest (median: 0.49 µg/d/kg-bw). For DEP, DnBP and DiBP, exposures to air and dust in the indoor environment accounted for approximately 100%, 15% and 50% of the total intake, respectively, with dermal absorption from the gas-phase being the major exposure pathway. More than 90% of the total intake of BBzP and DEHP came from sources other than indoor air and dust. Daily intake of DnBP and DiBP from all exposure pathways, based on levels of metabolites in urine samples, exceeded the Tolerable Daily Intake (TDI) for 22 and 23 children, respectively. Indoor exposures resulted in an average daily DiBP intake that exceeded the TDI for 14 children. Using the concept of relative cumulative Tolerable Daily Intake (TDI<sub>cum</sub>), which is applicable for phthalates that have established TDIs based on the same health endpoint, we examined the cumulative total exposure to DnBP, DiBP and DEHP from all pathways; it exceeded the tolerable levels for 30% of the children. From the three indoor pathways alone, several children had a cumulative intake that exceeded TDI<sub>cum</sub>. Exposures to phthalates present in the air and dust indoors meaningfully contribute to a child's total intake of certain phthalates. Such exposures, by themselves, may lead to intakes exceeding current limit values.

**General information**
- **State:** Published
- **Organisations:** Department of Civil Engineering, Section for Indoor Environment, Swedish Environmental Research Institute, Odense University Hospital
- **Authors:** Bekö, G. (Intern), Weschler, C. J. (Intern), Langer, S. (Ekstern), Callesen, M. (Forskerdatabase), Toftum, J. (Intern), Clausen, G. (Intern)
- **Pages:** e62442
- **Publication date:** 2013
- **Main Research Area:** Technical/natural sciences

**Publication information**
- **Journal:** P L o S One
- **Volume:** 8
- **Issue number:** 4
- **ISSN (Print):** 1932-6203
- **Ratings:**
  - BFI (2018): BFI-level 1
  - Web of Science (2018): Indexed yes
  - BFI (2017): BFI-level 1
The impact of heat load strength and positioning on the indoor environment generated by diffuse ceiling air supply and chilled beam with radial swirl jet was studied and compared. An office room with two persons and a meeting room with six persons were simulated in a test room (4.5 x 3.95 x 3.5 m³ (L x W x H)). A window (6.5 m²) was simulated by radiant panels. Four chilled beam units were installed symmetrically on the suspended ceiling together with two exhaust vents. The diffuse ceiling inlet was made of standard perforated acoustic tiles (0.5% total degree of perforation). The room air temperature was controlled at 24 °C. The quality of the generated indoor environment as defined in ISO standard 7730 (2005) was assessed based on comprehensive physical measurements. The systems created Category A thermal environment in cooling situations at heat load of 50 W·m⁻² and 78 W·m⁻² (office room) and Category B thermal environment in the meeting room at high heat load of 94 W·m⁻². The air distribution pattern was influenced by the convective flows from the heat sources. The maximum local velocity in the occupied zone was 0.23–0.26 m·s⁻¹. The diffuse ceiling supply did not ensure complete mixing (ventilation effectiveness of 0.4) and the air flow rate had to be above minimum to safeguard the indoor air quality. The radial swirl jet of chilled beam also was not capable of creating complete mixing at high and concentrated heat load (ventilation effectiveness of 0.7).
Effect of Personal Control over Thermal Environment in a Laboratorium Setting

Field studies have demonstrated that personal control over the indoor climate may increase comfort and could reduce SBS symptoms. A laboratory study was performed to investigate if being in control over the thermal environment influences comfort, symptoms and performance. The central hypothesis was that human responses to a thermal indoor environment depend on the availability of control opportunities.

This was tested in a field lab where subjects had a personal desk fan with a stepless controller at their workplace. Two conditions were tested: one (the first) with individual control and one without, but with identical indoor climate exposure as recorded during the first session. During both experimental conditions, 23 subjects were exposed for 120 min to an operative temperature of 28 °C and they were provided with a personal desk fan. During the first exposure subjects were allowed to adjust air velocity (and therefore local thermal environment) at any moment. For each subject the adjustments were recorded. In the second experiment, subjects were exposed to identical indoor environment conditions as recorded during the first experiment, but without individual control of the desk fan (control knob was hidden). During both conditions identical questionnaires and performance tests were used to evaluate comfort, symptom intensity and performance.

Limited differences were found when comparing the 'with control' and 'without control situation'. For the investigated case, the availability of control opportunities does not directly influence human perception to the thermal environment, symptoms or performance. However, personal preferences for the air velocity of the fan differ a lot. This confirms the need for personal indoor climate systems to satisfy the need of individuals.
Effects of different cooling principles on thermal sensation and physiological responses

Applying low exergy cooling concepts in the built environment allows reduction of use of high quality energy sources. Non-uniform thermal conditions, which may occur due to application of lowex systems, can result in discomfort. Two different cooling principles were studied: passive (through convection in terms of increased air velocities) and active cooling (through convection or radiation). Furthermore, two different ventilation techniques were included: mixing and displacement ventilation. Ten male subjects (age: 20-29) were exposed to six different cases: (1) PC-C-M; passive cooling through mixing ventilation, (2) AC-C-M; active cooling through convection by mixing ventilation, (3) AC-C-D; active cooling through convection by displacement ventilation, (4) AC-R-M-C; active cooling through radiation by the ceiling and mixing ventilation, (5) AC-R-M-F; active cooling through radiation by the floor and mixing ventilation, and (6) AC-R-D-F; active cooling through radiation by the floor and displacement ventilation. Though all cases were designed at PMV ≈ 0, subjective data indicate significant differences between the cases. For the prediction of thermal sensation and thermal comfort under non-uniform conditions, the operative temperature only is not sufficient. Combined local factors play an important role in the comfort assessment. Furthermore, non-uniform environments, as case 6, can achieve a comparable or even a more comfortable assessment compared to uniform environments.
Effect van binnenklimaatbeïnvloeding

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Technische Universiteit Eindhoven
Authors: te Kulve, M. (Ekstern), Boerstra, A. (Ekstern), Toftum, J. (Intern), Loomans, M. (Ekstern), Hensen, J. (Ekstern)
Pages: 8-12
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: TVVL Magazine
Issue number: 07/08
ISSN (Print): 0165-5523
Original language: Dutch
Electronic versions:
te Kulve et al TVVL Magazine 2013.pdf

Bibliographical note
Link til TVVL Magazine hvor artiklen blev publiceret: http://www.tvvl.nl/tvvl-magazine

Energy Analysis of the Ductless Personalized Ventilation
This study explores the impact of different occupancy profiles on the potential energy savings due to using ductless personalized ventilation (DPV) combined with displacement ventilation. Energy simulations were performed with the dynamic simulation software IDA-ICE in order to investigate optimal energy efficient strategies for implantation of DPV in practice. The impact of using DPV on annual energy use has been studied for different occupancy profiles in cold climates. The results suggest that using DPV combined with displacement ventilation may significantly reduce building energy use while providing good air quality and thermal comfort for the occupants. Matching DPV use with occupants presence at their workplaces may allow reducing the energy use of DPV significantly.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Technical University of Denmark
Authors: Lelong, C. (Ekstern), Dalewski, M. (Intern), Melikov, A. K. (Intern)
Number of pages: 9
Publication date: 2013

Host publication information
Title of host publication: Proceedings of 11th REHVA World Congress and the 8th International Conference on Indoor Air Quality, Ventilation and Energy Conservation in Buildings
Article number: 806
BFI conference series: Indoor Air Quality, Ventilation & Energy Conservation in Buildings (5010062)
Main Research Area: Technical/natural sciences
Conference: Clima 2013, Prague, Czech Republic, 16/06/2013 - 16/06/2013
Electronic versions:
Energy_Analysis_of_the_Ductless_Personalized_Ventilation.pdf
Publication: Research › Article in proceedings – Annual report year: 2014
Erfaringer fra projekt Dynamisk varmeregnskab

Denne rapport bygger på indeklimamålinger og interviews af beboere i to etagebyggerier. Rapporten blev til som en udvidelse af nogle af aktiviteterne i projektet "Dynamisk varmeregnskab med fokus på indeklima i lejligheder" (I det følgende benævnt som projekt dynamisk varmeregnskab) som blev tildelt støtte fra almenboliglovens forsøgsmidler i 2011 og skal ses i sammenhæng med den afsluttende rapport herfra.


General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Andersen, R. K. (Intern)
Number of pages: 30
Publication date: 2013

Evaluation of an improved air distribution system for aircraft cabin

An improved air distribution system for aircraft cabin was proposed in this paper. Personalized outlets were introduced and placed at the bottom of the baggage hold. Its ratio of fresh air to recirculation air and the conditioned temperature of different types of inlets were also designed carefully to meet the goals of high air quality, thermal comfort and energy saving. Some experiments were conducted to evaluate and compare its performances with two other systems. First the Flow Visualization with Green Laser (FVGL) technology was used to analyze the air flow. The top-in-side bottom-out pattern may have the disadvantages of an indirect path to deliver fresh air to passengers, a low fresh air utilization ratio and the potential to widely spreading airborne infectious diseases. The bottom-in-top-out pattern can overcome these disadvantages very well, but it also faces the stratification of contaminated air above the head of the passengers. The improved pattern may overcome the above challenges quite well while also delivering good ventilation performance. The modified Personal Exposure Effectiveness (PEE) was measured to compare their performances with regard to inhaled air quality. The measured results suggest that personalized inlet should be designed to adjust its supply air angle according to the height of the passenger's face to provide a higher fresh air utilization effectiveness and better air quality for passengers in the improved pattern. Some simulations revealed that the improved pattern had the potential to save energy by decreasing the amount of fresh air without significantly affecting air quality and thermal comfort.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Technical University of Denmark, Beijing University of Aeronautics and Astronautics
Authors: Pang, L. (Ekstern), Xu, J. (Ekstern), Fang, L. (Intern), Gong, M. (Ekstern), Zhang, H. (Ekstern), Zhang, Y. (Ekstern)
Pages: 145-152
Publication date: 2013
Main Research Area: Technical/natural sciences
Experimental analysis on performance of high temperature heat pump and desiccant wheel system

In order to solve the problem of high energy consumption for regeneration of desiccant wheel in the rotary desiccant system, high temperature heat pump and desiccant wheel (HTHP&DW) system and corresponding air conditioning unit is built and tested in the extensive thermal hygrometric environment. When the mixture refrigerant BY-3 is involved in the air source heat pump, the supply air temperatures are in the range as expected except that when in the extreme hot
environment (above 36°C), dehumidification capability are satisfied and the regeneration temperatures can satisfy the regeneration requirement of desiccant without additional heat. It is also found that outdoor air temperature, humidity ratio and regeneration air flow rate have great impact on the performance of heat pump based on the coefficient of performance (COP) evaluated. COP is not quite high, as the maximum value is 2.26 for heat pump and 2.08 for whole system respectively. Hence several suggestions are made for optimizing the system which is also helpful for facilitating the development of mature product. As a conclusion, HTHP&DW system could be a potential alternative with effective operation which can be promoted in most areas of China based on the result of our experiment.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Tianjin University
Authors: Sheng, Y. (Ekstern), Zhang, Y. (Ekstern), Deng, N. (Ekstern), Fang, L. (Intern), Nie, J. (Intern), Ma, L. (Ekstern)
Pages: 505-513
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: Energy and Buildings
Volume: 66
ISSN (Print): 0378-7788
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 4.64 SJR 2.093 SNIP 1.965
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.088 SNIP 2.174 CiteScore 4.07
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.123 SNIP 2.936 CiteScore 4.21
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.897 SNIP 2.433 CiteScore 3.79
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.816 SNIP 2.737 CiteScore 3.36
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.506 SNIP 2.536 CiteScore 3.23
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.631 SNIP 2.081
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.564 SNIP 1.79
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.624 SNIP 2.028
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.033 SNIP 1.718
Web of Science (2007): Indexed yes
Experimental evaluation of air distribution in mechanically ventilated residential rooms: Thermal comfort and ventilation effectiveness

The effect of low ventilation rates (1 or 0.5 air change per hour) on thermal comfort and ventilation effectiveness was experimentally studied in a simulated residential room equipped with radiant floor heating/cooling and mixing ventilation systems. The tests were performed for various positions of supply and extract air terminals and different winter and summer boundary conditions. Vertical air temperature, operative temperature and air velocity profiles were measured in different positions in the room, and equivalent temperatures were derived, in order to characterize thermal comfort. Contaminant removal effectiveness (CRE) and local air change index was measured in order to characterize ventilation effectiveness in the occupied zone. Acceptable thermal comfort was found in most experiments; however, air temperature differences higher than 3 °C occurred when floor cooling was combined with unconditioned outdoor air supply, i.e. at the supply air temperatures higher than the room air temperature. Moreover, low floor temperatures were needed to maintain the desired reference temperature in the stratified thermal environment. Mainly in cooling conditions the ventilation effectiveness depended on the positions of supply and extract air terminals and on the difference between the supply and the room air temperature, and it could be as low as 0.5, where 1 is complete mixing. © 2013 Elsevier B.V.
Experimental investigation on reduced exposure to pollutants indoors by applying wearable personalized ventilation

A wearable personalized ventilation unit able to improve inhaled air quality and reduce risk from airborne disease contamination is reported. The performance of the personalized ventilation device relies on control over the flow interaction near the face of a person by inserting a reduced amount of clean air into the breathing zone. Experiments at 23°C (73.4°F) were performed in a full-scale test room with a breathing thermal manikin resembling a seated occupant in a state of thermal comfort, with a realistic free convection flow around the body and breathing cycle. The room air was mixed with tracer gas. The personalized ventilation supplied isothermally clean air from circular or elliptical nozzles of different diameters (equivalent diameter: 0.025-0.035 m [0.08-0.12 ft]) positioned near the mouth of the manikin. The
enhancement of inhaled air quality was studied by varying the initial velocity (0.2-0.6 m/s [0.66-1.97 fps]), the distance between the nozzles and the mouth (0.02-0.06 m [0.07-0.2 ft]), or the direction of the jet (front, side, or below). The personalized ventilation made it possible to increase up to 94% the portion of clean air into the air inhaled. A wearable personalized ventilation unit can significantly reduce (more than six times) the number of secondarily infected occupants compared to mixing ventilation. © 2013 Copyright Taylor and Francis Group, LLC.
Experimental study including subjective evaluations of mixing and displacement ventilation combined with radiant floor heating/cooling system.

Sixteen subjects evaluated the indoor environment in four experiments with different combinations of ventilation systems and radiant heating/cooling systems. In the first two tests, the simulated residential room was equipped either by a mixing ventilation system supplying warm air for space heating or by a combination of radiant floor heating and mixing ventilation system. The vertical air temperature distribution was more uniform for floor heating. The discomfort due to cold feet/lower legs was higher for warm air heating, but no significant difference in thermal perceptions between the two mixing ventilation systems was found. The next two tests simulated an office room during summer, ventilated and cooled either by a displacement ventilation system alone or by a displacement ventilation system combined with radiant floor cooling. Displacement ventilation combined with floor cooling had lower floor temperature, warmer supply air, and less homogeneous vertical temperature profile, but it did not result in thermal discomfort on feet/lower legs or discomfort due to a vertical air temperature difference higher than for a displacement ventilation system alone, where the floor temperature was higher, supply air cooler, and vertical temperature profile more uniform.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Krajcik, M. (Intern), Tomasi, R. (Intern), Simone, A. (Intern), Olesen, B. W. (Intern)
Pages: 1063-1072
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: HVAC&R Research
Volume: 19
Issue number: 8
ISSN (Print): 2374-4731
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.01
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.514 SNIP 0.731
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.561 SNIP 0.891
ISI indexed (2013): ISI indexed yes
Exposure Control Indoors with Wearable Personal Exhaust Unit

A wearable personalized ventilation (PV) unit to reduce the risk from airborne disease contamination is reported. The PV unit consists of a nozzle, installed on a headset, which is used to locally exhaust the exhaled air before it mixes with the surroundings. Experiments at 22 °C were performed in a full-scale test room furnished as a double bed hospital room. A breathing thermal manikin with a realistic free convection flow around the body and breathing cycle was used to mimic a sick doctor. A second thermal manikin and a heated dummy were used to resemble two lying patients. The air exhaled by the doctor was mixed with tracer gas (R134 A) to mimic airborne pathogens. The PV nozzle was positioned frontally 0.02 m from the mouth of the doctor exhausting 0.25 L/s air. The performance of the PV in combination with mixing background air distribution at 3 ACH was compared with the case of only mixing background air distribution at 3, 6 and 12 ACH. The use of the device showed a great potential in reducing the concentration of exhaled air in the room to the level measured under mixing ventilation alone at 12 ACH. The high potential to capture exhaled air, makes the wearable PV applicable as an efficient engineering control method that can reduce the spread of pathogen laden air from sick occupants in densely occupied spaces, i.e. cinemas, public transportation, office buildings etc.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Technical University of Sofia
Authors: Bolashikov, Z. D. (Intern), Barova, M. I. (Ekstern), Melikov, A. K. (Intern)
Exposure to Exhaled Air from a Sick Occupant in a Two-Bed Hospital Room with Mixing Ventilation: Effect of Posture of Doctor and Air Change Rate

Full-scale measurements were performed in a climate chamber set as a two-bed hospital room, ventilated at 3, 6 and 12 ACH with overhead mixing ventilation. Air temperature was kept constant at 22 °C. Two breathing thermal manikins were used to mimic a sick patient lying on one side in one of the beds and a doctor. A thermal dummy mimicked an exposed patient lying in the second bed. The doctor either stood up or sat in a chair 0.55 m facing the sick patient. The ‘sick patient’ was exhaling through the mouth and inhaling from the nose. Tracer gas (R 134A) was mixed with the exhaled air to mimic airborne droplets and droplet nuclei of less than 5 μm aerodynamic diameter. Important finding of this study is that airflow distribution and interaction in rooms, position of the recipient with respect to the source, etc. may have greater impact on the exposure to exhaled air by a sick patient than the ventilation rate itself. Furthermore, increase in ventilation may affect adversely the exposure to exhaled air and thus enhance the risk from airborne cross infection.

Field Measurements of Perceived Air Quality in the Test-Bed for Innovative Climate Conditioning Technologies

Field measurements of perceived air quality were conducted in an experimental test bed for innovative building technologies situated at the Czech Technical University in Prague. The technologies included photocatalytically active paint, vacuum porous insulation and wall plaster containing phase change material. Technologies were installed in eight offices as part of the research project Clear-up. The offices were primarily used to carry out comparative tests for individual technologies. The present paper describes measurements done in parallel to the comparative tests to investigate the potential influence of aforementioned technologies on the perceived air quality. Additionally, the effect of Demand Controlled Ventilation (DCV) on the perceived air quality was tested. Measurements comprised of the assessments of perceived air quality and objective measurements of operative temperature, relative humidity and CO₂ concentration. Results showed that the mean sensory pollution load in the tested offices was 0.09±0.02 olf/m² (mean±SEM). This refers to a low-polluting building according to CEN Report CR 1752. The acceptability of the air quality was worst in unoccupied offices ventilated at 20 m³/h. Application of DCV decreased the CO₂ concentration, but did not result in statistically significant improvement of the perceived air quality. It was not possible to quantify the influence on the sensory pollution load of particular technologies tested as part of the Clear-up. However, the sensory pollution load in unoccupied offices equipped with those technologies was on average 0.07 olf/m² lower than in the reference office.
Field test of a thermal active building system (TABS) in an office building in Denmark

An increasing attention has been addressed in the last years to the assessment, at the same time, of energy performances and indoor environmental quality in buildings. Focusing on thermal comfort recent international standards as ISOEN7730 and EN15251 introduce criteria for using categories in the indoor environmental assessment of a building. At the same time, also use of low temperature heating and high temperature cooling systems in non-residential buildings has increased, due to the energy efficiency and the economical cooling and heating performance of this kind of plants. This paper presents an experimental study in an office building in Denmark where cooling in summer is provided by thermally activated building systems (TABS). Indoor climate quality evaluation, cooling system performance and energy consumption for a specific room were analyzed with different levels of internal gains. The experiments were carried out monitoring air and operative temperature, relative humidity and CO₂ levels in the room where internal heat gains from people who controlled and simulated by heated dummies positioned at the same workstations used by employees during the workdays. Supply and return water temperature in the pipes of the hydronic system, and energy consumption of the chillers were monitored. The performance of this test room was also analyzed by the dynamic building simulation tool EnergyPlus. The paper includes a comparison between experimental collected data and simulation results. Besides the paper show example on how to present data from long-term measurements or simulation results.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Politecnico di Torino
Authors: Raimondo, D. (Intern), Olesen, B. W. (Intern), Corgnati, S. P. (Ekstern)
Number of pages: 8
Pages: 2527-2534
Publication date: 2013

Host publication information
Title of host publication: Proceedings of BS2013
Main Research Area: Technical/natural sciences
Electronic versions:
p_2345.pdf
Source: FindIt
Source-ID: 255267860
Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

Healthy Buildings 2012: Ventilation and Thermal Comfort

An introduction is presented in which the editors discuss various reports within the issue on topics including the International Society of Indoor Air Quality and Climate (ISIAQ) conference, three different types of personalized exhaust (PE) devices, and personalized ventilation.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, National University of Singapore
Authors: Sekhar, C. (Ekstern), Wai, C. K. (Ekstern), Toftum, J. (Intern)
Number of pages: 3
Pages: 923-925
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: H V A C & R Research
How indoor environment affects performance
As experienced researchers in the effects of thermal comfort and indoor air quality on performance, we are often asked to give our best estimate of how, and to what extent, performance is affected by different aspects of indoor climate. This article provides a brief summary of our personal opinions, in the form of answers to 40 frequently asked questions. Our answers are based on the results of behavioral experiments conducted to date. We offer no opinions on long-term health effects of indoor environmental quality. We provide some references to relevant sources, but there is not enough space for all such references. We list some questions we cannot answer as topics for future research in this area.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Wyon, D. P. (Intern), Wargocki, P. (Intern)
Pages: 46-52
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: ASHRAE Journal
Volume: 55
Issue number: 3
ISSN (Print): 0001-2491
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.16 SJR 0.277 SNIP 0.772
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.236 SNIP 0.454 CiteScore 0.21
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.279 SNIP 0.443 CiteScore 0.2
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.312 SNIP 0.651 CiteScore 0.16
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.481 SNIP 1.066 CiteScore 0.19
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.292 SNIP 0.957 CiteScore 0.23
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.452 SNIP 1.051
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.518 SNIP 0.882
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.33 SNIP 0.904
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.528 SNIP 1.019
Human Response to Ductless Personalised Ventilation: Impact of Air Movement, Temperature and Cleanliness on Eye Symptoms

The performance of ductless personalized ventilation (DPV) in conjunction with displacement ventilation (DV) was studied in relation to peoples’ health, comfort and performance. This paper presents results on the impact of room air temperature, using of DPV and local air filtration on eye blink rate and tear film quality. In a test room with DV and six workstations 30 human subjects were exposed for four hours to each of the following 5 experimental conditions: 23 °C and DV only, 23 °C and DPV with air filter, 29 °C and DV only, 29 °C and DPV, and 29 °C and DPV with air filter. At warm environment facially applied individually controlled air movement of room air, with or without local filtering, did not have significant impact on eye blink frequency and tear film quality. The local air movement and air cleaning resulted in increased eye blinking frequency and improvement of tear film quality at 23 °C.

Human Response to Ductless Personalized Ventilation with Local Air Cleaning: Air Quality and Prevalence of SBS Symptoms

The impact of local air cleaning and cooling of the head region by ductless personalized ventilation (DPV) on perceived air quality (PAQ) and Sick Building Syndrome (SBS) symptoms was studied. Thirty subjects participated in experiments performed in a test room with displacement ventilation (DV) and six workstations, three of which had DPV. The DV kept air temperature in the occupied zone (1.1 m above the floor). Pollution load was simulated by PVC floor covering and the bioeffluents generated by the subjects (60% recirculated room air). DPV sucked the air distributed over the floor by the DV and supplied it to the breathing zone of the subjects. The subjects were allowed to control the position of the DPV supply diffuser and the personalized flow rate. Each subject participated in five 4-hour experiments: 23 °C with DV only, 23 °C with DPV with air filter, 29 °C with DV only, 29 °C with DPV with air filter and 29 °C with DPV without filter. During the experiments the subjects simulated office work and answered on computerized questionnaires. At warm environment PAQ and air freshness significantly improved when DPV was used. Eye dryness increased significantly with time but was not
influenced by air temperature and filtering. At 29 °C the facially applied air movement from DPV increased the eye dryness. The SBS symptoms increased with time and were higher (not significantly) at the warm conditions. Air movement did not have profound impact on the SBS symptoms, while filtering had only at 23 °C.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Dalewski, M. (Intern), Bivolarova, M. (Ekstern), Fillon, M. (Ekstern), Melikov, A. K. (Intern)
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Title of host publication: Proceedings of 11th REHVA World Congress and the 8th International Conference on Indoor Air Quality, Ventilation and Energy Conservation in Buildings
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BFI conference series: Indoor Air Quality, Ventilation & Energy Conservation in Buildings (5010062)
Main Research Area: Technical/natural sciences
Conference: Clima 2013, Prague, Czech Republic, 16/06/2013 - 16/06/2013
Electronic versions:
Human_Response.pdf
Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

Human response to local convective and radiant cooling in a warm environment.
The response of 24 human subjects to local convective cooling, radiant cooling, and combined radiant and convective cooling was studied at 28°C and 50% relative humidity. The local cooling devices used were (1) a tabletop cooling fan, (2) personalized ventilation providing a stream of clean air, (3) radiant panels below and above the desk in front of the desk occupant, and (4) the same two radiant panels but with small fans blowing room air toward the upper panel to be cooled and redirected toward the person. A reference condition without cooling was also tested. The cooling devices significantly (p<0.05) improved subjects’ thermal comfort compared to the condition without cooling. The acceptability of the thermal environment was similar for all cooling devices. The acceptability of air movement and perceived air quality increased when local cooling methods were used. The best results were achieved with personalized ventilation or the tabletop fan. Only minimal improvement in perceived air quality was reported when the radiant panel was used alone, indicating that in a warm environment, local convective cooling is superior to local radiant cooling as a means of improving perceived air quality. The intensity of the reported sick building syndrome symptoms increased during the exposure time, with or without cooling devices in operation. Air movement had very little effect on sick building syndrome symptoms, but they increased when the pollution level was high. The lowest prevalence of symptoms was reported with personalized ventilation and with the radiant panel with attached fans, which also caused subjects to report less fatigue. Sick building syndrome symptoms increased most when the tabletop fan, generating movement of polluted room air, was in operation. The temperature of the inhaled air rather than any local cooling of the head was associated with sick building syndrome symptoms, although this needs further study. The most preferred cooling method was personalized ventilation for six subjects, fan for eight subjects, and radiant panel (or radiant panel + fans) for nine subjects.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Section for Building Physics and Services, Silesian University of Technology, Technical University of Denmark, Shinshu University
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Publication information
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Ratings:
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.01
Impact of Air Movement on Eye Symptoms

The impact of direction, oscillation and temperature of isothermal room air movement on eye discomfort and tear film quality was studied. Twenty-four male subjects participated in the experiment. Horizontal air movement against the face and chest was generated by a large desk fan – LDF and a small desk fan (2.5 W) powered by laptop computer – USBF and upward movement by a personalized ventilation supplying air from desk front edge - PV. The exposed subject had control over the rotation speed of the fans as well as the personalized airflow rate and its direction to be against the chest, upward to the face or both. At room air temperature of 25 °C and relative humidity of 50 % the subjects were exposed for 30 min to three conditions - without elevated air movement and USBF with and without oscillation and to six conditions at 30 °C and 50 % RH – without elevated movement, USBF without oscillation when the airflow was directed against the face and when against the chest, LDF with and without oscillation and PV. Eye tear film samples were taken and analyzed at the beginning and the end of the exposures. Eye irritation and dryness were reported by the subjects. The air movement under individual control did not change significantly the tear film quality though tendency for improvement was observed.
Eye dryness increased much when the airflow was blowing constantly against the face compared to oscillating airflow, airflow directed against the chest and upward airflow against the face.

**General information**
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Shinshu University
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BFI conference series: Indoor Air Quality, Ventilation & Energy Conservation in Buildings (5010062)
Main Research Area: Technical/natural sciences
Conference: Clima 2013, Prague, Czech Republic, 16/06/2013 - 16/06/2013
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Impact_of_Air_Movement_on_Eye_Symptoms.pdf
Source: PublicationPreSubmission
Source-ID: 101978714
Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

**Impact of human presence on secondary organic aerosols derived from ozone-initiated chemistry in a simulated office environment**
Several studies have documented reductions in indoor ozone levels that occur as a consequence of its reactions with the exposed skin, hair and clothing of human occupants. One would anticipate that consumption of ozone via such reactions would impact co-occurring products derived from ozone's reactions with various indoor pollutants. The present study examines this possibility for secondary organic aerosols (SOA) derived from ozone-initiated chemistry with limonene, a commonly occurring indoor terpene. The experiments were conducted at realistic ozone and limonene concentrations in a 240 m³ chamber configured to simulate a typical open office environment. During an experiment the chamber was either unoccupied or occupied with 18-20 workers. Ozone and particle levels were continuously monitored using a UV photometric ozone analyzer and a fast mobility particle sizer (FMPS), respectively. Under otherwise identical conditions, when workers were present in the simulated office the ozone concentrations were approximately two-thirds and the SOA mass concentrations were approximately one-half of those measured when the office was unoccupied. This was observed whether new or used filters were present in the air handling system. These results illustrate the importance of accounting for occupancy when estimating human exposure to pollutants in various indoor settings. © 2013 American Chemical Society.

**General information**
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, National University of Singapore, National Research Council of Canada
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Pages: 3933-3941
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Web of Science (2018): Indexed yes
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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.26 SJR 2.538 SNIP 1.889
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Indoor air quality in the Swedish housing stock and its dependence on building characteristics

Data from a recent Swedish survey on the status of the housing stock and indoor air quality were placed in the public domain by the Swedish National Board of Housing, Building and Planning in 2011. The available parameters included the year of construction, dwelling location, type of ventilation system, temperature, relative humidity, air exchange rate (AER), and concentrations of nitrogen dioxide (NO2), formaldehyde and Total Volatile Organic Compounds (TVOC) from 157
single-family houses and 148 apartments. The median AER was lower in the single-family houses than in apartments (0.33h⁻¹ vs. 0.47h⁻¹). The majority of houses (80%) did not comply with the building code that requires 0.5 air changes per hour. The median concentrations in single-family houses and apartments were 6.0 and 10μg/m³, respectively, for NO₂, 22 and 13μg/m³ for formaldehyde, and 236 and 143μg/m³ for TVOC. All of these differences between single-family houses and apartments were statistically significant. The median values for AER and the median values for the concentrations of NO₂, formaldehyde and TVOC were similar to those found in other Scandinavian studies. Multivariate linear regression models revealed that air exchange rate was a significant predictor of the concentrations of all three indoor pollutants. While ventilation seemed to be a source of NO₂, increased ventilation rate appeared to decrease the indoor concentrations of formaldehyde and TVOC. © 2013 Elsevier Ltd.
Influence of occupant's heating set-point preferences on indoor environmental quality and heating demand in residential buildings

The aim of this study was to switch from a deterministic approach of building energy simulation toward a probabilistic one that takes into account the occupants interactions with the building controls. A probabilistic approach is proposed and applied to simulate occupant behavior realistically. The methodology was based on probabilistic evaluation of both input and output variables of building energy simulations. The developed methodology can be applied in all aspects of occupant's interactions with building controls, such as window openings, shading devices, etc., to achieve more realistic predictions of energy consumption. The aim was to compare the obtained results with a traditional deterministic use of the simulation program. Based on heating set-point behavior of 13 Danish dwellings, logistic regression was used to infer the probability of adjusting the set-point of thermostatic radiator valves. Three different models of occupant's interactions with heating controls were obtained and implemented in a building simulation tool. The models of occupant's behavior patterns were used to investigate how different behavior patterns influence indoor climate quality and energy consumption. Simulation results were given as probability distributions of energy consumption and indoor environmental quality depending on occupant's behavior. Copyright © 2013 Crown copyright.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Politecnico di Torino
Authors: Fabi, V. (Ekstern), Corgnati, S. P. (Ekstern), Andersen, R. K. (Intern)
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Web of Science (2018): Indexed yes
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Web of Science (2017): Indexed yes
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Scopus rating (2016): CiteScore 1.01
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
BFI (2014): BFI-level 1
Mixing Ventilation. Guide on mixing air distribution design

In this guidebook most of the known and used in practice methods for achieving mixing air distribution are discussed. Mixing ventilation has been applied to many different spaces providing fresh air and thermal comfort to the occupants. Today, a design engineer can choose from large selection of air diffusers and exhaust openings.

General information

State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Aachen Technical University, Aalborg University
Authors: Müller, D. (ed.) (Ekstern), Kandzia, C. (Ekstern), Kosonen, R. (Ekstern), Melikov, A. K. (Intern), Nielsen, P. V. (Ekstern)
Monitoring of indoor environment quality parameters and occupant perceptions in the Daikin nZEB Building in Herten, Germany

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Toftum, J. (Intern)
Publication date: 2013

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Main Research Area: Technical/natural sciences

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Numerical Study on the Contribution of Convective Mass Transfer Inside High-Porosity Adsorbents in the VOC Adsorption Process
The transfer mechanism of volatile organic compounds (VOCs) being trapped inside the various types of adsorbents is usually regarded as mere diffusion. This paper investigated the contribution of convective mass transfer inside the adsorbents used for VOC air-cleaning. The adsorbents are typically characterized by their high porosity and thickness which can be as thin as hundreds of microns. By numerical simulation, it was found that the air flow could penetrate the adsorbent matrix when the porosity was high. When the porosity is about 0.7 or even higher, the velocity profile inside the adsorbent and cavity would form, approximately, a consecutive parabola. The convective mass transfer inside the adsorbents would have little impact on the axial VOC transfer but could affect the average adsorption rate significantly at high porosities. The Peclet number Pe which is based on the inlet velocity, the pore diameter and the effective mass diffusion coefficient in the adsorbent could be used to judge the negligibility of the convective mass transfer inside the adsorbent. Pe = 0.52 could be taken as the critical point of neglecting the convective mass transfer inside the adsorbent, with the relative error of average adsorption rate of less than 10% as found by this study.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, University of Science and Technology of China
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Pages: 551-558
Publication date: 2013
Main Research Area: Technical/natural sciences

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Volume: 22
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Performance of Chilled Beam with Radial Swirl Jet and Diffuse Ceiling Air Supply in Heating Mode

The performance of diffuse ceiling air supply and chilled beam with swirl jet (CSW) in heating mode (winter situation) was studied and compared with regard to the generated indoor environment. An office mock-up with one occupant was simulated in a test room (4.5 x 3.95 x 3.5 m³ (L x W x H)). A window (6.5 m²) with cold surface (14 °C) was simulated by radiant panels. Four CSW chilled beam units were installed symmetrically on the suspended ceiling together with two exhaust vents. The diffuse ceiling inlet was made of standard perforated acoustic tiles (0.5% total degree of perforation). The room air temperature was kept at 21 °C. Tracer gas was used to simulate pollution from floor and desk. The experimental conditions comprised: 1) night time without heat sources in the room; the room air conditioning system was...
used to heat up the room; 2) heat load generated by an occupant (simulated by dressed thermal manikin) and a laptop; 3) heating by convector positioned under the window (convector used alone and convector used together with CSW supplying isothermal air for ventilation). The heat distribution provided by the systems was not effective compare to the distribution provided by convector. The tracer gas concentration in the occupied zone was considerably higher than the concentration at the exhaust. Airflow rate considerably higher (2.5–5.9 times higher) than the minimum ventilation rate required in the standards was needed to safeguard the indoor air quality.

Performance of Ductless Personalized Ventilation in Open-Plan Office - Field Survey

A field survey was conducted in an architectural company located in Syracuse, USA. 54 employees who participated in the survey performed mostly design work. Large open-plan office and several single offices ventilated by displacement air distribution were included in the survey. Ductless personalized ventilation was installed on 38 of the workstations (53 %). The DPV equipped with small fan and filter, sucks the clean and cool air distributed over the floor by the displacement ventilation and supplies it to the breathing zone of the occupant. The DPV allows for individual control of flow rate (i.e. velocity) and direction of the supplied personalized air. During the survey, carried out in July – September 2011, both DPV users and non-users reported daily on their thermal comfort, air quality and SBS symptoms. Continuous measurements of air temperature, operative temperature and relative humidity were performed. The occupants at the desks with DPV reported increased satisfaction with the indoor environment.

Personal Control Over Heating, Cooling and Ventilation: results of a workshop at Clima 2013 conference

This article presents a summary of a Workshop at 11th Clima World Conference 2013 in Prague. The workshop was organised by REHVA in cooperation with ISIAQ (International Society of Indoor Air Quality and Climate), and chaired by Atze Boerstra and Angela Simone.
Phthalate metabolites in urine samples from Danish children and correlations with phthalates in dust samples from their homes and daycare centers

Around the world humans use products that contain phthalates, and human exposure to certain of these phthalates has been associated with various adverse health effects. The aim of the present study has been to determine the concentrations of the metabolites of diethyl phthalate (DEP), di(n-butyl) phthalate (DnBP), di(iso-butyl) phthalate (DiBP), butyl benzyl phthalate (BBzP) and di(2-ethylhexyl) phthalate (DEHP) in urine samples from 441 Danish children (3–6 years old). These children were subjects in the Danish Indoor Environment and Children’s Health study. As part of each child's medical examination, a sample from his or her first morning urination was collected. These samples were subsequently analyzed for metabolites of the targeted phthalates. The measured concentrations of each metabolite were approximately log-normally distributed, and the metabolite concentrations significantly correlated with one another. Additionally, the mass fractions of DEP, DnBP, DiBP and BBzP in dust collected from the children's bedrooms and daycare centers significantly correlated with the concentrations of these phthalates' metabolites (monoethyl phthalate (MEP), mono-n-butyl phthalate (MnBP), mono-isobutyl phthalate (MiBP) and monobenzyl phthalate (MBzP), respectively) in the children's urine. Such correlations indicate that indoor exposures meaningfully contributed to the Danish children's intake of DEP, DnBP, DiBP and BBzP. This was not the case for DEHP. The urine concentrations of the phthalate metabolites measured in the present study were remarkably similar to those measured in urine samples from children living in countries distributed over four continents. These similarities reflect the globalization of children's exposure to phthalate containing products.
Preferred Air Velocity and Local Cooling Effect of desk fans in warm environments

Common experiences, standards, and laboratory studies show that increased air velocity helps to offset warm sensation due to high environmental temperatures. In warm climate regions the opening of windows and the use of desk or ceiling fans are the most common systems to generate increased airflows to compensate for higher environmental temperatures at the expense of no or relatively low energy consumption. When using desk fans, local air movement is generated around the occupant and a certain cooling effect is perceived. The impact of the local air movement generated by different air flow patterns, and the possibility to keep comfortable conditions for the occupants in warm environments were evaluated in studies with human subjects.

In an office-like climatic chamber, the effect of higher air velocity was investigated at room temperatures between 26°C to 34°C and at constant absolute humidity of 12.2 g/kg. By a thermal manikin the effect of direct air movement generated by a personal desk fan at 26 °C, 28 °C, or 30 °C room temperatures and the achievable thermal comfort was also analyzed.

Results show that it is possible to offset warm sensation within a range of indoor conditions using increased air velocity. Besides, higher air velocities and personal control increase the acceptability of the indoor environment at higher air temperatures with a limited energy consumption compared to full air conditioning during summer seasons in warmer countries. Comparing the study with Danish subjects with previous findings with Chinese subjects showed that subjects used to warmer climate could accept higher air velocities and felt less uncomfortable.

General information
State: Published
Organisations: Department of Mechanical Engineering, Department of Civil Engineering, Section for Indoor Environment
Authors: Simone, A. (Intern), Olesen, B. W. (Intern)
Number of pages: 10
Publication date: 2013
Progress in thermal comfort research over the last twenty years

Climate change and the urgency of decarbonizing the built environment are driving technological innovation in the way we deliver thermal comfort to occupants. These changes, in turn, seem to be setting the directions for contemporary thermal comfort research. This article presents a literature review of major changes, developments, and trends in the field of thermal comfort research over the last 20 years. One of the main paradigm shifts was the fundamental conceptual reorientation that has taken place in thermal comfort thinking over the last 20 years; a shift away from the physically based determinism of Fanger's comfort model toward the mainstream and acceptance of the adaptive comfort model. Another noticeable shift has been from the undesirable toward the desirable qualities of air movement. Additionally, sophisticated models covering the physics and physiology of the human body were developed, driven by the continuous challenge to model thermal comfort at the same anatomical resolution and to combine these localized signals into a coherent, global thermal perception. Finally, the demand for ever increasing building energy efficiency is pushing technological innovation in the way we deliver comfortable indoor environments. These trends, in turn, continue setting the directions for contemporary thermal comfort research for the next decades.
Providing better thermal and air quality conditions in school classrooms would be cost-effective

This paper is an overall summary of research by the authors on how classroom conditions affect the performance of schoolwork by children, motivated by the fact that the thermal and air quality conditions in school classrooms are now almost universally worse than the relevant standards and building codes stipulate that they should be. This is sometimes because financial resources for the maintenance and upgrade of school buildings are inadequate, but it is also because schools are increasingly allowing classroom temperatures to drift above the recommended range of 20–22 °C in warm weather and allowing outdoor air supply rates to remain so low that carbon dioxide (CO2) levels during school hours exceed 1000 ppm for long periods, in order to conserve energy. The research that is summarized in this paper shows that the indoor environmental consequences of either of these investment-free but ill-advised energy conservation measures can reduce children's performance of schoolwork by as much as 30%, so a more sophisticated approach to maintaining good classroom indoor environmental quality (IEQ) is required.

General information
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Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Wargocki, P. (Intern), Wyon, D. P. (Intern)
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BFI (2018): BFI-level 1
Radiant Floor Cooling Combined with Mixing Ventilation in a Residential Room: Thermal Comfort and Ventilation Effectiveness

Mixing air ventilation system is one of the main ventilation concepts applied in residential buildings. The effect of combining the mixing ventilation system with the radiant floor heating has been well established, whereas the validation of using the floor for cooling in summer is still in progress. An experimental laboratory study in a simulated residential room with a seated occupant simulated by a thermal manikin was performed in order to evaluate thermal comfort and ventilation effectiveness. Thermal comfort was evaluated by means of vertical air temperature and air velocity profiles and by thermal manikin equivalent temperatures. Contaminant removal effectiveness and air change efficiency were used to characterize the ventilation effectiveness. The vertical air temperature differences that occurred when floor cooling was combined with cold conditioned air supply were well within the limits for comfortable thermal environment recommended by the standards. The cooler supply air mixed well and the effect of the position of air terminal devices was small. When warm unconditioned outside air was supplied by mixing ventilation in combination with the radiant floor cooling, low floor temperature was needed to keep the desired room temperature, followed by increased vertical air temperature differences of about 4 °C for a sitting person, and the ventilation effectiveness was dominated by the position of air terminal devices and the supply air flow.

General information

State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
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Main Research Area: Technical/natural sciences

Rapport over analyse af boligejerens socioøkonomiske gevinst ved indeklimaforbedring som følge af energirenovering


General information

State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Andersen, R. K. (Intern), Toftum, J. (Intern)
Number of pages: 33
Publication date: 2013
Reducing Health Risks from Indoor Exposures in Rapidly Developing Urban China.

Background: Over the past two decades there has been a large migration of China's population from rural to urban regions. At the same time, residences in cities have changed in character from single-story or low-rise buildings to high-rise structures constructed and furnished with many synthetic materials. As a consequence, indoor exposures to pollutants with outdoor and indoor sources have changed significantly. Objectives: We briefly discuss the inferred impact that urbanization and modernization have had on indoor exposures and public health in China. We argue that growing adverse health costs associated with these changes are not inevitable, and we present steps that could be taken to reduce indoor exposures to harmful pollutants. Discussion: As documented by China’s Ministry of Health, there have been significant increases in morbidity and mortality among urban residents over the past 20 years. Evidence suggests that the population’s exposure to air pollutants has contributed to increases in lung cancer, cardiovascular disease, pulmonary disease, and birth defects. Whether a pollutant has an outdoor or an indoor source, most exposure to the pollutant occurs indoors. Going forward, indoor exposures can be reduced by limiting the ingress of outdoor pollutants (while providing adequate ventilation with clean air), minimizing indoor sources of pollutants, updating government policies related to indoor pollution, and addressing indoor air quality during a building's initial design. Conclusions: Taking the suggested steps could lead to significant reductions in morbidity and mortality, greatly reducing the societal costs associated with pollutant derived ill health.
Robustness of building design with respect to energy related occupant behaviour

Occupant behaviour is often the first reason for the discrepancy between designed and real total energy use in buildings. A possible solution to bridge this gap is designing buildings whose performances show little variations despite of alternating occupants' behaviour. The aim of this work was to investigate how occupants' behaviour varies according to the building envelope design: different input values have been chosen for three design features - thermal mass, transparency and solar shadings - in order to discover the most robust ones. The study is earned out through simulations on an office building in 3 weather climates and probabilistic models for window opening and use of shading, based on real occupants' behaviour, have been implemented. By testing the influence of building's design on occupants' behaviour, the present contribution highlights the importance of the robustness' evaluation of a building during the design phase in order to obtain more realistic energy predictions.

General information

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Organisations: Department of Civil Engineering, Section for Indoor Environment, Department of Mechanical Engineering, Politecnico di Torino
Authors: Fabi, V. (Ekstern), Buso, T. (Ekstern), Andersen, R. K. (Intern), Corgnati, S. P. (Ekstern), Olesen, B. W. (Intern)
Pages: 1999-2006
Publication date: 2013

Host publication information
Solar Sustainable Heating, Cooling and Ventilation of a Net Zero Energy House

Present work addresses the heating, cooling and ventilation concerns of the Technical University of Denmark’s house, Fold, for Solar Decathlon Europe 2012. Various innovative approaches are investigated, namely, utilization of ground, photo-voltaic/thermal (PV/T) panels and phase change materials (PCM). The ground heat exchanger acts as the heat sink and heat source for cooling and heating seasons, respectively. Free cooling enables the same cooling effect to be delivered with 8% of the energy consumption of a representative chiller. The heating and cooling needs of the house are addressed by the embedded pipes which are coupled with the ground. Ventilation is mainly used to control the humidity and to remove sensory and chemical pollution. PV/T panels enable the house to be a "plus" energy house. PV/T also yields to a solar fraction of 63% and 31% for Madrid and Copenhagen, respectively. A combination of embedded pipes and PCM was simulated and results show energy savings up to 30%, for cooling season in Madrid, compared to using only embedded pipes. However this option was not realized in the actual house. Once this house is built, tested and optimized, further possibilities will be investigated in order to apply a similar strategy to the entire building block. This will lead to considerable amount of primary energy savings and consequently avoided greenhouse gas emissions.

General information

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Organisations: Department of Civil Engineering, Section for Indoor Environment, Department of Management Engineering, Technical University of Denmark
Authors: Kazancı, O. B. (Intern), Skrupskelis, M. (Ekstern), Olesen, B. W. (Intern), Pavlov, G. K. (Intern)
Number of pages: 10
Publication date: 2013
Event: Paper presented at Clima 2013, Prague, Czech Republic.
Main Research Area: Technical/natural sciences

Electronic versions:

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Publication: Research - peer-review › Paper – Annual report year: 2013
Standards for securing adequate indoor air quality across Europe: setting the scene for health based ventilation guidelines proposed by the HealthVent project

Background: Inadequate IAQ causes a loss of 2 million healthy life years annually in the EU. Europeans spend typically over 85–90% of their time indoors and the main factors that affect negatively the characteristics of the air they breathe are outdoor air used to ventilate indoor spaces and indoor sources of pollution. Ventilation is one of many factors determining IAQ. The aim of DG SANCO funded HealthVent project was to assess how ventilation should be defined in terms of achieving conditions for securing health.

Methods: Review of the available literature was made so as to break down the health effects of IAQ into different components: exposures to indoor and outdoor air pollutants, association with different morbidities and the way ventilation based approaches could minimise their impact. Disability adjusted life years (DALYs), a common metric to allow comparability of impacts on various types of diseases and mortality was used in risk analysis. Ventilation rate was defined as volume of fresh air introduced into the space per person (L/sp).

Results: The data in the reviewed studies on ventilation and health were found inadequate to set the health-based ventilation rates mainly because the studies improperly characterised exposures and because of their inhomogeneity. Risk modelling simulations of different strategies resulting in reduction of DALYs suggested that healthbased ventilation requirements should be combined with source control strategies and if necessary cleaning of outdoor air in order to be efficient. As a consequence HealthVent proposed that source control is a key strategy for IAQ and that ventilation should be an ultimate measure. HealthVent defined the minimum reference ventilation rate to reduce risk of health to be set at 4 L/s per person. This rate is only to handle human bioeffluents and is determined mainly considering the metabolic CO2 production. It is only applicable if all other pollutants meet WHO guidelines for ambient and indoor air quality. If they do not meet these guidelines after applying source control and when air used for ventilation is clean health-based ventilation rate should be a multiple of the minimum rate.

Conclusions: Optimal strategy for ensuring adequate IAQ to ensure health conditions must include cleaning of ambient air (if necessary) and source control; only then health-based ventilation rate can be defined. Such approach is expected to half the BOD caused by indoor exposures.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, University of Milan, University of Porto, National Institute for Health and Welfare, Association Asthma
Authors: Wargocki, P. (Intern), Carrer, P. (Ekstern), de Oliveira Fernandes, E. (Ekstern), Hanninen, O. (Ekstern), Popov, T. (Ekstern)
Pages: 170
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Conference: European Academy of Allergy and Clinical Immunology & World Allergy Organization World Allergy & Asthma Congress, Milan, Italy, 22/06/2013 - 22/06/2013
Main Research Area: Technical/natural sciences

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  - Web of Science (2014): Indexed yes
  - BFI (2013): BFI-level 1
  - Scopus rating (2013): SJR 2.195 SNIP 1.902 CiteScore 4.91
A building is a complex system where many components interact with each other therefore the control system plays a key role regarding the energy consumption and the occupant thermal comfort.

This study is concerned with a detached, one-storey, single family, energy-plus house. It is equipped with a ground heat exchanger, a ground coupled heat pump, embedded pipes in the floor and in the ceiling, a ventilation system (mechanical and natural), a domestic hot water tank and photovoltaic/thermal panels on the roof.

Preliminary evaluations showed that for Madrid, change of indoor set-point in cooling season from 23°C to 25°C (±1 K) can decrease the cooling need by 23%. Hence, an interest arose in order to quantify the energy saving potential with respect to different set-points and dead-bands. However occupant comfort should not be neglected for the sake of energy savings.

This study focuses on the effects of the set-points and dead-bands of different components on the energy consumption together with the occupant thermal comfort. Evaluations are carried out with TRNSYS for Copenhagen and Madrid in order to compare climatic effects.
The Effects of Ventilation in Homes on Health

It is estimated that people in the developed world spend more than 85-90% of their time indoors. Of this, most is spent in homes. To minimize health risks from pollutants occurring in homes, exposures should be controlled. The most effective way to achieve this is to control sources of pollutants and to reduce emissions. Often, especially in existing buildings, this strategy is difficult to implement, in which case exposures are controlled by providing sufficient, presumably clean, outdoor ventilation air to dilute and remove the contaminants. The present paper attempts to find out how much ventilation is needed in existing homes to reduce health risks. This is achieved by reviewing the published scientific literature investigating the association between measured ventilation rates and the measured and observed health problems. The paper concludes that, generally, there are very few studies on this issue and many of them suffer from deficient experimental design, as well as a lack of proper characterization of actual exposures occurring indoors. Based on the available data, in the reviewed studies, it seems likely that health risks may occur when ventilation rates are below 0.4 air changes per hour in existing homes. No data were found indicating that buildings having dedicated natural ventilation systems perform less well than the dwellings in which mechanical ventilation systems are installed. Newly installed mechanical ventilation systems were observed to improve health conditions. In homes with existing ventilation systems this positive effect was less evident, probably due to poor performance of the system (too low ventilation rates and/or poor maintenance). Studies are recommended in which exposures are much better characterized (by for example measuring the pollutants indicated by the WHO Guidelines for Indoor Air Quality and improving ventilation measurements). Exposures should also be controlled using different ventilation methods for comparison. Future studies should also advance the understanding of how ventilation systems should be operated to achieve optimal performance. These data would create further input and support to the guidelines for ventilation based on health developed currently in the framework of the HealthVent project (www.healthvent.eu).

General information
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Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Wargocki, P. (Intern)
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Pages: 101-118
Publication date: 2013
Main Research Area: Technical/natural sciences

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BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.414 SNIP 0.533 CiteScore 0.78
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.356 SNIP 0.62 CiteScore 0.47
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.218 SNIP 0.207 CiteScore 0.3
ISI indexed (2013): ISI indexed yes
The Oxidative Capacity of Indoor Atmospheres

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Aix-Marseille University
Authors: Gligorovski, S. (Ekstern), Weschler, C. J. (Intern)
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Main Research Area: Technical/natural sciences

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Scopus rating (2016): CiteScore 6.26 SJR 2.538 SNIP 1.889
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.584 SNIP 1.828 CiteScore 5.61
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.777 SNIP 2.017 CiteScore 5.5
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.956 SNIP 2.103 CiteScore 5.52
ISI indexed (2013): ISI indexed yes
Thermal comfort in commercial kitchens (RP-1469): Procedure and physical measurements (Part 1)

The indoor climate in commercial kitchens is often unsatisfactory, and working conditions can have a significant effect on employees' comfort and productivity. The type of establishment (fast food, casual, etc.) and climatic zone can influence thermal conditions in the kitchens. Moreover, the size and arrangement of the kitchen zones, appliances, etc., further complicate an evaluation of the indoor thermal environment in commercial kitchens. In general, comfort criteria are stipulated in international standards (e.g., ASHRAE 55 or ISO EN 7730), but are these standardized methods applicable to such environments as commercial kitchens? This article describes a data collection protocol based on measurements of physical and subjective parameters. The procedure was used to investigate more than 100 commercial kitchens in the United States in both summer and winter. The physical measurements revealed that there is a large range of kitchens environments and confirmed that employees are exposed to a warm-to-hot environment. The measured ranges of activities and temperatures in many cases were outside the range recommended by ASHRAE 55 and ISO EN 7730. The study showed that the predicted mean vote/percentage people dissatisfied (PMV/PPD) index is not directly appropriate for all thermal conditions in commercial kitchens.

General information
Thermal Comfort in Simulated Office Environment with Four Convective and Radiant Cooling Systems

Experiments with 24 human subjects in a simulated office with four cooling systems were performed. The systems were: chilled beam (CB), chilled beam with integrated radiant panel (CBR), chilled ceiling with overhead mixing ventilation (CCMV) and four desk partition mounted radiant cooling panels with overhead mixing ventilation (MVRC). Whole body thermal sensation (TS) and whole body TS acceptability under the four systems in a simulated office room for one hour exposure were collected. The simulated two-man office (4.12 x 4.20 x 2.89 m, L x W x H) was kept at 26 °C room air temperature. Moderate heat load of 64 W/m² was generated by simulated solar heat load, 2 laptops and 2 occupants, giving in total 1104 W. The supplied outdoor air temperature was kept at 16 °C. The supply air flow rate for CB, CBR and CCMV was set to 26 L/s (category II low-polluting building, EN 15251-2007). For MVRC supply airflow of 44 L/s was set in order to maintain 26 °C room air temperature. Under the studied conditions, all four systems showed similar performance with respect to whole body TS: occupants felt between “neutral” to “slightly warm” on the TS scale in EN 15251-2007. Female felt whole body TS closer to “neutral” compared to male, whose votes were closer to the “slightly warm” thermal sensation. The whole body TS acceptability was rated close to “clearly acceptable” (EN 15251-2007) and was independent of subject's gender for all tested systems.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Halton OY, Technical University of Denmark
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Number of pages: 10
Publication date: 2013
Thermal Environment evaluation in commercial kitchens

The indoor climate in commercial kitchens is often unsatisfactory and the working conditions can have a significant effect on employees’ comfort and productivity. The differences between type (fast food, dining, etc.) and climatic zone can have an influence on the environment conditions and on the employees’ perception of kitchens thermal conditions. Moreover, size and arrangement of the kitchen zones, appliances, etc., complicate further an evaluation of the indoor thermal environment in kitchens.

The on field physical measurements together with the occupants’ feedback is the effective way of defining the values of thermal comfort parameters in kitchens. It can also help to evaluate if the standardized methods are applicable for such non-uniform environment, like commercial kitchens.

By using an established method and procedure for evaluating the indoor thermal comfort in commercial kitchens more than 100 kitchens environments in the United States were investigated in summer and winter. Results show the influence due to type of kitchen (fast food, casual, etc.) and climatic region. Physical measurement confirmed that communally the workers are exposed to a warm or hot environment, with temperature even higher than the ones that can be supported by the human physical strength. PMV/PPD index resulted not suitable for application in commercial kitchens. Kitchens environments with a big range of operative temperature were investigated.

Thermal Environment Evaluation in Commercial Kitchens of United States

The indoor climate in commercial kitchens is often unsatisfactory and the working conditions can have a significant effect on employees’ comfort and productivity. The differences between type (fast food, dining, etc.) and climatic zone can have an influence on the environment conditions and on the employees’ perception of kitchens thermal conditions. Moreover, size and arrangement of the kitchen zones, appliances, etc., complicate further an evaluation of the indoor thermal environment in kitchens.

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By using an established method and procedure for evaluating the indoor thermal comfort in commercial kitchens more than 100 kitchens environments in the United States were investigated in summer and winter. Results show the influence due to type of kitchen (fast food, casual, etc.) and climatic region. Physical measurement confirmed that communally the workers are exposed to a warm or hot environment, with temperature even higher than the ones that can be supported by the human physical strength. PMV/PPD index resulted not suitable for application in commercial kitchens. Kitchens environments with a big range of operative temperature were investigated.
The world's largest study of the indoor environment in commercial kitchens

The International Centre for Indoor Environment and Energy (ICIEE) at DTU Civil Engineering has conducted a study on the thermal conditions of the working environment in more than 100 commercial kitchens in the USA during summer and winter. The study shows that employees generally feel the working environment is warm and they'd like it cooler; but they still find it acceptable.

General information
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Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Olesen, B. W. (Intern), Simone, A. (Intern)
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Main Research Area: Technical/natural sciences
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Source-ID: u::10437
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Udelukker den nye standard DS 469 brugen af gulvvarme?

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Authors: Olesen, B. W. (Intern)
Pages: 14-20
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Main Research Area: Technical/natural sciences

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Volume: 49
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Original language: Danish
Electronic versions:
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Source: dtu
Source-ID: u::9183
Publication: Research › Journal article – Annual report year: 2013

Ultrafine particles: Exposure and source apportionment in 56 Danish homes

Particle number (PN) concentrations (10-300 nm in size) were continuously measured over a period of ~45 h in 56 residences of nonsmokers in Copenhagen, Denmark. The highest concentrations were measured when occupants were present and awake (geometric mean, GM: $22.3 \times 10^3$ cm$^{-3}$), the lowest when the homes were vacant (GM: $6.1 \times 10^3$ cm$^{-3}$) or the occupants were asleep (GM: $5.1 \times 10^3$ cm$^{-3}$). Diary entries regarding occupancy and particle related activities were used to identify source events and apportion the daily integrated exposure among sources. Source events clearly resulted in increased PN concentrations and decreased average particle diameter. For a given event, elevated particle concentrations persisted for several hours after the emission of fresh particles ceased. The residential daily integrated PN exposure in the 56 homes ranged between $37 \times 10^3$ and $6.0 \times 10^5$ particles per cm$^3$ h/day (GM: $3.3 \times 10^5$ cm$^{-3}$ h/day). On average, ~90% of this exposure occurred outside of the period from midnight to 6 a.m. Source events, especially candle burning, cooking, toasting, and unknown activities, were responsible on average for ~65% of the residential integrated exposure (51% without the unknown activities). Candle burning occurred in half of the homes where, on average, it was responsible for almost 60% of the integrated exposure. © 2013 American Chemical Society.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Lund University, University of Copenhagen
Use of personalized ventilation for improving health, comfort, and performance at high room temperature and humidity

The effect of personalized ventilation (PV) on people's health, comfort, and performance in a warm and humid environment (26 and 28°C at 70% relative humidity) was studied and compared with their responses in a comfortable environment (23°C and 40% relative humidity). Thirty subjects participated in five 4-h experiments in a climate chamber. Under the conditions with PV, the subjects were able to control the rate and direction of the supplied personalized flow of clean air. Subjective responses were collected through questionnaires. During all exposures, the subjects were occupied with tasks used to assess their performance. Objective measures of tear film stability, concentration of stress biomarkers in saliva, and eye blinking rate were taken. Using PV significantly improved the perceived air quality (PAQ) and thermal sensation and decreased the intensity of Sick Building Syndrome (SBS) symptoms to those prevailing in a comfortable room environment without PV. Self-estimated and objectively measured performance was improved. Increasing the temperature and relative humidity, but not the use of PV, significantly decreased tear film quality and the concentration of salivary alpha-amylase, indicating lower mental arousal and alertness. The use of PV improved tear film stability as compared to that in a warm environment without PV.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Silesian University of Technology, Technical University of Denmark
Authors: Melikov, A. K. (Intern), Skwarczynski, M. (Intern), Kaczmarczyk, J. (Ekstern), Zabecky, J. (Ekstern)
Pages: 250-263
Publication date: 2013
Main Research Area: Technical/natural sciences
Validation of models of users' window opening behaviour in residential buildings

The characterisation of window opening behaviour is crucial for suitable prediction of building performance (energy consumption, indoor environmental quality, etc.) by means of simulations. In this paper, data from a measurement campaign was used to validate three models of window opening behaviour. Data from the measurement campaign was used as input in the models to calculate the probability of opening and closing windows. Afterwards, the validation was carried out by comparing the predicted probabilities with the actual measured state of the windows in the dwellings.

General information

State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Politecnico di Torino
Authors: Corgnati, S. P. (Ekstern), Andersen, R. K. (Intern), Fabi, V. (Ekstern)
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Main Research Area: Technical/natural sciences
Energy utilization, Buildings
Warmth and performance: reply to the letter from Leyten and Kurvers (2013)

General information
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Organisations: Department of Civil Engineering, Section for Indoor Environment, Technical University of Denmark, Shanghai Jiao Tong University
Authors: Lan, L. (Ekstern), Wargocki, P. (Intern), Wyon, D. P. (Intern), Lian, Z. (Ekstern)
Pages: 437-438
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Web of Science (2017): Indexed yes
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Scopus rating (2016): CiteScore 3.55
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Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 2.42
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Web of Science (2009): Indexed yes
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Scopus rating (2008): SJR 0.757 SNIP 2.168
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.933 SNIP 3.724
Web of Science (2007): Indexed yes
Window opening behaviour modelled from measurements in Danish dwellings

A method of defining occupants' window opening behaviour patterns in simulation programs, based on measurements is proposed. Occupants' window opening behaviour has a strong effect on indoor environment and the energy consumed to sustain it. Only few models of window opening behaviour exist and these are solely based on the thermal indoor/outdoor environment. Consequently, users of simulation software are often left with little or no guidance for the modelling of occupants' window opening behaviour, resulting in potentially large discrepancies between real and simulated energy consumption and indoor environment. Measurements of occupant's window opening behaviour were conducted in 15 dwellings in Denmark during eight months. Indoor and outdoor environmental conditions were monitored in an effort to relate the behaviour of the occupants to the environmental conditions. The dwellings were categorized in four groups according to ventilation type (natural/mechanical) and ownership (owner-occupied/rented) in order to investigate common patterns of behaviour. Logistic regression was used to infer the probability of opening and closing a window. The occupants' window opening behaviour was governed by different but distinct habits in each dwelling. However, common patterns were also identified in the analysis: Indoor CO2 concentration (used as indicator of indoor air quality) and outdoor temperature were the two single most important variables in determining the window opening and closing probability, respectively. The models could be implemented into most simulation programs, which would enable a better chance of mimicking the behaviour of the occupants in the building and thus simulating the indoor environment and energy consumption correctly. © 2013 Elsevier Ltd.
WS 8: Personal Control Over Heating, Cooling and Ventilation

General information
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Organisations: Department of Civil Engineering, Section for Indoor Environment, Eindhoven University of Technology
Authors: Simone, A. (Intern), Boerstra, A. (Ekstern)
Pages: 41-48
Publication date: 2013

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Publisher: Federation of European Heating and Air-Conditioning Associations, REHVA
Series: REHVA Guidebooks
Number: Report No.5
Main Research Area: Technical/natural sciences
Advanced air distribution for minimizing airborne cross infection in aircraft cabin

The performance of personalized ventilation combined with local suction at each seat was studied for the purpose of minimizing airborne cross-infection in vehicle compartments. Experiments were carried out in a simulated aircraft cabin section (3 rows, 21 seats). One breathing thermal manikin simulated "infected" polluting passenger and another simulated "exposed" passenger. Personalized ventilation supplied clean air at 10 L/s from front against manikins' face. Air was sucked at 10 L/s by a suction system of two nozzles positioned on the sides of "infected" manikin's head. The cabin was ventilated at 180 L/s. The concentration of Freon mixed with air exhaled by the "infected" manikin was measured. The personalized flow pushed the contaminated exhaled air backwards where it was pulled by the suction and exhausted before mixing with the cabin air. This resulted in substantial decrease of the tracer gas concentration in the air inhaled by the "exposed" manikin and the exhausted cabin air.

Air distribution and ventilation effectiveness in an occupied room heated by warm air

Air distribution, ventilation effectiveness and thermal environment were experimentally studied in a simulated room in a low-energy building heated and ventilated by warm air supplied by a mixing ventilation system. Measurements were performed for various positions of the air terminal devices and at different simulated outside conditions, internal heat gains and air change rates. Floor heating was also simulated and compared with the warm air heating system. Vertical air temperature profiles, air velocity profiles and equivalent temperatures were derived in order to describe the thermal environment. Contaminant removal effectiveness and air change efficiency were used to evaluate ventilation
effectiveness. No significant risk of thermal discomfort due to vertical air temperature differences or draught was found. When the room was heated by warm air, buoyancy forces were important for ventilation effectiveness at low air change rates. The effect of increasing air change on the ventilation effectiveness depended on the position of air terminal devices. Depending on the position of air terminal devices, the ventilation effectiveness varied between 0.4 and 1.2, where 1 is complete mixing. When a radiant floor heating system was simulated, the cooler ventilation air introduced to the room mixed well and created uniform conditions with a ventilation effectiveness of about 1.
Airflow characteristics in the breathing zone of a seated person using desk incorporated pair of confluent jets as personalized ventilation - effect of supply velocities

A workplace with desk, desk incorporated personalized ventilation (PV) and a dressed thermal manikin with realistic body and surface temperature distribution were set in a test room (4.70 m x 1.62 m x 2.6 m). 15 L/s were supplied from a ceiling diffuser to ventilate the room at 26 °C air temperature. The PV consisted of two plane jets placed beside each other (confluent jets) and along the front edge of the desk. The slots had dimensions: 0.06 m x 0.5 m (W x L). The manikin was seated upright with abdomen pressed against the front edge of the desk. The airflow supplied isothermally and upwards from the inner jet (closest to manikin) was the same, twice bigger or twice lower compared to that of the outer jet. The mean velocity field at the breathing zone was measured by Particle Image Velocimetry: a dual cavity laser (λ = 532 nm) and a CCD camera - 35 mm lenses. Glycerol droplets (seeding) were added to the total volume air supply. The maximum absolute mean velocity measured near the manikin’s mouth was 0.25 m/s, when the two confluent jets supplied 8 L/s each. Same velocity was measured when the inner jet was supplying 8 L/s and the outer 4 L/s. The opposite combination, i.e. outer jet 8 L/s and inner 4 L/s, resulted in lower velocity (0.13 m/s) compared to that of the free convection layer alone: 0.20 m/s. The increased velocity at the face allowed more clean air to be inhaled.

General information
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Organisations: Department of Civil Engineering, Section for Indoor Environment, Department of Wind Energy, Department of Mechanical Engineering, Fluid Mechanics, Coastal and Maritime Engineering, University of Tokyo
Authors: Bolashikov, Z. D. (Intern), Nagano, H. (Ekstern), Melikov, A. K. (Intern), Velte, C. M. (Intern), Meyer, K. E. (Intern)
Number of pages: 6
Publication date: 2012
Main Research Area: Technical/natural sciences
Personalized ventilation, Control, Confluent jets, Free convection, PIV
Electronic versions:
Airflow_characteristics_in_the_breathing_zone_Final.pdf
Publication: Research - peer-review › Paper – Annual report year: 2012

Air movement and perceived air quality
The impact of air movement on perceived air quality (PAQ) and sick building syndrome (SBS) symptoms was studied. In total, 124 human subjects participated in four series of experiments performed in climate chambers at different combinations of room air temperature (20, 23, 26 and 28 °C), relative humidity (30, 40 and 70%) and pollution level (low and high). Most of the experiments were performed with and without facially applied airflow at elevated velocity. The importance of the use of recirculated room air and clean, cool and dry outdoor air was studied. The exposures ranged from 60. min to 235. min. Acceptability of PAQ and freshness of the air improved when air movement was applied. The elevated air movement diminished the negative impact of increased air temperature, relative humidity and pollution level on PAQ. The degree of improvement depended on the pollution level, the temperature and the humidity of the room air. At a low humidity level of 30% an increased velocity could compensate for the decrease in perceived air quality due to an elevated temperature ranging from 20 °C to 26 °C. In a room with 26 °C, increased air movement was also able to compensate for an increase in humidity from 30% to 60%, but not to 70%. The elevated velocity of recirculated polluted
room air did not decrease the intensity of SBS symptoms, but movement of clean, cool and dry air did so. Energy-saving strategy of improving occupants' comfort in rooms by moving room air at high velocity and maintaining room temperature high at reduced supply of outdoor air or by a decrease of indoor air enthalpy should be cautiously implemented in buildings because the pollution level may still cause negative health effects. © 2011 Elsevier Ltd.
ASHRAE IAQ 2010: Airborne infection control ventilation, IAQ & energy

Some key messages that emerged from the conference were:

• Continued lack of certainty about the benefits of forced ventilation over natural ventilation, even for infection control.
• Lack of quantitative scientific justification for the dilution ventilation rates in our guidance documents.
• Knowledge that proximity to an infected person affects infection rate, but the continued lack of certainty about whether that is due to large "ballistic" droplets or just a higher concentration of smaller airborne particles.

Besides the papers from the IAQ 2010 conference mentioned above, this special issue also includes ten additional papers on similar research areas. © 2012 Copyright Taylor and Francis Group, LLC.
Assessing the Influence of Indoor Exposure to "Outdoor Ozone" on the Relationship between Ozone and Short-term Mortality in US Communities

BACKGROUND: City-to-city differences have been reported for the increase in short-term mortality associated with a given increase in ozone concentration (ozone mortality coefficient). Although ozone concentrations are monitored at central outdoor locations, a large fraction of total ozone exposure occurs indoors.

OBJECTIVES: To clarify the influence of indoor exposure to ozone of outdoor origin on short-term mortality, we conducted an analysis to determine whether variation in ozone mortality coefficients among U.S. cities might be partly explained by differences in total ozone exposure (from both outdoor and indoor exposures) resulting from the same outdoor ozone concentration.

METHODS: We estimated average annual air change rates (the overall rate at which indoor air is replaced with outdoor air) and used these to estimate the change in total ozone exposure per unit change in outdoor ozone exposure (ozone exposure coefficient) for 18 cities that had been included in the National Morbidity and Mortality Air Pollution Study (NMMAPS). We then examined associations between both parameters and published ozone mortality coefficients.

RESULTS: For the 18 targeted NMMAPS cities, the association between ozone mortality coefficients and ozone exposure coefficients was strong (1-hr ozone metric: $R^2 = 0.58, p < 0.001$; 8-hr ozone: $R^2 = 0.56, p < 0.001$; 24-hr ozone: $R^2 = 0.48, p = 0.001$). When extended to another 72 NMMAPS cities, the associations remained strong ($R^2 = 0.47-0.63; p < 0.001$).

CONCLUSIONS: Differences in ozone mortality coefficients among cities appear to partially reflect differences in total ozone exposure resulting from differences in the amount of outdoor ozone that is transported indoors.
Associations between multiple indoor environmental factors and clinically confirmed allergic disease in early childhood

Background: Previous studies, mainly questionnaires have reported associations between some indoor environmental factors and allergic diseases. Our aim was to investigate the possible association between objectively assessed indoor environmental factors and clinically confirmed asthma, rhinoconjunctivitis and atopic dermatitis.

Method: A crosssectional case-cohort study (n = 500) based on 2835 children, aged 3–5 years, responding to a questionnaire, consisted of 300 subjects randomly selected and 200 cases with at least two parentally reported doctor diagnosed allergic diseases (asthma, allergic rhinoconjunctivitis or atopic dermatitis). The same physician conducted a clinical examination of all the 500 children including structured interview on allergic heredity, clinical and medical history. Specific s-IgE against inhalant and food allergens was determined. The homes were investigated by inspectors assessing air change rates, relative humidity, temperature, CO2, and dust samples were collected for analyses of indoor allergens, phthalates, nicotine and polyaromatic hydrocarbons. The diagnosis of allergic disease was based on internationally accepted criteria.

Result: In the base group (n = 300) asthma was clinically diagnosed in 5.1%, rhinoconjunctivitis in 5.1% and atopic dermatitis in 11.0%. Air change rates were below the recommended 0.5 in 56% of all the homes. Air change rates were higher among children asthma/rhinoconjunctivitis (P < 0.05). Stratified analyses showed lower air change rates (P < 0.05) in sensitized children with asthma. Concentrations of nicotine and house dust mite allergens were higher (P < 0.05) and cat allergens lower (P < 0.05) in the asthma group. When the diagnosis of allergic disease was based solely on questionnaire data no significant associations between environmental factors and allergic disease were found.

Conclusion: Air change rates were insufficient in the majority of the homes, and low rates were associated with higher concentrations of HDM allergens and sensitization in children with asthma. Asthma was associated with higher levels of nicotine and phthalates in dust. Pet keeping history proved an active avoidance behavior against cats. The lower levels of cat allergens among asthmatics may reflect avoidance behavior against ‘visible’ allergen sources (cat) but not to ‘invisible’ allergens (HDM). Questionnaire studies are inappropriate for evaluation for analysis of interaction between indoor.
Bed Microenvironment in Hospital Patient Rooms with Natural or Mechanical Ventilation

We studied how to provide patients in bed with thermally comfortable microenvironment in both naturally and mechanically ventilated hospital rooms for both winter and summer seasons. A climate chamber was used to resemble a hospital room and thermal manikin to simulate a patient lying in a bed. The manikin was dressed and covered by a quilt with its head resting on a pillow. The effect of local heating was studied at room air temperature of 10 and 16 °C and of local cooling at 28 and 35 °C. Electrical radiant heater, heated blanket, heated pillow, personalized ventilation (PV) and heated boots were used to provide local heating and PV, cooled mattress, ventilated bed and cooling fan to provide local cooling. The heating/cooling effect of the methods (when used alone or combined) was identified by comparing heat loss from manikin’s body and equivalent temperature with these obtained at a reference temperature of 22 °C. The effect of air movement (0.2, 0.4 and 1 m/s) at the bed vicinity was also studied. Electrical radiant heater in combination with heated bed showed to be the most effective at 10 and 16 °C and the combined use of PV and cooled mattress or ventilated bed was the most effective at 28 and 35 °C. Air movement with elevated velocity, especially 1 m/s, decreased the local...
Children's health and its association with indoor environments in Danish homes and daycare centres – methods

The principle objective of the Danish research program Indoor Environment and Children's Health (IECH) was to explore associations between various exposures that children experience in their indoor environments (specifically their homes and daycare centers) and their well-being and health. The targeted health endpoints were allergy, asthma, and certain respiratory symptoms. The study was designed with two stages. In the first stage, a questionnaire survey was distributed to more than 17,000 families with children between the ages of 1 and 5. The questionnaire focused on the children's health and the environments within the homes they inhabited and daycare facilities they attended. More than 11,000 questionnaires were returned. In the second stage, a subsample of 500 children was selected for more detailed studies, including an extensive set of measurements in their homes and daycare centers and a clinical examination; all clinical examinations were carried out by the same physician. In this study, the methods used for data collection within the IECH research program are presented and discussed. Furthermore, initial findings are presented regarding descriptors of the study population and selected characteristics of the children's dwellings and daycare centers.
Cognitive test performance following exposure to noise in an open-office simulation study

Objective: Noise in open-plan offices may increase mental fatigue of the employees at the end of the day. Measurements: 225 employees completed a screening questionnaire. Of these, 50 persons (33 females) who normally worked in open-plan offices agreed to participate in the experiment. All who participated completed two counter balanced experimental sessions, one with exposure to simulation of office noise (Leq=55 dB(A)) and one without noise (Leq=50 dB(A)). To simulate a workday, each session lasted about 7 hours, where the participants engaged in different computerised work tasks. Before and after each simulated workday, the participants performed different tests, including Choice Reaction Time (CRT) test, Sustained Attention to Response Task (SART) test, and a Two-Back Task (TBT) test. Results: Working in noise did not affect the number of correct trials in the cognitive test after work. Yet, there were differences in performance between subgroups that were defined with respect to the degree of disturbance to noise they experienced in their normal work conditions. Conclusion: There were no signs of increased mental fatigue during the experimental sessions. However, there were slight differences in test performance between groups reporting being disturbed by noise for more or less than 50% of the time in their normal open office environment.

Demand specifying variables and current ventilation rate requirements with respect to the future use of VOC sensing for DCV control

Demand Controlled Ventilation (DCV) is a well established principle to provide a certain indoor environmental quality, defined both in the terms of air quality and thermal comfort. This is accomplished by adjusting the supplied airflow rate according to a certain demand indicator, which conventionally has been the temperature or the CO2-concentration. When compared to schedule driven ventilation, application of DCV can lead to substantial energy savings. However, CO2 is the pollutant related to human occupancy and it does not provide any indication of so called building-related pollution. Building itself as well as its furnishing and equipment together with different human activities happening in them, are significant sources of different chemicals that may aggravate comfort and in some cases even negatively affect the health of the occupants. That is why emissions of those compounds should be also taken into account in the ventilation control. Recent development in gas sensing technology resulted in a new generation of relatively cheap and practically applicable sensors that can offer measurements of some of the pollutants mentioned above – mainly Volatile Organic Compounds (VOC). This seems to bring a new dimension into the control of DCV systems. This paper is a contribution to the workshop on utilization of VOC sensing technology used for DCV control. The aim of the paper is to provide a short review of different types of demand variables used to control DCV systems and summarize ventilation rate requirements contained in current standards and guidelines with respect to the future potential of VOC sensing.
**Ductless personalized ventilation with local air cleaning**

An experiment with 28 human subjects was performed to examine effects of using a local air cleaning device combined with ductless personalized ventilation (DPV) on perceived air quality. Experiments were performed in a test room with displacement ventilation. The DPV at one of two desks was equipped with an activated carbon filter installed at the air intake, while the DPV at the second desk was without such a filter. The air temperature in the occupied zone (1.1 m above the floor) was 29 °C. The pollution load in the room was simulated by PVC floor covering. The subjects assessed acceptability of air quality, odour intensity and air freshness at both desks in random order. Lower odour intensity and higher air freshness was reported at the desk with DPV with the activated carbon filter. The results suggest that using local air cleaning devices integrated with DPV may improve perceived air quality.

**Effect of open-plan office noise on occupant comfort and performance**

This study investigated effects on comfort, symptoms, and office work performance of exposure to office noise. Forty-nine subjects who were employees working in open-plan offices participated in two full-day experiments simulating an ordinary work day; one day with and one day without exposure to pre-recorded office noise. Exposure to office noise affected negatively ratings of adverse perceptions, selected symptoms, and self-assessed performance, but not the performance of the simulated office tasks. Occupants who in their daily work were disturbed by open-plan office noise were less tolerant to the noise exposure than those who were not.
Energy efficient window opening for air quality control in classrooms

The aim of the present work was to study how to maximize indoor environmental quality and energy performance in classrooms, when having different ventilation alternatives combined with a visual CO₂ feedback. In this effort, in heating and cooling seasons, field experiments were carried out in pairs of naturally and mechanically ventilated classrooms during normal school hours with and without CO₂ sensors that provided a green/yellow/red visual indication. At the end of each week children reported their perceptions and symptoms using a questionnaire. The classroom temperature, humidity and CO₂ levels were continuously measured together with the outdoor conditions. Magnetic sensors recorded opening of windows and classrooms energy usage was recorded by the meters installed on water-based radiators. An energy simulation model was created in IDA-ICE-4 to reproduce and compare energy demands/performance. With the CO₂ feedback more windows were open and the levels of CO₂ were reduced, as expected. As a consequence of more windows opened in this condition the energy use for heating in winter was increased and for cooling in summer reduced. Results show that split-cooling in summer can have negative effects on air quality when no CO₂ feedback is installed, as less windows are opened then suggesting temperature as the main factor causing window opening. Children reported that they liked to use the CO₂ feedback, with their perceptions and symptoms somewhat improved when feedback was installed but the results did not reach statistical significance. To improve indoor air quality in schools, CO₂ feedback was shown to be an effective tool in naturally ventilated classrooms.

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Authors: Faria Da Silva, N. A. (Intern)
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Estimates of total phthalate intakes for Danish children and the contributions to these intakes from dust ingestion, inhalation and dermal absorption in homes and daycare centers

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Authors: Bekö, G. (Intern), Weschler, C. J. (Intern), Langer, S. (Ekstern), Callesen, M. (Eksternt), Toftum, J. (Intern), Clausen, G. (Intern)
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Exposure of health care workers and occupants to coughed airborne pathogens in a double-bed hospital patient room with overhead mixing ventilation

The exposure of a doctor and a second patient was studied in a simulated two-bed hospital isolation room. The room was ventilated at three air change rates (3h⁻¹, 6h⁻¹, and 12h⁻¹) by mixing air distribution keeping at 22°C (71.6°F). The effect of the distance between the doctor and the coughing person, the posture of the coughing patient (lying sideways facing the doctor or on back), and the position of the doctor (facing the coughing patient or standing sideways) was examined with respect to exposure to coughed air. A thermal manikin with realistic body shape and surface temperature distribution was used to resemble the doctor. A coughing patient (equipped with cough generator) lying in one bed and another patient in the second bed were simulated by two heated dummies with simplified geometry. The cough consisted of 100% CO₂. The
peak cough time was 4s, when the doctor was closest to the sick patient's bed, and more than doubled for the exposed patient. The level of exposure (peak concentration level) depended strongly on the positioning and distance of the doctor from the infected patient and posture of the coughing patient. Peak concentration level varied widely from 194 to 10,228ppm. Ventilation rates of 12h⁻¹ (recommended by present hospital standards) resulted in background velocities exceeding 0.5m/s (98.43fpm), suggesting elevated risk from draught discomfort.

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Scopus rating (2011): SJR 0.498 SNIP 0.742
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BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.93 SNIP 0.956
Web of Science (2010): Indexed yes
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Scopus rating (2009): SJR 1.614 SNIP 1.187
Web of Science (2009): Indexed yes
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Scopus rating (2008): SJR 0.791 SNIP 0.903
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Scopus rating (2007): SJR 0.677 SNIP 1.639
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.843 SNIP 1.29
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.4 SNIP 1.26
Exposure of health care workers and occupants to coughed air in a hospital room with displacement air distribution: impact of ventilation rate and distance from coughing patient

The exposure of a doctor and a second patient to coughed air by an infected patient was studied in a simulated two-bed hospital patient room. The air temperature in the room, ventilated at two air change rates (3 h⁻¹ and 6 h⁻¹) was kept 22 °C. Thermal manikin with realistic body shape and surface temperature distribution was used as the doctor standing 0.55, 1.1 or 2.8 m downstream the cough. A coughing thermal dummy, lying in one bed and a second thermal manikin in the other bed (1.3 m away), were used as the "sick" and the "exposed" patients. The cough consisted of 100% CO₂. The doctor and the coughing patient faced each other. The Peak Cough Time (PCT) was around 6 s, when the doctor was 0.55 m downstream the cough and increased when the distance between the sick patient and the doctor increased. The highest Peak Concentration Level (PCL) for the doctor, i.e. excess of CO₂ level in inhaled air above background concentration (ppm), for the three measured distances was at 6 h⁻¹. PCL decreased with distance. The exposure of the second patient was low when the doctor was at 0.55 or 1.1 m downstream the cough (blocking effect), but was quite high when at 2.8 m. 6 h⁻¹, recommended in present hospital standards as minimum ventilation rate in hospital patient rooms, resulted in elevated exposure to coughed air for the doctor, suggesting increased risk from airborne cross-infection. Displacement air distribution does not reduce the risk from cross-infection.

Ground source heat pump combined with thermo-active building system with incorporated PCM for low-energy residential house

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Authors: Pavlov, G. K. (Intern), Olesen, B. W. (Intern), Skrupskelis, M. (Ekstern), Kazanci, O. B. (Intern)
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Human preference and acceptance of increased air velocity to offset warm sensation at increased room temperatures

Previous studies have demonstrated that in summertime increased air velocities can compensate for higher room temperatures to achieve comfortable conditions. In order to increase air movement, windows opening, ceiling or desk fans can be used at the expense of relatively low energy consumption. The present climatic chamber study examined energy performance and achievable thermal comfort of traditional and bladeless desk fans. Different effects of mechanical and simulated-natural airflow patterns were also investigated. 32 Scandinavians, performing office activities and wearing light clothes, were exposed to a increased air movement generated by a personal desk fan. The subjects could continuously regulate the fans under three fixed environmental conditions (operative temperatures equal to 26 °C, 28 °C, or 30 °C, and same absolute humidity 12.2 g/m³). The experimental study showed that increased air velocity under personal control make the indoor environment acceptable at higher air temperatures. This will during summer season and in warmer countries improve thermal comfort without too high energy costs. There was significant individual difference in the preferred air velocities, which indicate that personal control is important. The accepted air velocities depended on the type and source of the increased velocity. The Scandinavian subjects did not accept so high velocities as found in studies with Chinese subjects.
Human response to ductless personalized ventilation coupled with displacement ventilation

A human subject experiment was carried out to investigate the extent to which ductless personalized ventilation (DPV) in conjunction with displacement ventilation can improve perceived air quality (PAQ) and thermal comfort at elevated room air temperature in comparison with displacement ventilation alone. The experimental conditions comprised displacement ventilation alone (room air temperature of 23 °C, 26 °C, 29 °C) and DPV with displacement ventilation (26 °C, 29 °C), both operating at supply air temperatures 3, 5 or 6K lower than room air temperature, as well as mixing ventilation (23 °C, 3 K). During one hour exposure participants answered questionnaires regarding PAQ and thermal comfort. PAQ was significantly better with DPV than without DPV at the same background conditions. Thermal comfort improved when DPV was used. Combining DPV with displacement ventilation showed the potential for improving PAQ and thermal comfort when room air temperature is above the comfortable temperature range.

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Organisations: Department of Civil Engineering, Section for Indoor Environment, Technical University of Denmark
Authors: Dalewski, M. (Intern), Veselý, M. (Ekstern), Melikov, A. K. (Intern)
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HVAC systems in a field laboratory for indoor climate study

This paper presents the design of a HVAC system for a field lab. The design integrated mixing ventilation, displacement ventilation, low impulse vertical ventilation, personalized ventilation, natural ventilation, hybrid ventilation, active chilled beams, radiant ceiling and floor, and heat convectors. The field lab was designed for experimental research, education and demonstration of ventilation and air-conditioning principals with special focus on studying the impact of different air distribution and heating/cooling methods on human comfort and health. The system can also be used for testing under realistic conditions the performance of air processing units (e.g. a special air handling unit, an air cleaning devices, etc.) including their energy consumption and human response. The field lab can accommodate up to 50 occupants and supply 750 L/s of conditioned outdoor fresh air with the controlled room temperature in the range from 10 to 35 °C and relative humidity in the range from 15 to 80 %. The field lab can be used to test the performance of each system included in the field lab as well as the combined performance of two or more systems.

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Hvordan er det nu med de der luftstrømninger?
Impact of geometry of a sedentary occupant simulator on the generated thermal plume: Experimental investigation

The characteristics of the thermal plume generated by a sitting person were experimentally studied using four human body simulators with different complexities of geometry but equal surface area and heat generation: a vertical cylinder, a rectangular box, a dummy, and a thermal manikin. The experiments were performed in a climate chamber with an air temperature and mean radiant temperature of 23°C (73.4°F) and an upward airflow with a velocity of less than 0.05 m/s (0.164 ft/s). Distributions of air temperature excess and air speed were measured in the thermal plume 0.7 m (2.3 ft) above each of the simulators. The results show that the thermal plume generated by the dummy comprising head, torso, and legs has a similar shape of the cross-section and integral characteristics to the manikin plume; therefore, the dummy can successfully be used as a simulator of a sitting person. Simple shaped models of a sitting human without a clear indication of legs, such as a cylinder and a rectangular box, are not recommended for use. The plume of the cylinder is symmetrical and concentrated, while the plume above the rectangular box is sensitive to the surroundings and can have two maxima of air speed distribution.
Impact of personal factors and furniture arrangement on the thermal plume above a sitting occupant

The impact of thermal insulation and the design of clothing and chair, the blocking effect of a table and breathing on the thermal plume above a sitting thermal manikin was studied in a climate chamber. Air speed and temperature in the plume cross-section 0.7 m above the manikin head were measured. Results show that loose clothing increases the volume flux by 24%, changes the shape of the plume and thus should be carefully simulated. Tight clothing and chair design do not affect the plume volume flux and need not be considered in full-scale experiments. However, the convective part of the sensible heat loss increases with thermal insulation of a chair, and may be important in detailed CFD predictions. A wig on the manikin head appears to be important because a bald head decreases volume flux by 15%. Positioning the table tightly in front of the body affects air temperature and velocity distributions in the plume and increases volume flux by almost 50%. Exhaling through the mouth expands the plume, resulting in the integral characteristics being 40% greater and therefore should be considered in numerical simulations or experiments with thermal manikins, while exhaling through the nose can be disregarded. The volume flux of the thermal plume 0.7 m above the head of a sedentary occupant can be calculated with 25% uncertainty, using values for the convective heat loss equal to 30% of the sensible heat generated by
the body and the distance of the virtual plume origin equal to −1.60 m.

**General information**

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Organisations: Section for Indoor Environment, Department of Civil Engineering, Silesian University of Technology
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- Scopus rating (2011): SJR 1.144 SNIP 2.255 CiteScore 2.76
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- Scopus rating (2010): SJR 1.235 SNIP 2.001
- Web of Science (2010): Indexed yes
- BFI (2009): BFI-level 1
- Scopus rating (2009): SJR 1.028 SNIP 1.865
- Web of Science (2009): Indexed yes
- BFI (2008): BFI-level 1
- Scopus rating (2008): SJR 0.924 SNIP 1.38
- Web of Science (2008): Indexed yes
- Scopus rating (2007): SJR 0.788 SNIP 1.778
- Web of Science (2007): Indexed yes
- Scopus rating (2006): SJR 1.03 SNIP 1.63
- Scopus rating (2005): SJR 0.955 SNIP 1.225
- Web of Science (2005): Indexed yes
- Scopus rating (2004): SJR 0.548 SNIP 1.266
- Scopus rating (2003): SJR 0.948 SNIP 0.921
Impacts of a clay plaster on indoor air quality assessed using chemical and sensory measurements

Passive removal materials (PRMs) are building materials or furnishings that effectively control indoor pollution without substantial formation of chemical byproducts and without an energy penalty. Recent studies have suggested that clay might be an effective PRM for ozone. To assess clay wall plaster as a PRM for improving air quality by controlling ozone, perceived air quality (PAQ) was determined in the presence of eight combinations of an emitting and reactive pollutant source (new carpet), clay plaster applied to gypsum wallboard, and chamber air with and without ozone. A panel of 24 human subjects assessed air quality in twin 30m³ chambers using a continuous acceptability scale. Air samples were collected immediately prior to panel assessment to quantify concentrations of C5–C10 saturated n-aldehydes and two aromatic aldehydes that are commonly produced by reaction of ozone with carpet. Perceived air quality was most acceptable and concentrations of aldehydes were lowest when only clay plaster or both clay plaster and carpet were present in the chambers without ozone. The least acceptable PAQ and the highest concentrations of aldehydes were observed when carpet and ozone were present together; addition of clay plaster for this condition improved PAQ and considerably decreased aldehyde concentrations.

General information
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Organisations: Department of Civil Engineering, Section for Indoor Environment, University of Texas, Missouri University of Science and Technology
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Increasing demand for energy efficiency places new requirements on energy use in historic buildings. Efficient energy use is essential if a historic building is to be used and preserved, especially buildings with conventional uses such as residential buildings and offices. This paper presents results which combine energy auditing with building energy simulation and an indoor environment survey among the occupants of the building. Both when comparing simulations with measurements as well as with survey results good agreement was found. The two efficiency measures that are predicted to increase energy and thermal performance the most for this group of buildings were reduced infiltration and increasing heat-exchanger efficiency.

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Authors: Rohdin, P. (Ekstern), Dalewski, M. (Intern), Moshfegh, B. (Ekstern)
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Indoor Exposure to "Outdoor PM10" Assessing Its Influence on the Relationship Between PM10 and Short-term Mortality in US Cities

Background: Seasonal and regional differences have been reported for the increase in short-term mortality associated with a given increase in the concentration of outdoor particulate matter with an aerodynamic diameter smaller than 10 μm (PM10 mortality coefficient). Some of this difference may be because of seasonal and regional differences in indoor exposure to PM10 of outdoor origin. Methods: From a previous study, we obtained PM10 mortality coefficients for each season in seven U.S. regions. We then estimated the change in the sum of indoor and outdoor PM10 exposure per unit change in outdoor PM10 exposure (PM10 exposure coefficient) for each season in each region. This was originally accomplished by estimating PM10 exposure coefficients for 19 cities within the regions for which we had modeled building infiltration rates. We subsequently expanded the analysis to include 64 additional cities with less well-characterized building infiltration rates. Results: The correlation (r = 0.71 [95% confidence interval = 0.46 to 0.86]) between PM10 mortality coefficients and PM10 exposure coefficients (28 data pairs; four seasons in each of seven regions) was strong using exposure coefficients derived from the originally targeted 19 National Morbidity, Mortality, and Air Pollutants Study cities within the regions. The correlation remained strong (r = 0.67 [0.40 to 0.84]) when PM10 exposure coefficients were derived using 83 cities within the regions (the original 19 plus the additional 64). Conclusions: Seasonal and regional differences in PM10 mortality coefficients appear to partially reflect seasonal and regional differences in total PM10...
exposure per unit change in outdoor exposure.

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Organisations: Department of Civil Engineering, Section for Indoor Environment, Tsinghua University
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BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.889 SNIP 1.919 CiteScore 3.15
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.996 SNIP 1.953 CiteScore 3.28
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.759 SNIP 2.291 CiteScore 3.5
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.613 SNIP 2.046 CiteScore 3.36
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.382 SNIP 1.857 CiteScore 3.36
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.913 SNIP 1.767
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.232 SNIP 1.997
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 2.512 SNIP 2.015
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.284 SNIP 2.035
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 2.067 SNIP 1.991
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.811 SNIP 1.72
Scopus rating (2004): SJR 2.091 SNIP 1.851
Scopus rating (2003): SJR 1.928 SNIP 1.756
Scopus rating (2002): SJR 1.692 SNIP 1.666
Scopus rating (2001): SJR 1.821 SNIP 1.86
Scopus rating (2000): SJR 1.823 SNIP 1.823
Scopus rating (1999): SJR 1.672 SNIP 1.83
Original language: English
DOIs:
Influence of User Behaviour on Indoor Environmental Quality and Heating Energy Consumptions in Danish Dwellings

Models of occupants' interactions with heating controls based on measurements were implemented in a simulation program. Simulation results were given as probability distributions of energy consumption and indoor environmental quality depending on user behaviour. Heating set-point behaviour of 13 Danish dwellings were analysed by means of logistic regression to infer the probability of adjusting the set-point of TRVs. Three different models of occupant’s interactions with heating controls were obtained and implemented in a building simulation tool. They were used to investigate how different probabilistic user patterns influence indoor climate quality and energy consumptions. The aim was to compare the obtained results with an actual/deterministic use of the simulation program. Since comfort categories are related to users’ expectations and the users’ impact is crucial on determining the energy consumption, findings highlight the influence of comfort categories on energy consumption. The probabilistic methodology can be applied in all aspects of user interactions with building controls such as window openings, shading devices, etc. to achieve more realistic predictions of energy consumptions.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Politecnico di Torino
Authors: Fabi, V. (Ekstern), Andersen, R. K. (Intern), Corgnati, S. P. (Ekstern), Venezia, F. (Ekstern)
Number of pages: 8
Publication date: 2012
Main Research Area: Technical/natural sciences
Occupant Behaviour, Indoor Environmental Quality, Energy consumption

Bibliographical note
Topic 11. Computer tools and experimental techniques for assessment of building energy and built environments

Inhaled air quality with desk incorporated personalized ventilation (PV): parametric study

A workstation consisting of a desk with installed personalized ventilation (PV) and a dressed breathing thermal manikin simulating seated occupant was set in a full-scale test room. The room was conditioned by overhead ventilation at 26 oC. The PV consisted of two confluent jets incorporated along the front edge of the desk and supplying clean personalized air vertically towards the face of the manikin. The inner jet (closest to the body) delivered always clean outdoor air and the outer jet provided room air mixed with tracer gas (R134a) at the same flow rate as the inner jet. The breathing thermal manikin was seated with abdomen pressed against the table edge. The amount of clean air inhaled by the manikin was measured under numerous experiments studying different combinations of personalized airflow rates (isothermal) - 2, 4, 6, 8 and 10 L/s, widths of the two jets - 0.03 and 0.06 m, posture of the manikin - seated with the abdomen pressed against the table edge, moved backwards from or leaned over the table. The best performance was achieved with the 0.06 m openings: 85% of PV air was inhaled by the occupant at 10 L/s. The portion of clean PV air inhaled by the manikin was 80% when it was bent over the table, 76% when the manikin was seated upright and 45% when the manikin was moved backwards.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, University of Tokyo
Authors: Bolashikov, Z. D. (Intern), Nagano, H. (Ekstern), Melikov, A. K. (Intern), Kato, S. (Ekstern)
Number of pages: 6
Publication date: 2012
Main Research Area: Technical/natural sciences
Personalized ventilation, Control, Confluent jets, Air quality, Body posture
Electronic versions:
Inhaled_air_quality_Final.pdf

Intake to Production Ratio: A Measure of Exposure Intimacy for Manufactured Chemicals

BACKGROUND: Limited data are available to assess human exposure to thousands of chemicals currently in commerce. Information that relates human intake of a chemical to its production and use can help inform understanding of
mechanisms and pathways that control exposure and support efforts to protect public health. OBJECTIVES: We introduce the intake-to-production ratio (IPR) as an economy-wide quantitative indicator of the extent to which chemical production results in human exposure. METHODS: The IPR was evaluated as the ratio of two terms: aggregate rate of chemical uptake in a human population (inferred from urinary excretion data) divided by the rate that chemical is produced in or imported into that population’s economy. We used biomonitoring data from the U.S. Centers for Disease Control and Prevention along with chemical manufacturing data reported by the U.S. Environmental Protection Agency, as well as other published data, to estimate the IPR for nine chemicals in the United States. Results are reported in units of parts per million, where 1 ppm indicates 1 g of chemical uptake for every million grams of economy-wide use. RESULTS: Estimated IPR values for the studied compounds span many orders of magnitude from a low of 0.6 ppm for bisphenol A to a high of > 180,000 ppm for methyl paraben. Intermediate results were obtained for five phthalates and two chlorinated aromatic compounds: 120 ppm for butyl benzyl phthalate, 670 ppm for di(2-ethylhexyl) phthalate, 760 ppm for di(n-butyl) phthalate, 1,040 ppm for para-dichlorobenzene, 6,800 ppm for di(isobutyl) phthalate, 7,700 ppm for diethyl phthalate, and 8,000-24,000 ppm (range) for triclosan. CONCLUSION: The IPR is well suited as an aggregate metric of exposure intensity for characterizing population-level exposure to synthesized chemicals, particularly those that move fairly rapidly from manufacture to human intake and have relatively stable production and intake rates.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, University of California, Virginia Tech, U.S. Environmental Protection Agency
Authors: Nazaroff, W. (Ekstern), Weschler, C. J. (Intern), Little, J. C. (Ekstern), Hubal, E. A. C. (Ekstern)
Pages: 1678-1683
Publication date: 2012
Main Research Area: Technical/natural sciences

Publication information
Journal: Environmental Health Perspectives
Volume: 120
Issue number: 12
ISSN (Print): 0091-6765
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.62 SJR 3.067 SNIP 2.362
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 3.569 SNIP 2.363 CiteScore 5.58
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 3.244 SNIP 2.319 CiteScore 5.13
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 3.059 SNIP 2.354 CiteScore 4.92
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.949 SNIP 2.319 CiteScore 4.77
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 3.125 SNIP 2.314 CiteScore 4.56
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.744 SNIP 2.188
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.591 SNIP 2.209
Interzonal airflows in five Danish homes during two seasons

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Gustavsen, S. (Intern), Bekö, G. (Intern), Toftum, J. (Intern), Clausen, G. (Intern)
Number of pages: 2
Publication date: 2012
Main Research Area: Technical/natural sciences
Bibliographical note
Paper No.: 8A.7
Publication: Research - peer-review › Paper – Annual report year: 2012

Investigation of Subject perceptions of the Environment in Commercial kitchens

In a country such as the United States, the largest employee sector is in the restaurant industry. This makes the commercial kitchens an important space that needs to be evaluated and consequently improved in terms of thermal comfort and indoor air quality conditions, for the wellbeing of the employees. It is relevant to know how the employees assess the thermal conditions and what their subjective reactions in commercial kitchens are. The subjective feedback is the effective way, together with the physical measurements, of defining the values of thermal comfort parameters in commercial kitchens. Today, no study on subjective feedback from kitchen employees has been reported. In the present paper, two types of survey were developed and tested in the field. The questions are based on the ISO 10551 standard and adapted to the kitchen environment. Answers dealing with the working conditions and the environment in general, including some facts about the person (age, weight, height, etc.), and SBS symptoms, were recorded.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Simone, A. (Intern), Olesen, B. W. (Intern)
Number of pages: 6
Publication date: 2012
Main physical environmental drivers of occupant behaviour with regard to space heating energy demand

Several studies have highlighted the significant gap between the predicted energy performance of buildings and their measured actual performance. Uncertainties regarding behaviour of building occupants are one of the key factors limiting the ability of energy simulation tools to accurately predict real building energy requirements.

The paper focuses on the particular topics of space heating energy demand related to the occupants habits of adjusting heating set-points. The parameters influencing the user interaction with the heating control system are analyzed in literature for residential buildings, and the resulted influencing factors are illustrated.

Statistical analysis of data coming from measurement carried out in Danish dwellings are performed to infer the probability of adjusting the thermostatic radiators valves and to determine the relationship between the (indoor and outdoor) environmental conditions and the occupants’ heating set-point preferences. The paper aims at providing a reliable basis for a more accurate description of control action models in performance simulation applications.

Main physical environmental variables driving occupant behaviour with regard to natural ventilation

Energy consumption in buildings is influenced by building properties, building controls and the way that these are used by the occupants of the building.

This paper focuses on natural ventilation concerning the occupants’ habits of opening/closing the windows in residential buildings. Preeminent variables influencing the occupants’ use of windows are investigated and the main results of a literature review are highlighted. Statistical analysis of data coming from measurements of occupants’ window opening, conducted in 15 dwellings in Denmark, are developed to infer the probability of opening and closing windows and to determine relationships between environmental conditions and the occupants’ window opening behaviour. The main physical environmental variables that have been found to be important drivers in determining the action to open or close windows are defined on the basis of the measurements.

The ultimate goal is to provide more accurate information about driving forces related to the window opening and closing behaviour.
Model-based approach to account for the variation of primary VOC emissions over time in the identification of indoor VOC sources

The study objectives were to improve the understanding of the long-term variation of VOC emission chromatograms of building materials and to develop a method to account for this variation in the identification of individual sources of VOC emissions. This is of importance for the application of the source identification method since materials age over time in real indoor environments. The method is based on the mixed air sample measurements containing pollutants from multiple aged materials and the emission signatures of individual new materials determined by PTR-MS. Three emission decay source models were employed and evaluated for their ability to track the change of individual material emission signatures by PTR-MS over a nine-month period. Nine building material specimens were studied in a ventilated 50-L small-size chamber for their emissions individually for nine months, and also in combination later. Chamber exhaust air was sampled by PTR-MS to construct a temporal profile of emission signature unique to individual product type. The similar process was taken to measure mixture emissions from multiple materials, which is for applying and validating the developed method for source identification enhancement, considering the variation in long-term emission rates of individual VOCs. Results showed that the proposed approach could predict the emission signatures of individual building materials at a later time (9-month) with less than 6% difference variance, and hence indicated the potential of the source identification method for aged materials in real indoor environments.
Occupants' window opening behaviour: A literature review of factors influencing occupant behaviour and models

Energy consumption in buildings is influenced by several factors related to the building properties and the building controls, some of them highly connected to the behaviour of their occupants. In this paper, a definition of items referring to occupant behaviour related to the building control systems is proposed, based on studies presented in literature and a general process leading to the effects on energy consumptions is identified. Existing studies on the topic of window opening behaviour are highlighted and a theoretical framework to deal with occupants’ interactions with building controls, aimed at improving or maintaining the preferred indoor environmental conditions, is elaborated. This approach is used to look into the drivers for the actions taken by the occupants (windows opening and closing) and to investigate the existing models in literature of these actions for both residential and office buildings. The analysis of the literature highlights how a shared approach on identifying the driving forces for occupants' window opening and closing behaviour has not yet been reached. However, the reporting of variables found not to be drivers may reveal contradictions in the obtained results and may be a significant tool to help direct future research.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Politecnico di Torino
Authors: Fabi, V. (Ekstern), Andersen, R. K. (Intern), Corgnati, S. (Ekstern), Olesen, B. W. (Intern)
Pages: 188-198
Publication date: 2012
Main Research Area: Technical/natural sciences

Publication information
Quantitative relationships between occupant satisfaction and satisfaction aspects of indoor environmental quality and building design

The article examines which subjectively evaluated indoor environmental parameters and building features mostly affect occupants’ satisfaction in mainly US office buildings. The study analyzed data from a web-based survey administered to 52,980 occupants in 351 office buildings over 10 years by the Center for the Built Environment. The survey uses 7-point ordered scale questions pertaining to satisfaction with indoor environmental parameters, workspace, and building features. The average building occupant was satisfied with his/her workspace and building. Proportional odds ordinal logistic regression shows that satisfaction with all 15 parameters listed in the survey contributed significantly to overall workspace satisfaction. The most important parameters were satisfaction with amount of space (odds ratio OR 1.57, 95% CI: 1.55–1.59), noise level (OR 1.27, 95% CI: 1.25–1.29), and visual privacy (OR 1.26, 95% CI: 1.24–1.28). Satisfaction with amount of space was ranked to be most important for workspace satisfaction, regardless of age group (below 30, 31–50 or over 50 years old), gender, type of office (single or shared offices, or cubicles), distance of workspace from a window (within 4.6 m or further), or satisfaction level with workspace (satisfied or dissatisfied). Satisfaction with amount of space was not related to the gross amount of space available per person.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, University of California at Berkeley
Authors: Frontczak, M. J. (Intern), Schiavon, S. (Ekstern), Goins, J. (Ekstern), Arens, E. (Ekstern), Zhang, H. (Ekstern), Wargocki, P. (Intern)
Pages: 119-131
Publication date: 2012
Main Research Area: Technical/natural sciences

Publication information
Journal: Indoor Air
A questionnaire survey in Danish homes investigated the factors that influence occupants' comfort. The questionnaire contained questions on inhabitants' behaviour, their knowledge as regards building systems designed for controlling the indoor environment and the ways in which they achieve comfort. A total of 2499 questionnaires were sent to inhabitants of the most common types of housing in Denmark; 645 persons replied (response rate of 26%). The results show that the main indoor environmental parameters (visual, acoustic and thermal conditions, and air quality) are considered by occupants to be the most important parameters determining comfort. Manual control of the indoor environment was indicated by the respondents as highly preferred, and only in the case of temperature did they accept both manual and automatic control. The respondents indicated that they were confident about how the systems for controlling indoor environmental quality in their homes should be used. 54% of them reported to have had at least one problem related to the indoor environment at home. A majority of those respondents did not try to search for information on how to solve the problem. This may suggest that there is a need for increasing people's awareness regarding the consequences of a poor indoor environment on their health and for improving people's knowledge on how to ensure a good indoor climate.
Radiant Ceiling Panels Combined with Localized Methods for Improved Thermal Comfort of Both Patient and Medical Staff in Patient Room

The objectives were to identify whether ceiling installed radiant heating panels can provide thermal comfort to the occupants in a patient room, and to determine a method for optimal thermal environment to both patient and medical staff simultaneously. The experiments were performed in a climate chamber resembling a single-bed patient room under convective air conditioning alone or combined with the ceiling installed radiant heating panels. Two thermal manikins simulated a patient lying in the bed and a doctor standing next to the patient. Conventional cotton blanket, electric blanket, electric mattress were used to provide local heating for the patient. The effects of the methods were identified by comparing the manikin based equivalent temperatures. The optimal thermal comfort level for both patient and medical staff would obtained when two conventional cotton blankets were used with extra clothing for the patient, at room air temperature adjusted to be comfortable for the doctor.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Waseda Univeristy, Technical University of Denmark
Authors: Mori, S. (Ekstern), Barova, M. (Ekstern), Bolashikov, Z. D. (Intern), Melikov, A. K. (Intern), Tanabe, S. (Ekstern)
Number of pages: 6
Publication date: 2012

Host publication information
Title of host publication: Proceedings of 9th International Meeting for manikins and Modeling (9I3M)
Main Research Area: Technical/natural sciences
Conference: 9th International Meeting for Manikins and Modeling, Tokyo, Japan, 21/08/2012 - 21/08/2012
Hospital environment, local heating, radiant heating panels, thermal manikin, equivalent temperature
Electronic versions: 9I3M_Full_Paper_SakuraMORI.pdf
Source: PublicationPreSubmission
Source-ID: 102122382
Publication: Research - peer-review › Article in proceedings – Annual report year: 2012

Rapid Methods to Estimate Potential Exposure to Semivolatile Organic Compounds in the Indoor Environment

A systematic and efficient strategy is needed to assess and manage potential risks to human health that arise from the manufacture and use of thousands of chemicals. Among available tools for rapid assessment of large numbers of
chemicals, significant gaps are associated with the capability to evaluate exposures that occur indoors. For semivolatile organic compounds (SVOCs), exposure is strongly influenced by the types of products in which these SVOCs occur. We propose methods for obtaining screening-level estimates for two primary SVOC source classes: additives in products used indoors and ingredients in products sprayed or applied to interior surfaces. Accounting for product use, emission characteristics, and the properties of the SVOCs, we estimate exposure via inhalation of SVOCs in the gas-phase, inhalation of SVOCs sorbed to airborne particles, ingestion of SVOCs sorbed to dust, and dermal sorption of SVOCs from the air into the blood. We also evaluate how exposure to the general public will change if chemical substitutions are made. Further development of a comprehensive set of models including the other SVOC-containing products and the other SVOC exposure pathways, together with appropriate methods for estimating or measuring the key parameters (in particular, the gas-phase concentration in equilibrium with the material-phase concentration of the SVOC in the product, or y0), is needed. When combined with rapid toxicity estimates, screening-level exposure estimates can contribute to health-risk-based prioritization of a wide range of chemicals of concern.

**General information**

State: Published  
Organisations: Department of Civil Engineering, Section for Indoor Environment, Department of Mechanical Engineering, Virginia Tech, University of California, U.S. Environmental Protection Agency  
Authors: Little, J. C. (Ekstern), Weschler, C. J. (Intern), Nazaroff, W. W. (Ekstern), Liu, Z. (Ekstern), Cohen Hubal, E. A. (Ekstern)  
Pages: 11171-11178  
Publication date: 2012  
Main Research Area: Technical/natural sciences

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BFI (2018): BFI-level 2  
Web of Science (2018): Indexed yes  
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Web of Science (2017): Indexed yes  
BFI (2016): BFI-level 2  
Scopus rating (2016): CiteScore 6.26 SJR 2.538 SNIP 1.889  
Web of Science (2016): Indexed yes  
BFI (2015): BFI-level 2  
Scopus rating (2015): SJR 2.584 SNIP 1.828 CiteScore 5.61  
Web of Science (2015): Indexed yes  
BFI (2014): BFI-level 2  
Scopus rating (2014): SJR 2.777 SNIP 2.017 CiteScore 5.5  
Web of Science (2014): Indexed yes  
BFI (2013): BFI-level 2  
Scopus rating (2013): SJR 2.956 SNIP 2.103 CiteScore 5.52  
ISI indexed (2013): ISI indexed yes  
Web of Science (2013): Indexed yes  
BFI (2012): BFI-level 2  
Scopus rating (2012): SJR 3.146 SNIP 2.056 CiteScore 5.17  
ISI indexed (2012): ISI indexed yes  
Web of Science (2012): Indexed yes  
BFI (2011): BFI-level 2  
Scopus rating (2011): SJR 3.178 SNIP 1.953 CiteScore 5.16  
ISI indexed (2011): ISI indexed yes  
Web of Science (2011): Indexed yes  
BFI (2010): BFI-level 2  
Scopus rating (2010): SJR 2.964 SNIP 1.729  
Web of Science (2010): Indexed yes  
BFI (2009): BFI-level 2  
Scopus rating (2009): SJR 2.835 SNIP 1.803
Reduced exposure to coughed air by a novel ventilation method for hospital patient rooms

A novel hospital bed integrated ventilation and cleaning unit (HBIVCU) for local airflow control and cleansing, limiting the airborne spread of contagious air coughed from a sick patient in a hospital room, was developed. The performance efficiency of the unit, to successfully reduce occupants' exposure to coughed air, was studied in a full-scale, two-bed hospital room mock-up, 4.65 m x 4.65 m x 2.60 m (W x L x H), with two patients and a doctor. Four units were placed along the two sides of both beds close to the head. The room was ventilated by overhead mixing air distribution at 22 °C room air temperature. The sick coughing patient was simulated by a heated dummy with simplified geometry equipped with a cough generator. Similar heated dummy was used for the second patient. A dressed breathing thermal manikin with realistic human body and surface temperature was used to mimic a doctor standing beside the bed and facing the coughing patient. The generated cough consisted of 100% CO$_2$. The mouth was simulated by a circular opening of 0.021 m diameter. The characteristics of the cough were: peak flow - 10 L/s, cough volume - 2.5 L, duration - 0.5 s and maximum velocity - 28.9 m/s. The performance of the novel unit, at background ventilation rates of 3 h$^{-1}$ and 6 h$^{-1}$, was evaluated by measuring the excess CO$_2$ concentration at the mouth of both the doctor and the exposed patient. When the novel method was not used, the CO$_2$ concentration (exposure) measured in the air “inhaled” by the doctor exceeded 20 times the background CO$_2$ level and more than 12 times for the exposed patient. No increase in the CO$_2$ concentration in inhalation was measured for either the doctor or the second patient, when the HBIVCUs were operational.
Satisfaction and self-estimated performance in relation to indoor environmental parameters and building features

The paper examines how satisfaction with indoor environmental parameters and building features affects satisfaction and self-estimated job performance. The analyses used subjective responses from around 50,000 occupants collected mainly in US office buildings using a web-based survey administered by the Center for the Built Environment (CBE) over the period of ten years. Overall satisfaction with the workspace significantly improved self-estimated job performance; increased satisfaction with temperature was estimated to provide the greatest improvement in self-estimated job performance, followed by increase in satisfaction with noise and air quality. The improvement of building features such as amount of space, visual privacy and noise level offered the highest chance to improve satisfaction with workspace. The study implies that it should be carefully considered how investments to upgrade indoor environmental quality and building design are used, and that they should consider whether comfort or working morale are expected to be improved.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, University of California
Authors: Wargocki, P. (Intern), Frontczak, M. (Intern), Schiavon, S. (Ekstern), Goins, J. (Ekstern), Arens, E. (Ekstern), Zhang, H. (Ekstern)
Publication date: 2012

Host publication information
Title of host publication: 10th International Conference on Healthy Buildings 2012
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ISBN (Print): 9781627480758
Main Research Area: Technical/natural sciences
Conference: 10th International Conference on Healthy Buildings, Brisbane, Australia, 08/07/2012 - 08/07/2012
Air quality, Architectural design, Office buildings, Parameter estimation
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Source: dtu
Source-ID: n::oai:DTIC-ART:compendex/391960729::31905
Publication: Research - peer-review › Article in proceedings – Annual report year: 2013

Seasonal Variations of Indoor Microbial Exposures and Their Relation to Temperature, Relative Humidity, and Air Exchange Rate

Indoor microbial exposure has been related to adverse pulmonary health effects. Exposure assessment is not standardized, and various factors may affect the measured exposure. The aim of this study was to investigate the seasonal variation of selected microbial exposures and their associations with temperature, relative humidity, and air exchange rates in Danish homes. Airborne inhalable dust was sampled in five Danish homes throughout the four seasons of 1 year (indoors, n = 127; outdoors, n = 37). Measurements included culturable fungi and bacteria, endotoxin, N-acetyl-beta-d-glucosaminidase, total inflammatory potential, particles (0.75 to 15 μm), temperature, relative humidity, and air exchange rates. Significant seasonal variation was found for all indoor microbial exposures, excluding endotoxin. Indoor fungi peaked in summer (median, 235 CFU/m³) and were lowest in winter (median, 26 CFU/m³). Indoor bacteria peaked in spring (median, 2,165 CFU/m³) and were lowest in summer (median, 240 CFU/m³). Concentrations of fungi were predominately higher outdoors than indoors, whereas bacteria, endotoxin, and inhalable dust concentrations were highest indoors. Bacteria and endotoxin correlated with the mass of inhalable dust and number of particles. Temperature and air exchange rates were positively associated with fungi and N-acetyl-beta-d-glucosaminidase and negatively with bacteria and the total inflammatory potential. Although temperature, relative humidity, and air exchange rates were significantly associated with several indoor microbial exposures, they could not fully explain the observed seasonal variations when tested in a mixed statistical model. In conclusion, the season significantly affects indoor microbial exposures, which are influenced by temperature, relative humidity, and air exchange rates.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, National Research Center for Working Environment, University of Copenhagen
Pages: 8289-8297
Publication date: 2012
Main Research Area: Technical/natural sciences
Seat headrest-incorporated personalized ventilation: Thermal comfort and inhaled air quality

The performance of personalized ventilation with seat headrest-mounted air supply terminal devices (ATD), named seat headrest personalized ventilation (SHPV), was studied. Physical measurements using a breathing thermal manikin were taken to identify its ability to provide clean air to inhalation depending on design, shape, size and positioning of the ATD, flow rate and temperature of personalized air, room temperature, clothing thermal insulation of the manikin, etc. Tracer gas was mixed with the room air. The air supplied by the SHPV was free of tracer gas. Tracer gas concentration in the air inhaled by the manikin was measured and used to assess the clean air supply efficiency of the SHPV. The response of 35 subjects was collected to examine thermal comfort with the SHPV. The subjects participated in 3 experiments at personalized air temperature and room air temperature of 22/20 °C, 23/23 °C and 26/26 °C, respectively. Questionnaires were used to collect human responses. Personal exposure effectiveness (the portion of the clean personalized air in inhalation) of up to 99% was measured during the manikin experiments. The results suggest a dramatic improvement of inhaled air quality and a decreased risk of airborne cross-infection when SHPV is used. Subjects assessed the air movement and the cooling provided by the SHPV as acceptable. Acceptability was unchanged over in time and increased with the increase of the air temperature. No draught was reported. The SHPV can be used in spaces where occupants are seated most of the time, e.g. theatres, vehicle compartments, etc. © 2011.
Simulation and optimisation of a ground source heat pump with different ground heat exchanger configurations for a single-family residential house

In the future there will be an increased demand for energy efficient cooling of residential buildings. Therefore it is essential to develop cooling concepts that are passive and/or using very little primary energy. A possible solution is a ground source heat pump combined with a low-temperature heating and high-temperature cooling system. The present work evaluates the performance in relation to thermal comfort and energy consumption of a GSHP with different GHE concepts. The different configurations are analyzed being part of the energy supply system of a low-energy residential house, replicated for the climatic location of Copenhagen, Denmark. The study results show no significant difference in systems' COP values during the heating season. During the cooling season the systems with VGHEs and sub-slab GHEs have shown up to 50% higher COP values, compared to systems with HGHEs. For the studied geographical location, passive cooling by bypassing the heat pump and using only the ground heat exchanger can provide acceptable room temperatures.

General information

State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Pavlov, G. K. (Intern), Olesen, B. W. (Intern)
Number of pages: 6
Pages: 2119-2124
Publication date: 2012
Simulation of indoor environment in low energy housing

The aim of this study was to assess whether low energy consumption in dwellings imposes problems by deteriorating the indoor environment. Several indoor environment parameters were correlated with the energy consumption of low energy houses. One house from a village of low energy houses in Denmark was selected and sensitivity analyses were conducted for the importance of occupancy, ventilation, window opening, and heat recovery efficiency. In particular occupancy and venting played significant roles for the indoor environment and energy consumption. It was also shown that with passive measures, but also with the installation of a chiller, a comfortable thermal indoor environment could be achieved with only a minor increase in the energy consumption.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Uponor GmbH, Aalborg University
Authors: Vagiannis, G. (Ekstern), Knudsen, H. N. (Ekstern), Toftum, J. (Intern), Clausen, G. (Intern)
Number of pages: 6
Publication date: 2012
Main Research Area: Technical/natural sciences
Architecture and design, Building controls and automation, Energy performance, HVAC systems, Occupant/user control
Electronic versions: 9E.2.pdf

Subjective evaluation of different ventilation concepts combined with radiant heating and cooling

Sixteen subjects evaluated the indoor environment in four experiments with different combinations of ventilation and radiant heating/cooling systems. Two test setups simulated a room in a low energy building with a single occupant during winter. The room was equipped either by a ventilation system supplying warm air space heating or by a combination of radiant floor heating and mixing ventilation system. Next two test setups simulated an office room with two occupants during summer, ventilated and cooled by a single displacement ventilation system or by a radiant floor cooling combined with displacement ventilation. Vertical air temperature distribution was more uniform for floor heating than for warm air heating, but there was no significant difference in thermal perception between the two mixing ventilation systems. For the summer conditions the subjects voted warmer than predicted by the PMV and about one third preferred more air movement. No significant difference in thermal perception between the two displacement ventilation systems was found.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Krajoik, M. (Intern), Tomasi, R. (Intern), Simone, A. (Intern), Olesen, B. W. (Intern)
Number of pages: 6
Publication date: 2012
Subjective study of thermal acceptability of novel enhanced displacement ventilation system and implication of occupants' personal control

A novel air distribution principle of cooler air near the floor level being propelled upward via four fans mounted at each corner of a chair was developed to enhance the performance of conventional displacement ventilation (DV) system. Experiments were conducted in a well-controlled climate chamber with DV and constant heat load at different supply air temperatures, namely 20, 22, and 24 °C and room air temperatures, 22, 24, and 26 °C. Subjective assessments were carried out with 32 tropically-acclimatized college students who were given the choice to adjust the fan speed. Subjects’ thermal comfort and the implication of personal usage pattern of the enhanced DV system were studied. The results revealed that at the ambient temperature of 26 °C, subjects preferred higher air movement and were satisfied with the cooling provided by the fans. However, the subjects felt cooler at the waists at room air temperatures of 22 and 24 °C when the fans were in operation. It was also found that the Whole Body Thermal Sensation (WBTS) reported by the subjects was correlated with the Local Thermal Sensation (LTS) at the waist, the arms, the calf and the feet when the novel DV system was employed. An expression which allows predicting WBTS based on the LTS was developed. Recommendations for fan speed at different room air temperatures were derived.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Technical University of Denmark, National University of Singapore
Authors: Sun, W. (Ekstern), Cheong, K. (Ekstern), Melikov, A. K. (Intern)
Pages: 49-57
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BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.51 SJR 2.015 SNIP 2.198
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 2.093 SNIP 2.49 CiteScore 4.37
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.938 SNIP 2.797 CiteScore 4.14
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.581 SNIP 2.602 CiteScore 3.57
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.331 SNIP 2.875 CiteScore 3.06
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.144 SNIP 2.255 CiteScore 2.76
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.235 SNIP 2.001
Web of Science (2010): Indexed yes
Experimental evaluation is one of the means that allow thorough investigation of the indoor environment in a room. Providing that the measurement procedures are correct and that the investigator has the necessary experimental equipment available, experimental measurements can provide results with high accuracy and under well defined boundary conditions, which can be further verified by field measurements or used for validation of a computer simulation. A set of experimental studies of air distribution, ventilation effectiveness and thermal environment were carried out in a simulated room heated/cooled and ventilated by different concepts, at various boundary conditions, differing in supply air temperature, floor temperature, simulated heat gain/heat loss, nominal air change rate and positions of air terminal devices. The experimental room simulated corresponds to a residential room or a single office room located in a low-energy building. Procedures and indicators that can be successfully used for experimental investigations of indoor environment are described and a sample of measured data is reported.
SVOC exposure indoors: fresh look at dermal pathways

Abstract This paper critically examines indoor exposure to semivolatile organic compounds (SVOCs) via dermal pathways. First, it demonstrates that - in central tendency - an SVOC's abundance on indoor surfaces and in handwipes can be predicted reasonably well from gas-phase concentrations, assuming that thermodynamic equilibrium prevails. Then, equations are developed, based upon idealized mass-transport considerations, to estimate transdermal penetration of an SVOC either from its concentration in skin-surface lipids or its concentration in air. Kinetic constraints limit air-to-skin transport in the case of SVOCs that strongly sorb to skin-surface lipids. Air-to-skin transdermal uptake is estimated to be comparable to or larger than inhalation intake for many SVOCs of current or potential interest indoors, including butylated hydroxytoluene, chlordane, chlorpyrifos, diethyl phthalate, Galaxolide, geranyl acetone, nicotine (in free-base form), PCB28, PCB52, Phantolide, Texanol and Tonalide. Although air-to-skin transdermal uptake is anticipated to be slow for bisphenol A, we find that transdermal permeation may nonetheless be substantial following its transfer to skin via contact with contaminated surfaces. The paper concludes with explorations of the influence of particles and dust on dermal exposure, the role of clothing and bedding as transport vectors, and the potential significance of hair follicles as transport shunts through the epidermis. PRACTICAL IMPLICATIONS: Human exposure to indoor pollutants can occur through dietary and nondietary ingestion, inhalation, and dermal absorption. Many factors influence the relative importance of these pathways, including physical and chemical properties of the pollutants. This paper argues that exposure to indoor semivolatile organic compounds (SVOCs) through the dermal pathway has often been underestimated. Transdermal permeation of SVOCs can be substantially greater than is commonly assumed. Transport of SVOCs from the air to and through the skin is typically not taken into account in exposure assessments. Yet, for certain SVOCs, intake through skin is estimated to be substantially larger than intake through inhalation. Exposure scientists, risk assessors, and public health officials should be mindful of the dermal pathway when estimating exposures to indoor SVOCs. Also, they should recognize that health consequences vary with exposure pathway. For example, an SVOC that enters the blood through the skin does not encounter the same detoxifying enzymes that an ingested SVOC would experience in the stomach, intestines, and liver before it enters the blood.
The adjuvant effect of phthalate exposure on IgE sensitisation in early childhood

Background: Dust phthalate concentrations have previously been shown to be weakly associated with parentally reported allergic diseases, but the validity of the results have been questioned. Our aims were to investigate the association between phthalate diester exposure from two environments and IgE sensitization in children.

Method: A cross-sectional case-cohort study (n = 500) based on 2835 children, aged 3–5 years, responding to a questionnaire in the Danish Indoor Environment and Children’s Health study consisted of 300 subjects randomly selected and 200 cases with at least two parentally reported doctor diagnosed allergic diseases (asthma, allergic rhinoconjunctivitis or atopic dermatitis). The same physician conducted a clinical examination of all the 500 children including a structured interview on allergic heredity, clinical and medical history Specific serum-IgE against inhalant and food allergens was
determined. Samples of settled dust were collected from the children's bedroom and daycare center for analyses of five phthalates (DEP, DnBP, DiBP, BBzP & DEHP). Phthalate intakes through three different exposure routes were calculated. The diagnosis of allergic disease was based on internationally accepted criteria.

Result: In the group of randomly selected children IgE sensitization was associated with the total phthalate exposure (P < 0.05) with adjusted OR’s = 3.26. There was a clear dose-response relationship between total phthalate exposure in the homes and IgE sensitization in children with asthma, allergic rhinoconjunctivitis or atopic dermatitis (P < 0.05, aOR = 2.59) and DEHP exposure (P < 0.05, aOR = 3.45). IgE sensitization in children with asthma was associated with DnBP exposure (P < 0.05). IgE sensitization in the cases were associated (P < 0.05) with DnBP and BBzP exposure in the daycare centers, while analysis for the allergic diseases separately demonstrated an association with DEP, DnBP, DiBP and BBzP (P < 0.05). The association between IgE sensitization and DEP, DnBP, DiBP and BBzP was also found in the calculated phthalate intakes from the different exposure pathways, particularly in asthma (aOR > 18).

Conclusion: We found significant associations between IgE sensitization and both phthalate dust concentrations and calculated phthalate intakes. Such an association has previously been indicated in animal studies, but this is the first demonstration of such an association in human studies.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Odense University Hospital, University of Southern Denmark, Karlstad University, Aarhus University
Authors: Callesen, M. (Forskerdatabase), Weschler, C. J. (Intern), Jensen, T. (Ekstern), Clausen, G. (Intern), Toftum, J. (Intern), Bekö, G. (Intern), Bornehag, C. (Ekstern), Sigsgaard, T. (Forskerdatabase), Høst, A. (Ekstern)
Pages: 654-655
Publication date: 2012
Conference: 31st Congress of the European Academy of Allergy and Clinical Immunology, Geneva, Switzerland, 16/06/2012 - 16/06/2012
Main Research Area: Technical/natural sciences

Publication information
Journal: Allergy: European Journal of Allergy and Clinical Immunology
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BFI (2018): BFI-level 1
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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 6.23 SJR 2.724 SNIP 2.475
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 3.13 SNIP 2.127 CiteScore 5.73
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 2.464 SNIP 2.121 CiteScore 5.51
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 2.195 SNIP 1.902 CiteScore 4.91
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 2.008 SNIP 1.818 CiteScore 4.81
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 2.328 SNIP 1.781 CiteScore 4.89
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.826 SNIP 1.845
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.681 SNIP 0.958
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.433 SNIP 1.937
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.374 SNIP 1.862
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.523 SNIP 2.691
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.895 SNIP 1.651
Scopus rating (2004): SJR 0.771 SNIP 1.896
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.551 SNIP 1.107
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.672 SNIP 0.627
Scopus rating (2001): SJR 0.624 SNIP 0.489
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 0.714 SNIP 0.428
Scopus rating (1999): SJR 0.513 SNIP 0.28
Original language: English

Bibliographical note
Abstract 1749
Source: dtu
Source-ID: n:oai:DTIC-ART:isi/375979325::22134
Publication: Research - peer-review › Conference abstract in journal – Annual report year: 2012

The impact of a photocatalytic paint on indoor air pollutants: Sensory assessments
The ability of a commercial photocatalytically active cement-based paint to improve the perceived air quality was evaluated. The paint was applied to pieces of gypsum board with a total surface area of 13 m² (23% of the total wall surface). To initiate the photocatalytic activity, the paint was illuminated by bulbs emitting visible/UV light. A mixture of common indoor pollutants, including emissions from chipboard, linoleum and carpet, as well as human bioeffluents and isopropanol, were used to test the efficacy of the paint. A sensory panel of 35 subjects assessed the air quality in the test-room once before and twice after a step-change in the room condition (i.e., either a change in the sensory pollution load or the illumination of the paint). Illumination of the paint in the room polluted with building materials significantly decreased the acceptability of the air quality at both 40% (p < 0.01) and 95% (p < 0.05) of the final steady-state condition. Introduction of bioeffluents significantly affected the perceived air quality only shortly after the step-change (40% steady-state); with non-illuminated paint the acceptability decreased; with illuminated paint the acceptability increased. Emission of isopropanol at 1 cm³/h had no effect on the perceived air quality (both with and without illumination).

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Kolarik, J. (Intern), Toftum, J. (Intern)
Pages: 396-402
Publication date: 2012
Main Research Area: Technical/natural sciences

Publication information
Journal: Building and Environment
Volume: 57
ISSN (Print): 0360-1323
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
The influence of local effects on thermal sensation under non-uniform environmental conditions — Gender differences in thermophysiology, thermal comfort and productivity during convective and radiant cooling
Applying high temperature cooling concepts, i.e. high temperature cooling ($T_{\text{supply}}$ is 16–20°C) HVAC systems, in the built environment allows the reduction in the use of (high quality) energy. However, application of high temperature cooling systems can result in whole body and local discomfort of the occupants. Non-uniform thermal conditions, which may occur due to application of high temperature cooling systems, can be responsible for discomfort. Contradictions in literature exist regarding the validity of the often used predicted mean vote (PMV) index for both genders, and the index is not intended for evaluating the discomfort due to non-uniform environmental conditions. In some cases, however, combinations of local and general discomfort factors, for example draught under warm conditions, may not be uncomfortable. The objective of this study was to investigate gender differences in thermophysiology, thermal comfort and productivity in response to thermal non-uniform environmental conditions. Twenty healthy subjects (10 males and 10 females, age 20–29 years) were exposed to two different experimental conditions: a convective cooling situation (CC) and a radiant cooling situation (RC). During the experiments physiological responses, thermal comfort and productivity were measured. The results show that under both experimental conditions the actual mean thermal sensation votes significantly differ from the PMV-index; the subjects are feeling colder than predicted. Furthermore, the females are more uncomfortable and dissatisfied compared to the males. For females, the local sensations and skin temperatures of the extremities have a significant influence on whole body thermal sensation and are therefore important to consider under non-uniform environmental conditions.

**General information**

- **State**: Published
- **Organisations**: Department of Civil Engineering, Section for Indoor Environment, Eindhoven University of Technology, Maastricht University
- **Authors**: Schellen, L. (Ekstern), Loomans, M. (Ekstern), de Wit, M. (Ekstern), Olesen, B. (Intern), Lichtenbelt, W. V. M. (Ekstern)
- **Pages**: 252-261
- **Publication date**: 2012
- **Main Research Area**: Technical/natural sciences

**Publication information**

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- **Volume**: 107
- **Issue number**: 2
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- **Ratings**:  
  - BFI (2018): BFI-level 1
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  - Web of Science (2017): Indexed Yes
  - BFI (2016): BFI-level 1
  - Scopus rating (2016): CiteScore 2.53 SJR 1.05 SNIP 0.856
  - Web of Science (2016): Indexed yes
  - BFI (2015): BFI-level 1
  - Scopus rating (2015): SJR 1.286 SNIP 1.006 CiteScore 2.92
  - Web of Science (2015): Indexed yes
  - BFI (2014): BFI-level 1
  - Scopus rating (2014): SJR 1.489 SNIP 1.081 CiteScore 3.17
  - BFI (2013): BFI-level 1
  - Scopus rating (2013): SJR 1.473 SNIP 1.107 CiteScore 3.29
  - ISI indexed (2013): ISI indexed yes
  - Web of Science (2013): Indexed yes
  - BFI (2012): BFI-level 1
  - Scopus rating (2012): SJR 1.287 SNIP 1.046 CiteScore 3.25
  - ISI indexed (2012): ISI indexed yes
  - Web of Science (2012): Indexed yes
  - BFI (2011): BFI-level 1
  - Scopus rating (2011): SJR 1.227 SNIP 1.039 CiteScore 3.23
  - ISI indexed (2011): ISI indexed yes
  - Web of Science (2011): Indexed yes
  - BFI (2010): BFI-level 1
  - Scopus rating (2010): SJR 1.271 SNIP 1.051
  - BFI (2009): BFI-level 1

ISI indexed (2013): ISI indexed yes
Scopus rating (2009): SJR 1.399 SNIP 1.184
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.283 SNIP 1.046
Scopus rating (2007): SJR 1.162 SNIP 1.033
Scopus rating (2006): SJR 1.094 SNIP 1.055
Scopus rating (2005): SJR 1.045 SNIP 0.922
Scopus rating (2004): SJR 1.066 SNIP 1.006
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.898 SNIP 0.833
Scopus rating (2002): SJR 0.725 SNIP 0.744
Scopus rating (2001): SJR 0.567 SNIP 0.746
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 0.606 SNIP 0.763
Scopus rating (1999): SJR 0.673 SNIP 0.771
Original language: English
Non-uniform environmental conditions, Thermal comfort, Physiology, Productivity, Gender differences, Cooling
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Publication: Research - peer-review › Journal article – Annual report year: 2012

The influence of occupants' behaviour on energy consumption investigated in 290 identical dwellings and in 35 apartments

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Andersen, R. K. (Intern)
Number of pages: 2
Publication date: 2012
Event: Abstract from 10th International Conference on Healthy Buildings, Brisbane, Australia.
Main Research Area: Technical/natural sciences
Electronic versions:
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Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2012

The response rate in postal epidemiological studies in the context of national cultural behaviour

The purpose of this study was to analyse the effect of national cultural differences on the response rate, obtained in questionnaire based epidemiological studies on allergy and asthma, performed in Sweden (DBH) and Bulgaria (ALLHOME). The two studies used one and the same methodology, but the obtained response rate was different: 78.8% in DBH and 34.5% in ALLHOME. The differences in the obtained response rate and the reasons for these differences were analyzed on the basis of the Hofstede’s cultural dimensions’ indexes, which clearly show the distinction in the national cultural behaviour of people in Sweden and Bulgaria. It was found that national culture could strongly influence the response behaviour of people in epidemiological studies and Hofstede’s indexes can be useful tool when designing and performing epidemiological studies, and in particular – questionnaire surveys.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Technical University of Sofia, ALECTIA A/S, Swedish National Testing and Research Institute, Alexander's University Hospital, Karlstad University
Authors: Angelova, R. A. (Ekstern), Naydenov, K. (Ekstern), Hägerhed-Engman, L. (Ekstern), Melikov, A. K. (Intern), Popov, T. A. (Ekstern), Stankov, P. (Ekstern), Bornehag, C. (Ekstern)
Number of pages: 6
Publication date: 2012

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Thermal and Air Quality Acceptability in Buildings that Reduce Energy by Reducing Minimum Airflow from Overhead Diffusers

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, University of California, Taylor Engineering, Price Industries
Authors: Arens, E. (Ekstern), Zhang, H. (Ekstern), Hoyt, T. (Ekstern), Kaam, S. (Ekstern), Goins, J. (Ekstern), Baumann, F. (Ekstern), Zhai, Y. (Ekstern), Webster, T. (Ekstern), West, B. (Ekstern), Paliaga, G. (Ekstern), Stein, J. (Ekstern), Seidl, R. (Ekstern), Tully, B. (Ekstern), Rimmer, J. (Ekstern), Toftum, J. (Intern)
Number of pages: 158
Publication date: 2012

Thermal energy storage - A review of concepts and systems for heating and cooling applications in buildings: Part 1 - Seasonal storage in the ground
The use of thermal energy storage (TES) in buildings in combination with space heating and/or space cooling has recently received much attention. A variety of TES techniques have developed over the past decades. TES systems can provide short-term storage for peak-load shaving as well as long-term (seasonal) storage for the introduction of natural and renewable energy sources. TES systems for heating or cooling are utilized in applications where there is a time mismatch between the demand and the most economically favorable supply of energy. The selection of a TES system mainly depends on the storage period required, economic viability, and operating conditions. One of the main issues impeding the utilization of the full potential of natural and renewable energy sources, e.g., solar and geothermal, for space heating and space cooling applications is the development of economically competitive and reliable means for seasonal storage of thermal energy. This is particularly true at locations where seasonal variations of solar radiation are significant and/or in climates where seasonally varying space heating and cooling loads dominate energy consumption. This article conducts a literature review of different seasonal thermal energy storage concepts in the ground. The aim is to provide the basis for development of new intelligent TES possibilities in buildings.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Pavlov, G. K. (Intern), Olesen, B. W. (Intern)
Pages: 515-538
Publication date: 2012
Main Research Area: Technical/natural sciences
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BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.01
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.514 SNIP 0.731
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.561 SNIP 0.891
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.544 SNIP 1.104
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.498 SNIP 0.742
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.93 SNIP 0.956
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.614 SNIP 1.187
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.791 SNIP 0.903
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.677 SNIP 1.639
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.843 SNIP 1.29
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.4 SNIP 1.26
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.054 SNIP 2.001
Scopus rating (2003): SJR 1.055 SNIP 1.28
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.917 SNIP 1.739
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.637 SNIP 2.271
Scopus rating (2000): SJR 0.67 SNIP 2.027
Scopus rating (1999): SJR 0.357 SNIP 0.753
Original language: English
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Source: dtu
Source-ID: n:oai:DTIC-ART:isi/366266444::17612
Publication: Research - peer-review › Journal article – Annual report year: 2012
Thermal Environment evaluation in Commercial kitchens: Procedure of data collection
The indoor climate in commercial kitchens is often unsatisfactory and the working conditions can have a significant effect on employees’ comfort and productivity. The type (fast food, casual, etc.) and climatic zone can influence the thermal conditions in the kitchens. Moreover, size and arrangement of the kitchen zones, appliances, etc., complicate further an evaluation of the indoor thermal environment in kitchens. In general, comfort criteria are expressed in international standards such as ASHRAE 55 or ISO EN7730. But are these standardised methods applicable for such environments as commercial kitchens? There is therefore a need to study the indoor environment in commercial kitchens and to establish standardized methods and procedures for setting criteria that have to be met for the design and operation of kitchens. The present paper introduces a data collection protocol based on physical and subjective parameters. Measurements showed weak and strong points of the procedure in order to evaluate the thermal comfort environment in commercial kitchens and its acceptability.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Simone, A. (Intern), Olesen, B. W. (Intern)
Number of pages: 6
Publication date: 2012

Thermo Active Building Systems Using Building Mass To Heat and Cool
Using the thermal storage capacity of the concrete slabs between each floor in multistory buildings to heat or cool is a trend that began in the early 1990s in Switzerland.1,2 Pipes carrying water for heating and cooling are embedded in the center of the concrete slab. In central Europe (Germany, Austria, Netherlands, etc.), this type of system has been installed in a significant number of new office buildings since the late 1990s. The trend is spreading to other parts of the world (the rest of Europe, North America and Asia).

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Indoor Environment
Authors: Olesen, B. W. (Intern)
Pages: 44-52
Publication date: 2012
Main Research Area: Technical/natural sciences
Use of CO₂ feedback as a retrofit solution for improving air quality in naturally ventilated classrooms
Carbon dioxide (CO₂) sensors that provide a green/yellow/red visual indication were installed in pairs of naturally ventilated classrooms during normal school operation. During a two-week period in the heating and the cooling season, teachers and students were instructed to open the windows in response to the CO₂ feedback in one week and open them as they would normally do, without feedback, in the other week. In the cooling season, two pairs of classrooms were monitored, one pair with split cooling in operation and the other pair with no cooling. The resulting indoor environmental conditions in these classrooms and window opening behaviour were monitored. Children also reported their perceptions and symptoms. Resulting energy use was measured and used to estimate annual energy use. Providing CO₂ feedback reduced CO₂ levels. More windows were opened in this condition, and this increased energy use for heating and reduced the cooling requirement. Split-cooling reduced the frequency of window opening when no CO₂ feedback was present, suggesting that classroom temperature is the driving factor for this behavioural response. Children liked CO₂ feedback; their perceptions and symptoms were somewhat improved with CO₂ feedback, although many of these changes did not reach formal statistical significance.
Use of local convective and radiant cooling at warm environment

Use of local convective and radiant cooling at warm environment: effect on thermal comfort and perceived air quality

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Technical University of Denmark, Shinshu University, Silesian University of Technology
Authors: Melikov, A. K. (Intern), Krejcirikova, B. (Intern), Kaczmarczyk, J. (Ekstern), Duszyk, M. (Ekstern), Sakoi, T. (Ekstern)
Number of pages: 7
Publication date: 2012
Main Research Area: Technical/natural sciences
Schools, Classrooms, Carbon dioxide, Ventilation, Retrofit solution, Energy
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Source: dtu
Source-ID: u::6577
Publication: Research - peer-review › Article in proceedings – Annual report year: 2012

Use of local convective and radiant cooling at warm environment

The effect of four local cooling devices (convective, radiant and combined) on SBS symptoms reported by 24 subjects at 28 °C and 50% RH was studied. The devices studied were: (1) desk cooling fan, (2) personalized ventilation providing clean air, (3) two radiant panels and (4) two radiant panels with one panel equipped with small fans. A reference condition without cooling was tested as well. The response of the subjects to the exposed conditions was collected by computerized questionnaires. The cooling devices significantly (p<0.05) improved subjects’ thermal comfort compared to without cooling. The acceptability of the thermal environment was similar for all cooling devices. The acceptability of air movement and PAQ increased when the local cooling methods were used. The best results were achieved with personalized ventilation and cooling fan. The minimal improvement in PAQ was reported when the radiant panel was used alone. The use of the local cooling devices led to increase of eye irritation. The reported SBS symptoms increased during the exposure time in all studied conditions, i.e. with and without cooling devices. The lowest prevalence of symptoms was with personalized ventilation and with radiant panel with attached fans, which also helped people to feel less fatigue. The SBS symptoms increased the most when the cooling fan, generating movement of polluted room air, was used.
Window opening behaviour: simulations of occupant behaviour in residential buildings using models based on a field survey

Window opening behaviour has been shown to have a significant impact on airflow rates and hence energy consumption. Nevertheless, the inhabitant behaviour related to window opening in residential buildings is currently poorly investigated through both field surveys and building energy simulations. In particular, reliable information regarding user behaviour in residential buildings is crucial for suitable prediction of building performance (energy consumption, indoor environmental quality, etc.). To face this issue, measurements of indoor climate and outdoor environmental parameters and window “opening and closing” actions were performed in 15 dwellings from January to August 2008 in Denmark. Probabilistic models of inhabitants’ window “opening and closing” behaviour were developed and implemented in the energy simulation software IDA ICE to improve window opening and closing strategies in simulations. The present contribution extends the knowledge about the windows control in dwellings and underlines the importance of appropriate occupant behaviour models for a better prediction of energy consumptions in buildings.

Advanced air distribution

The aim of total volume air distribution (TVAD) involves achieving uniform temperature and velocity in the occupied zone and environment designed for an average occupant. The supply of large amounts of clean and cool air are needed to maintain temperature and pollution concentration at acceptable levels in the entire space, leading to increased energy consumption and the use of large and costly HVAC and duct systems. The performance of desk installed PV combined with background TVAD used for room temperature control has been studied in an office building located in a hot and humid climate. Ventilation in hospitals is essential to decrease the risk of airborne cross-infection. At present, mixing air distribution at a minimum of 12 ach is used in infection wards. Advanced air distribution has the potential to aid in achieving healthy, comfortable and productive indoor environments at levels higher than what can be achieved today with the commonly used total volume air distribution principles.
Air cleaning using regenerative silica gel wheel
This paper discussed the necessity of indoor air cleaning and the state of the art information on gas-phase air cleaning technology. The performance and problems of oxidation and sorption air cleaning technology were summarized and analysed based on the literature studies. Eventually, based on an experimental study, a technology called clean air heat pump is proposed as a practical approach for indoor air cleaning.

Airflow characteristics at the breathing zone of a seated person: Passive control over the interaction of the free convection flow and locally applied airflow from front for personalized ventilation application
A workstation with a desk-mounted Personalized Ventilation (PV) unit, with circular diffuser (d = 0.185 m) supplying air from the front/above towards the face of a thermal manikin with realistic body shape and temperature distribution was set in a climate chamber (4.70 m x 1.62 m x 2.6 m). The distance between manikin’s face and the diffuser was 0.4 m. Mixing overhead ventilation at 15 L/s was used to ventilate the chamber. The room air temperature was kept at 20 °C. The PV air was supplied isothermally at 4, 6 or 8 L/s. The thermal manikin was sitting 0.1 m away from the front edge of the table. Passive method for control over the airflow characteristics at the breathing zone to increase the amount of clean air in inhalation consisted of a rectangular board (0.63 m x 0.36 m) placed below the table and pressed against the abdominal. It acted as a barrier reducing the convection flow upcoming from the lower body. The resultant velocity field at the breathing zone was measured with Particle Image Velocimetry: a dual cavity laser (λ = 532 nm) and two CCD cameras with 35 and 60 mm lenses. Seeding consisting of glycerol droplets (d = 2-3 μm) was added to the total volume supply. The blocking of the convection layer by the board decreased twice the absolute mean velocity at the mouth: from 0.2 m/s to 0.1 m/s. This made it possible for the PV flow already at 4 L/s to penetrate the free convection flow, which without the board was achieved at the PV flow rate of 6 L/s.
Airflow Characteristics at the Breathing Zone of a Seated Person: Active Control over the Interaction of the Free Convection Flow and Locally Applied Airflow from Front for Personalized Ventilation Application

A method for active control over the interaction between the free convection flow around occupant’s body and locally applied airflow from front on the velocity field at the breathing zone of a seated person was studied. A workplace equipped with personalised ventilation (PV) generating flow from front/above against the face of a thermal manikin with realistic body shape and surface temperature distribution (used to resemble a seated human body) was set in a climate chamber (4.70 m x 1.62 m x 2.60 m). The air temperature in the chamber was kept at 20 °C. Ceiling diffuser supplied ventilation air at 15 l/s. The PV air was supplied isothermally at 4, 6 or 8 L/s. The PV diffuser with diameter 0.18 m, was located at distance 0.4 m from the face of the manikin. The distance between the lower chest of the manikin and the front edge of the desk was 0.1 m. Box with 6 small computer fans (suction box) was installed below the table board, above the thighs of the manikin, and was used to exhaust the air of the free convection flow coming from the lower body parts of the manikin. The velocity field at the breathing zone was measured with Particle Image Velocimetry consisting of a dual cavity laser and two CCD cameras. The maximum absolute mean velocity measured in the convective layer at the mouth of the manikin was 0.20 m/s and was reduced to 0.09 m/s when the suction box was used. Thus the weakened boundary layer can be penetrated by the PV flow at the lowered velocity. The use of the suction box and the PV at 4 L/s resulted in the same velocity at the breathing zone as when only PV was used at 6 L/s. The maximum absol
A relation between calculated human body exergy consumption rate and subjectively assessed thermal sensation

Application of the exergy concept to research on the built environment is a relatively new approach. It helps to optimize climate conditioning systems so that they meet the requirements of sustainable building design. As the building should provide a healthy and comfortable environment for its occupants, it is reasonable to consider both the exergy flows in building and those within the human body. Until now, no data have been available on the relation between human-body exergy consumption rates and subjectively assessed thermal sensation. The objective of the present work was to relate thermal sensation data, from earlier thermal comfort studies, to calculated human-body exergy consumption rates. The results show that the minimum human body exergy consumption rate is associated with thermal sensation votes close to thermal neutrality, tending to the slightly cool side of thermal sensation. Generally, the relationship between air temperature and the exergy consumption rate, as a first approximation, shows an increasing trend. Taking account of both convective and radiative heat exchange between the human body and the surrounding environment by using the calculated operative temperature, exergy consumption rates increase as the operative temperature increases above 24 °C or decreases below 22 °C. With the data available so far, a second-order polynomial relationship between thermal sensation and the exergy consumption rate was established.

General information
State: Published
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A system for the comparison of tools for the simulation of water-based radiant heating and cooling systems

Low temperature heating and high temperature cooling systems such as thermally activated building systems (TABS) offer the chance to use low exergy sources, which can be very beneficial financially as well as ecologically when using...
renewable energy sources. The above has led to a considerable increase of water based radiant systems in modern buildings and a need for reliable simulation tools to predict the indoor environment and energy performance. This paper describes the comparison of the building simulation tools IDA ICE, IES, EnergyPlus and TRNSYS. The simulation tools are compared to each other using the same room and boundary conditions. The results show significant differences in predicted room temperatures, heating and cooling degree hours as well as thermal comfort in winter and summer.

**General information**
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**Buildings for smart cities**

**General information**
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Organisations: Systems Analysis Division. Management, Management, Risø National Laboratory for Sustainable Energy, Information Service, Risø Innovation, Innovation Systems and Foresight, Department of Management Engineering, Section for Building Physics and Services, Department of Civil Engineering, Section for Indoor Environment
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**Building Thermal Energy Storage - Concepts and Applications**

**General information**
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
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Calculation of the yearly energy performance of heating systems based on the European Building Energy Directive and related CEN Standards

According to the Energy Performance of Buildings Directive (EPBD) all new European buildings (residential, commercial, industrial, etc.) must since 2006 have an energy declaration based on the calculated energy performance of the building, including heating, ventilating, cooling and lighting systems. This energy declaration must refer to the primary energy or CO2 emissions. The European Organization for Standardization (CEN) has prepared a series of standards for energy performance calculations for buildings and systems. This paper presents related standards for heating systems. The relevant CEN-standards are presented and a sample calculation of energy performance is made for a small single family house, an office building and an industrial building in three different geographical locations: Stockholm, Brussels, and Venice. The additional heat losses from heating systems can be 10–20% of the building energy demand. The additional loss depends on the type of heat emitter, type of control, pump and boiler. Keywords: Heating systems; CEN standards; Energy performance; Calculation methods

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BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.506 SNIP 2.536 CiteScore 3.23
Can commonly-used fan-driven air cleaning technologies improve indoor air quality? A literature review

Air cleaning techniques have been applied worldwide with the goal of improving indoor air quality. The effectiveness of applying these techniques varies widely, and pollutant removal efficiency is usually determined in controlled laboratory environments which may not be realized in practice. Some air cleaners are largely ineffective, and some produce harmful by-products. To summarize what is known regarding the effectiveness of fan-driven air cleaning technologies, a state-of-the-art review of the scientific literature was undertaken by a multidisciplinary panel of experts from Europe, North America, and Asia with expertise in air cleaning, aerosol science, medicine, chemistry and ventilation. The effects on health were not examined. Over 26,000 articles were identified in major literature databases; 400 were selected as being relevant based on their titles and abstracts by the first two authors, who further reduced the number of articles to 160 based on the full texts. These articles were reviewed by the panel using predefined inclusion criteria during their first meeting. Additions were also made by the panel. Of these, 133 articles were finally selected for detailed review. Each article was assessed independently by two members of the panel and then judged by the entire panel during a consensus meeting. During this process 59 articles were deemed conclusive and their results were used for final reporting at their second meeting. The conclusions are that: (1) None of the reviewed technologies was able to effectively remove all indoor pollutants and many were found to generate undesirable by-products during operation. (2) Particle filtration and sorption of gaseous pollutants were among the most effective air cleaning technologies, but there is insufficient information regarding long-term performance and proper maintenance. (3) The existing data make it difficult to extract information such as Clean Air Delivery Rate (CADR), which represents a common benchmark for comparing the performance of different air cleaning technologies. (4) To compare and select suitable indoor air cleaning devices, a labeling system accounting for characteristics such as CADR, energy consumption, volume, harmful by-products, and life span is necessary. For that purpose, a standard test room and condition should be built and studied. (5) Although there is evidence that some air cleaning technologies improve indoor air quality, further research is needed before any of them can be confidently recommended for use in indoor environments.

General information
Can we meet the ventilation required in international standards in an energy efficient way?

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Comparison Of Air Change Rates Obtained By Different Ventilation Measurement Techniques In Five Danish Homes.

General information
State: Published
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Consideration Of The Change Of Material Emission Signatures Due To Long-term Emissions For Enhancing Voc Source Identification

The objectives of this study were to characterize the changes of VOC material emission profiles over time and develop a method to account for such changes in order to enhance a source identification technique that is based on the measurements of mixed air samples and the emission signatures of individual building materials determined by PTRMS. Source models, including powerlaw model, doubleexponential decay model and mechanistic diffusion model, were employed to track the change of individual material emission signatures by PTRMS over a ninemonth period. Samples of nine typical building materials were tested individually for nine months and later in combination to obtain actual mixture emissions. VOC emissions from each material were measured in a 50liter smallscale chamber. Chamber air was sampled by PTRMS over a 28day period to determine their emission rate decay characteristics as well as to establish the initial profile of emission signatures unique to individual materials tested.

General information
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Publication date: 2011

Description of occupant behaviour in building energy simulation: state-of-art and concepts for Improvements
Energy and indoor environmental performance of buildings are highly influenced by outdoor/indoor climate, by building characteristics, and by occupants' behaviour. Building simulation tools cannot precisely replicate the actual performance of buildings because the simulations are based on a number of basic assumptions that affect the results. Therefore, the calculated energy performance may differ significantly from the real energy consumption. One of the key reasons is the current inability to properly model occupant behaviour and to quantify the associated uncertainties in building performance predictions. By consequence, a better description of parameters related to occupant behaviour is highly required. In this paper, the state of art in occupant behaviour modelling within energy simulation tools is analysed and some concepts related to possible improvements of simulation tools are proposed towards more accurate energy consumption predictions.

Development of a novel methodology for indoor emission source identification
The objective of this study was to develop and evaluate a methodology to identify individual sources of emissions based on the measurements of mixed air samples and the emission signatures of individual materials previously determined by Proton Transfer Reaction-Mass Spectrometry (PTR-MS), an on-line analytical device. The methodology based on signal processing principles was developed by employing the method of multiple regression least squares (MRLS) and a normalization technique. Samples of nine typical building materials were tested individually and in combination, including carpet, ceiling material, gypsum board, linoleum, two paints, polyolefine, PVC and wood. Volatile Organic Compound (VOC) emissions from each material were measured in a 50-liter small-scale chamber. Chamber air was sampled by PTR-
MS to establish a database of emission signatures unique to each individual material. The same task was performed to measure combined emissions from material mixtures for the application and validation of the developed signal separation method. Results showed that the proposed method could identify the individual sources under laboratory conditions with two, three, five and seven materials present. Further experiments and investigation are needed for cases where the relative emission rates among different compounds may change over a long-term period.
Device and method for reducing spread of microorganisms and airborne health hazardous matter and/or for protection from microorganisms and airborne health hazardous matter

Disclosed is an air distribution control unit or a filtration/ventilation unit which is portable and/or can be mounted on or integrated in furniture e.g. as a cabinet of at the head region six a bed. The filtration/ventilation unit cleanses air from a person/patient by aspirating the person's/patient's exhalation air into the filtration/ventilation unit. To construct an at least partly isolated area around the patient, filtered air can be directed e.g. vertically out of the filtration/ventilation unit to perform an air curtain. Use of the filtration/ventilation unit reduces the risk of dissipation of airborne diseases and health hazardous matter, and reduces the amount of air to ventilate a room with patients.

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Differences Between Passive And Active Cooling Systems In Gender, Physiological Responses, Thermal Sensation And Productivity

could occur due to application of low energy/exergy cooling systems, on human thermal comfort, physiological responses, and productivity. Furthermore, focus is on the differences between gender. This paper presents preliminary results obtained from experiments with four test subjects. To examine the influence of passive and active cooling systems a climate room setup with experimental subjects is used. Twenty subjects (10 male; 10 female; age: 1830; BMI: 1825) will participate in the experiments. So far, one male subject visited the climate room on six occasions: passive cooling through (1) mixing ventilation (To=26°C), active cooling by convection through (2) mixing and (3) displacement ventilation, active cooling by radiation (4) through the ceiling and mixing ventilation (5) through the floor and mixing ventilation and (6)
through the floor and displacement ventilation. Three female subjects visited the climate room on two occasions: (1) and (4). During the experiments both physiological responses and thermal sensation were measured. To assess the productivity and performance a 'Remote Performance Measurement' (RPM) method was used.

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Effect of occupant behaviour related influencing factors on final energy end uses in buildings
Different aspects are investigated in order to highlight the causes of increased energy consumption in buildings: in particular, the ongoing project IEA ECBCS Annex 53 groups the “influencing factors” into seven major categories emphasising the role of occupant behaviour on energy consumptions. In fact, although building envelope and systems characteristics are known to have a significant effect on energy consumption, their performances can be already assessed in the design phase: and their energy performances have significantly increased in recent years for new and retrofitted buildings thanks to regulations and policies. At the same time, there has been a shift in the direction of research related to energy and environmental performance of buildings towards a focus on human-centred concerns. One key reason is a greater awareness that these concerns of human well-being are keyparameters in the performance of buildings, as highlighted by the huge gap between real and predicted energy consumptions depending on actual use of the buildings. Based on a dedicated literature review, the effect of the occupant behaviour on the energy consumptions is here firstly introduced. Then, the influencing parameters affecting final energy end uses (heating, cooling, ventilation, lighting) are presented and critically discussed in order to show the importance of a better description of occupant behaviour in energy prediction tools.

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Publication date: 2011

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Effect of streamer plasma air purifier on sbs symptoms and performance of office work
Subjective experiments were conducted to evaluate the effect of a streamer plasma air purifier on perceived air quality, SBS symptoms and performance of office work during 5-hour exposure of 32 recruited subjects in field laboratory in which real materials were used to establishing a realistic level of air pollution. Intensity of SBS symptoms were indicated using visual-analogue scales. Subjects’ performance was evaluated with several computer tasks. The results show that operation of the air purifiers improved perceived air quality and reduced the odor intensity of indoor air. Eye dryness symptom was found significantly improved when the air purifiers were used but no other SBS symptoms or performance of office work were improved when the air purifiers were in operation compared to the condition when they were off.
Effects of thermal discomfort in an office on perceived air quality, SBS symptoms, physiological responses and human performance

The effects of thermal discomfort on health and human performance were investigated in an office, in an attempt to elucidate the physiological mechanisms involved. Twelve subjects (six men and six women) performed neurobehavioral tests and tasks typical of office work while thermally neutral (at 22°C) and while warm (at 30°C). Multiple physiological measurements and subjective assessment were made. The results show that when the subjects felt warm, they assessed the air quality to be worse, reported increased intensity of many sick building syndrome symptoms, expressed more negative mood, and were less willing to exert effort. Task performance decreased when the subjects felt warm. Their heart rate, respiratory ventilation, and end-tidal partial pressure of carbon dioxide increased significantly, and their arterial oxygen saturation decreased. Tear film quality was found to be significantly reduced at the higher temperature when they felt warm. No effects were observed on salivary biomarkers (alpha-amylase and cortisol). The present results imply that the negative effects on health and performance that occur when people feel thermally warm at raised temperatures are caused by physiological mechanisms.
Effects on perceived air quality of a photocatalytic cement-based paint tested under steady-state and transient conditions

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Kolarik, J. (Intern), Toftum, J. (Intern)
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Exergy analysis: The effect of relative humidity, air temperature and effective clothing insulation on thermal comfort

Exergy analysis enables us to make connections among processes inside the human body and processes in a building. So far, only the effect of different combinations of air temperatures and mean radiant temperatures have been studied, with constant relative humidity in experimental conditions. The objective of this study is to determine the effects of different levels of relative humidity (RH), air temperature (Ta) and effective clothing insulation on thermal comfort conditions from the exergy point of view. The performed analyses take into consideration the available data from the study by Toftum et al. (1998). The effect of different levels of RH, Ta and effective clothing insulation on human body exergy balance chain, changes in human body exergy consumption rate (hbExCr) and predicted mean vote (PMV) index were analyzed. The results show that thermal comfort conditions do not always result in lower hbExCr as it was proven in previous studies. Variations in effective clothing insulation, Ta and RH affect individual parts of human body exergy balance chain with an important effect on hbExCr. At hot and dry conditions the hbExCr is the largest while at hot and humid conditions it is the minimal. Hot and dry and cold and dry conditions have similar hbExCr. The difference appears, if the whole human body exergy balance chain is taken into consideration. To maintain comfortable conditions it is important that exergy consumption and stored exergy are at optimal values with a rational combination of exergy input and output.
Experimental Study of Air Distribution and Ventilation Effectiveness in a Room with a Combination of Different Mechanical Ventilation and Heating/Cooling Systems

Mixing and displacement ventilation are common systems in commercial buildings, while mixing ventilation is used in residential buildings. Displacement ventilation provides fresh air to the occupied zone in a more efficient way than mixing ventilation but it is important to know how well it works with a floor system for heating or cooling. Can, for example, a floor heating system warm up the supply air too fast and destroy the displacement effect? Will floor cooling, combined with displacement ventilation, result in too high a vertical temperature difference and too low a temperature at feet level? The required amount of ventilation depends on the ventilation effectiveness. In standards, the recommended values for ventilation effectiveness depend on the position of the supply and exhaust device and on the difference between supply and room air temperature. Among others, for warm air heating the ventilation effectiveness is always less than 1 and can be as low as 0.4. This would then require an increased amount of ventilation. A combination of floor heating/cooling, radiators, air cooling, displacement ventilation, mixed ventilation and different combinations of supply and return grilles have, in this study, been experimentally tested. The studies on a displacement ventilation system show lower vertical air temperature differences and higher ventilation effectiveness when it is combined with a floor heating system. With floor cooling, the displacement ventilation system should be designed with a higher supply air temperature. Furthermore, the buoyancy flows from warm or cold windows and occupants influence the airflow pattern and increase the mixing of supply air into the occupied zone.

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Web of Science (2017): Indexed Yes
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Scopus rating (2016): SJR 0.3 SNIP 0.204 CiteScore 0.39
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.414 SNIP 0.533 CiteScore 0.78
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.356 SNIP 0.62 CiteScore 0.47
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.218 SNIP 0.207 CiteScore 0.3
ISI indexed (2013): ISI indexed yes
Exposure to exhaled air from a sick occupant in a two-bed hospital room with mixing ventilation: effect of distance from sick occupant and air change rate

Full-scale measurements were performed in a climate chamber set as a two-bed hospital room, ventilated at 3, 6 and 12 h⁻¹. Air temperature was kept constant at 22 °C. Two breathing thermal manikins were used: a sick patient lying on one side in one bed and a doctor. A thermal dummy mimicked an exposed patient lying in the second bed. The doctor stood 0.55 m or 1.1 m facing the sick patient. The breathing mode of the “sick patient” was: exhalation mouth/inhalation nose. Tracer gas (R-134a) was mixed with the exhaled air. Important finding of this study is that airflow distribution and interaction in rooms, distance between the source and recipient, etc. may play more important role for the exposure to the air exhaled by the sick patient than the ventilation rate. Increase in ventilation may affect adversely the exposure to exhaled air and thus enhance the risk from airborne cross infection.
Human comfort and self-estimated performance in relation to indoor environmental parameters and building features

The main objective of the Ph.D. study was to examine occupants' perception of comfort and self-estimated job performance in non-industrial buildings (homes and offices), in particular how building occupants understand comfort and which parameters, not necessarily related to indoor environments, influence the perception of comfort.

To meet the objective, the following actions were taken: (1) a literature survey exploring which indoor environmental parameters (thermal, acoustic, visual environment and air quality) predominantly determine overall comfort and whether other factors unrelated to the indoor environment influence the perception of comfort; the literature survey summarized 42 peer-reviewed and conference articles and 1 book covering the period from 1970 to 2009; (2) preparation, distribution and analysis of a questionnaire survey sent to 2499 addresses representing the most common types of residential buildings in Denmark and filled out by 645 persons (response rate of 26%); and (3) analysis of the post-occupancy satisfaction survey conducted by the Center for the Built Environment (CBE) at the University of California Berkeley in 351 mainly U.S. office buildings and filled out by 52,980 building occupants. The results of the literature survey showed that thermal, acoustic and visual environments and air quality all influenced evaluation of the overall indoor environment and that thermal comfort was ranked in the majority of cases to be of slightly greater importance for overall comfort than acoustic and visual comfort and satisfaction with air quality. The data from the Danish residential buildings showed actually slightly different results, indicating that when the acceptability of thermal, acoustic, visual conditions and air quality are of a similar magnitude, corresponding to low levels of dissatisfaction, then the acceptability of the overall indoor environment can be approximated by averaging acceptability of these individual parameters.

The literature survey suggested also that there are other factors unrelated to indoor environment such as personal characteristics of building occupants, building-related factors (type of building and control over the indoor environment) and the outdoor climate (including seasonal changes), that can influence the perception of comfort. Providing people with the possibility to control the indoor environment had a beneficial effect on the perception of comfort, indicating that control over the indoor environment should be delegated to building occupants. When the systems for controlling thermal environment are designed, the building type (naturally ventilated or air-conditioned) and local climate conditions should be taken into account. This has been further confirmed by the results from the Danish residential buildings showing that not only indoor environmental parameters contributed to occupants' comfort but also a peaceful atmosphere, contact with nature and the view through a window.

In office buildings, overall satisfaction with personal workspace was influenced by satisfaction with not only indoor environmental parameters but also satisfaction with workspace and building features. The highest increase in overall satisfaction with personal workspace would be achieved when increasing satisfaction with the amount of space for work and storage, noise level and visual privacy. However, if job performance is considered, then satisfaction with the main indoor environmental parameters should be addressed first as they affected self-estimated job performance to the highest extent. The present study showed that overall satisfaction with personal workspace affected significantly the self-estimated job performance. Increasing overall satisfaction with the personal workspace by about 15% would correspond to an increase of self-estimated job performance by 3.7%. Among indoor environmental parameters and building features, satisfaction with temperature was the most important parameter for self-estimated job performance, followed by satisfaction with noise level and air quality. It is obvious that there is a discrepancy between ranking of indoor environmental parameters and building features regarding their importance for overall workspace satisfaction and self-estimated job performance. Thus, the investments in improving conditions in indoor environments should be made according to whether improvement of satisfaction or self-estimated job performance is the aim.

The study in Danish residential buildings indicated that manual control of the indoor environment was highly preferred, and only in the case of temperature did respondents accept both manual and automatic control. The majority of respondents who reported having at least one problem related to the indoor environment, did not try to find information on how to solve the problem. This may suggest that there is a need for increasing people's awareness regarding the consequences of a poor indoor environment on their health and for improving people's knowledge on how to ensure a good indoor climate.
The present results, although comprehensive, need further validation.

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Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Frontczak, M. J. (Intern), Wargocki, P. (Intern)
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Original language: English

Series: DTU Civil Engineering Report
Number: R-260
ISSN: 1601-2917
Main Research Area: Technical/natural sciences

Electronic versions:
Monika_Frontczaks_PhD_pdf_final_fra_SPE.pdf

Bibliographical note
De foreliggende resultater har, selv om de er omfattende, brug for yderligere validering.

Publication: Research › Ph.D. thesis – Annual report year: 2012

**Hvad koster et godt indeklima på folkeskoler?**

**General information**
State: Published
Organisations: Section for Building Physics and Services, Department of Civil Engineering, Section for Indoor Environment
Authors: Marxen, C. (Ekstern), Knorborg, R. B. (Ekstern), Hviid, C. A. (Intern), Wargocki, P. (Intern)
Pages: 40,42,44,49
Publication date: 2011
Main Research Area: Technical/natural sciences

**Publication information**
Journal: H V A C Magasinet
Issue number: 9
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Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: Danish
Links:
http://techmedia.swiflet.com/tm/hvac/59/1/
Source: orbit
Source-ID: 316328
Publication: Communication › Journal article – Annual report year: 2011

**Impact of air temperature, relative humidity, air movement and pollution on eye blinking**
The effect of indoor air temperature, relative humidity, velocity and pollution on occupants’ eye blink frequency (BF) was examined. In total sixty subjects participated in eight 4 hour experiments without and with facially applied air movement under individual control of the subjects. Air movement of either polluted room air supplied isothermally or cool and clean air was used. Eye blinking video record for the last 15 min of each exposure were analysed. The increase of the room air temperature and relative humidity from 23 °C and 40% to 26 °C and 70% or to 28 °C and 70% decreased the BF. At temperature of 26 °C and relative humidity of 70% facially applied flow of polluted room air didn’t have significant impact on BF in comparison without air movement. The increase of BF due to decrease of temperature and humidity and increase of velocity may be compensated due to the increase in air cleanliness.

**General information**
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Technical University of Denmark, Lublin University of Technology, Silesian University of Technology
Authors: Melikov, A. K. (Intern), Lyubenova, V. S. (Ekstern), Skwarczynski, M. (Ekstern), Kaczmarczyk, J. (Ekstern)
Publication date: 2011

**Host publication information**
Title of host publication: Proceedings of Indoor Air 2011
Main Research Area: Technical/natural sciences
Conference: 12th International Conference on Indoor Air Quality and Climate, Austin, TX, United States, 05/06/2011 - 05/06/2011
Relative humidity, Eye blink frequency, Air movement, Pollution, Air temperature
Links:
http://lifelong.engr.utexas.edu/2011/
Source: orbit
Source-ID: 317122
Publication: Research - peer-review › Article in proceedings – Annual report year: 2011

**Impact of breathing on the thermal plume above a human body**
The characteristics of the thermal plume above a human body should be well-defined in order to properly design the indoor environment and allow correct simulation of the indoor conditions by CFD or experimentally. The objective of the presented study was to investigate the influence of breathing on the characteristics of the thermal plume generated by a sitting person. The experiment was performed in a climate chamber with upward piston flow. Air temperature was 23°C, vertical temperature gradient was approx. 0.07 K/m and velocity was lower than 0.05 m/s. Radiant temperature asymmetry
was close to 0°C. A thermal manikin with female body shape equipped with an artificial lung was used to simulate the dry heat loss and breathing process of a sitting occupant. Three cases were examined: non-breathing, exhalation through nose, and exhalation through mouth. Measurements of the air temperature and speed in the plume cross-section 0.7 m above the manikin head were performed. Exhalation through the mouth affects the characteristics of the thermal plume 0.7 m above the manikin head, while exhalation through the nose has only small impact. Air velocity and temperature excess distributions in the plume generated by the manikin exhaling through the nose are comparable to the distributions over the non-breathing manikin. Exhalation through the mouth causes wider plume cross-section and increases the volume flux, momentum flux, buoyancy force density and enthalpy flux compared to the non-breathing case.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Department of Mechanical Engineering, Silesian University of Technology
Authors: Zukowska, D. (Intern), Melikov, A. K. (Intern), Popiolek, Z. (Intern), Spletsteser, J. (Ekstern)
Publication date: 2011

Host publication information
Title of host publication: Roomvent 2011
Publisher: TAPIR Akademisk Forlag
Main Research Area: Technical/natural sciences
Conference: Roomvent - 12th International Conference on Air Distribution in Rooms, Trondheim, Norway, 19/06/2011 - 19/06/2011
Thermal plume, Sitting person, Breathing, Thermal manikin
Source: orbit
Source-ID: 274648
Publication: Research - peer-review › Article in proceedings – Annual report year: 2011

Impact of facially applied air movement on the development of the thermal plume above a sitting occupant
In the future the implementation of low power office equipment in practice will make thermal plumes generated by occupants one of the dominant flows affecting the air distribution in spaces. Advanced air distribution methods, such as personalized ventilation, are expected to become widely implemented in practice. In this study the impact of locally applied airflow on the thermal plume generated by a sitting human body was investigated. The experiment was performed in a climate chamber with upward piston flow. A thermal manikin was sitting on a computer chair behind a table. The air speed and temperature were measured across the plume 0.7 m above the manikin head when an airflow of 10 l/s was supplied first against the face of the manikin and then upward from the front edge of the desk. The use of the flow, against the face or upward tangentially to the chest, disturbed significantly the free convection boundary layer enveloping the body and caused scattering in the measured values of air speed and temperature excess in the plume. In comparison with the case without airflow, the integral characteristics including volume flux, momentum flux, buoyancy force density and enthalpy flux were greater when the flow was supplied upward tangentially to the chest and lower when it was supplied against the face.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Department of Mechanical Engineering, Silesian University of Technology
Authors: Zukowska, D. (Intern), Melikov, A. K. (Intern), Popiolek, Z. J. (Intern), Spletsteser, J. (Ekstern)
Publication date: 2011

Host publication information
Title of host publication: Roomvent 2011
Publisher: TAPIR Akademisk Forlag
Main Research Area: Technical/natural sciences
Conference: Roomvent - 12th International Conference on Air Distribution in Rooms, Trondheim, Norway, 19/06/2011 - 19/06/2011
Thermal plume, Sitting person, Thermal manikin, Personalized ventilation
Source: orbit
Source-ID: 274649
Publication: Research - peer-review › Article in proceedings – Annual report year: 2011

Impacts Of Passive Removal Materials On Indoor Air Quality
Indoor air quality (IAQ) was determined in the presence of eight combinations of building materials with and without ozone. Air samples were collected in twin 30 m³ chambers to assess the C5 to C10 aldehyde content of the air while a panel of 18 to 23 human subjects assessed air quality using a continuous acceptability scale. Materials were either new carpet that was aired out for three weeks, clay plaster applied to gypsum wallboard that was aired out for up to one month, both materials, or neither. Perceived Air Quality (PAQ) assessed by the panel was most acceptable and concentrations of aldehydes were lowest when only clay plaster or both clay plaster and carpet were in the chambers without ozone. The least acceptable PAQ and the highest concentrations of aldehydes were observed when carpet and ozone were present
Implementation of multivariate linear mixed-effects models in the analysis of indoor climate performance experiments

The aim of the current study was to apply multivariate mixed-effects modeling to analyze experimental data on the relation between air quality and the performance of office work. The method estimates in one step the effect of the exposure on a multi-dimensional response variable, and yields important information on the correlation between the different dimensions of the response variable, which in this study was composed of both subjective perceptions and a two-dimensional performance task outcome. Such correlation is typically not included in the output from univariate analysis methods. Data originated from three different series of experiments investigating the effects of air quality on performance. The example analyses resulted in a significant and positive correlation between two performance tasks, indicating that the two tasks to some extent measured the same dimension of mental performance. The analysis seems superior to conventional univariate statistics and the information provided may be important for the design of performance experiments in general and for the conclusions that can be based on such studies.

General information

State: Published
Organisations: DTU Data Analysis, Department of Informatics and Mathematical Modeling, Section for Indoor Environment, Department of Civil Engineering, ALECTIA A/S
Authors: Jensen, K. L. (Ekstern), Spliid, H. (Intern), Toftum, J. (Intern)
Pages: 129-136
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Main Research Area: Technical/natural sciences
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Journal: International Journal of Biometeorology
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Web of Science (2018): Indexed yes
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Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.792 SNIP 1.223 CiteScore 2.25
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.729 SNIP 1.226 CiteScore 1.9
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.811 SNIP 1.448 CiteScore 2.66
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.738 SNIP 1.341 CiteScore 2.29
ISI indexed (2013): ISI indexed yes
Indoor air quality, Multivariate mixed-effects modeling, Statistical analysis, Experimental design, Performance

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Links:
http://www.springerlink.com/content/gv867252q84527x3/

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Indeklima i skoler – Status og konsekvenser

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Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Toftum, J. (Intern), Wargocki, P. (Intern), Clausen, G. (Intern)
Number of pages: 28
Publication date: 2011

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Main Research Area: Technical/natural sciences
Electronic versions:
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Source: orbit
Source-ID: 316350
Publication: Research - peer-review › Report – Annual report year: 2011

Indoor Climate Quality Assessment -: Evaluation of indoor thermal and indoor air quality
This Guidebook gives building professionals useful support in the practical measurements and monitoring of the indoor climate in buildings. It is evident that energy consumption in a building is directly influenced by required and maintained indoor comfort level. Wireless technologies for measurement and monitoring have allowed a significantly increased number of possible applications, especially in existing buildings. The Guidebook illustrates several cases with the
instrumentation of the monitoring and assessment of indoor climate.

**General information**
State: Published
Organisations: Department of Mechanical Engineering, Section for Indoor Environment, Department of Civil Engineering
Publication date: 2011

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Publisher: Federation of European Heating and Air-Conditioning Associations, REHVA
Volume: 14
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Series: REHVA Guidebooks
Number: 14
Main Research Area: Technical/natural sciences
Links:
http://www.rehva.eu/
Source: orbit
Source-ID: 317166
Publication: Research - peer-review › Book – Annual report year: 2011

**Indoor Environment Exposure and Absenteeism in 151 Danish Day-Care Facilities**

**General information**
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Odense University Hospital, Odense City Government and Administration, Nyborg Town Administration
Authors: Clausen, G. (Intern), Gustavsen, S. (Intern), Buhl, S. (Ekstern), Ladegaard, M. B. (Ekstern), Callesen, M. (Ekstern), Toftum, J. (Intern)
Pages: 754
Publication date: 2011

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Title of host publication: Proceedings of Indoor Air 2011
Main Research Area: Technical/natural sciences
Conference: 12th International Conference on Indoor Air Quality and Climate, Austin, TX, United States, 05/06/2011 - 05/06/2011
Links:
http://lifelong.engr.utexas.edu/2011/
Source: orbit
Source-ID: 316157
Publication: Research - peer-review › Article in proceedings – Annual report year: 2011

**Internationale visioner**

**General information**
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Toftum, J. (Intern)
Pages: 6-6
Publication date: 2011

**Publication information**
Journal: H V A C Magasinet
Issue number: 13
ISSN (Print): 1603-6913
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ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Literature survey on how different factors influence human comfort in indoor environments

The present paper shows the results of a literature survey aimed at exploring how the indoor environment in buildings affects human comfort. The survey was made to gather data that can be useful when new concepts of controlling the indoor environment are developed. The following indoor environmental conditions influencing comfort in the built environment were surveyed: thermal, visual and acoustic, as well as air quality. The literature was surveyed to determine which of these conditions were ranked by building users as being the most important determinants of comfort. The survey also examined the extent to which other factors unrelated to the indoor environment, such as individual characteristics of building occupants, building-related factors and outdoor climate including seasonal changes, influence whether the indoor environment is evaluated as comfortable or not. The results suggest that when developing systems for controlling the indoor environment, the type of building and outdoor climate, including season, should be taken into account. Providing occupants with the possibility to control the indoor environment improves thermal and visual comfort as well as satisfaction with the air quality. Thermal comfort is ranked by building occupants to be of greater importance compared with visual and acoustic comfort and good air quality. It also seems to influence to a higher degree the overall satisfaction with indoor
environmental quality compared with the impact of other indoor environmental conditions.

**General information**

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Organisations: Section for Indoor Environment, Department of Civil Engineering  
Authors: Frontczak, M. J. (Intern), Wargocki, P. (Intern)  
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Main Research Area: Technical/natural sciences

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- BFI (2018): BFI-level 1
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- BFI (2017): BFI-level 1
- Web of Science (2017): Indexed yes
- BFI (2016): BFI-level 1
- Scopus rating (2016): CiteScore 4.51 SJR 2.015 SNIP 2.198
- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 1
- Scopus rating (2015): SJR 2.093 SNIP 2.49 CiteScore 4.37
- Web of Science (2015): Indexed yes
- BFI (2014): BFI-level 1
- Scopus rating (2014): SJR 1.938 SNIP 2.797 CiteScore 4.14
- Web of Science (2014): Indexed yes
- BFI (2013): BFI-level 1
- Scopus rating (2013): SJR 1.581 SNIP 2.602 CiteScore 3.57
- ISI indexed (2013): ISI indexed yes
- Web of Science (2013): Indexed yes
- BFI (2012): BFI-level 1
- Scopus rating (2012): SJR 1.331 SNIP 2.875 CiteScore 3.06
- ISI indexed (2012): ISI indexed yes
- Web of Science (2012): Indexed yes
- BFI (2011): BFI-level 1
- Scopus rating (2011): SJR 1.144 SNIP 2.255 CiteScore 2.76
- ISI indexed (2011): ISI indexed yes
- Web of Science (2011): Indexed yes
- BFI (2010): BFI-level 1
- Scopus rating (2010): SJR 1.235 SNIP 2.001
- Web of Science (2010): Indexed yes
- BFI (2009): BFI-level 1
- Scopus rating (2009): SJR 1.028 SNIP 1.865
- Web of Science (2009): Indexed yes
- BFI (2008): BFI-level 1
- Scopus rating (2008): SJR 0.924 SNIP 1.38
- Web of Science (2008): Indexed yes
- Scopus rating (2007): SJR 0.788 SNIP 1.778
- Web of Science (2007): Indexed yes
- Scopus rating (2006): SJR 1.03 SNIP 1.63
- Scopus rating (2005): SJR 0.955 SNIP 1.225
- Web of Science (2005): Indexed yes
- Scopus rating (2004): SJR 0.548 SNIP 1.266
Measure the effects of thermal discomfort on the performance of office work
Accuracy and speed are the two distinct aspects of human performance. A method was proposed by which the speed and accuracy were integrated into one measure by designing the tasks in such a way that the participants can only proceed to the next test when the task was performed without errors. The method was examined through a subjective experiment with thermal environment as the prototypical example. The experimental results indicate that the negative effects of thermal discomfort on human performance were evaluated well by the tasks designed with the proposed method. It provides a useful tool for better measurement of human performance and helps to facilitate the development of quantitative relationship between IEQ and productivity.

Modeling of ventilation rates in bedrooms based on building characteristics and occupant behavior
Linear regression model, Air change rate, Carbon dioxide, Homes
Links:
http://www.isiaq.org/events/indoor-air-2011
Modeling ventilation rates in bedrooms based on building characteristics and occupant behavior

Air change rate (ACR) data obtained from the bedrooms of 500 Danish children and presented in an earlier paper were analyzed in more detail. Questionnaires distributed to the families, home inspections and interviews with the parents provided information about a broad range of residential characteristics and occupant behavior. These were tested in several linear regression models to identify the degree of effect each selected independent variable has on the total ACR. The measured ACRs are summarized by some of the most significant variables such as room volume (higher ACR in smaller rooms), number of people sleeping in the bedroom (higher ACR with more people), average window and door opening habits (higher ACR with more opening), sharing the bedroom with other family members (higher ACR in shared rooms), location of the measured room (higher ACR above ground floor), year of construction (lowest ACR in buildings from early 1970s), observed condensation on the bedroom window (higher ACR at less condensation), etc. The best-fitting model explained 46% of the variability in the air change rates. Variables related to occupant behavior were stronger predictors of ventilation rate (model R² = 0.30) than those related to building characteristics (model R² = 0.09). Although not perfectly accurate on a room-to-room basis, our best-fitting model may be useful when a rough estimate of the average air change rate for larger study populations is required in future indoor air quality models.
Modelling occupants’ heating set-point preferences
Discrepancies between simulated and actual occupant behaviour can offset the actual energy consumption by several orders of magnitude compared to simulation results. Thus, there is a need to set up guidelines to increase the reliability of forecasts of environmental conditions and energy consumption. Simultaneous measurement of the set-point of thermostatic radiator valves (trv), and indoor and outdoor environment characteristics was carried out in 15 dwellings in Denmark in 2008. Linear regression was used to infer a model of occupants’ interactions with trvs. This model could easily be implemented in most simulation software packages to increase the validity of the simulation outcomes.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Andersen, R. V. (Intern), Olesen, B. W. (Intern), Toftum, J. (Intern)
Pages: 1451-1456
Publication date: 2011

Host publication information
Title of host publication: Proceedings of Building Simulation 2011: 12th Conference of International Building Performance Simulation Association
Main Research Area: Technical/natural sciences
Electronic versions:
prod11324288510555.p.pdf
Links:
http://www.bs2011.org/
Source: orbit
Source-ID: 315988
Publication: Research - peer-review › Article in proceedings – Annual report year: 2011

Modelling window opening behaviour in Danish dwellings
In this paper we present and analyse data from two studies of window opening behaviour in residential buildings in Denmark. Based on measurements of indoor environment, weather and window opening behaviour in 15 dwellings, we propose a model that will predict window opening behaviour. The data showed that other factors than thermal effects impact the behaviour of the occupants. Some of these factors were included in the model. We present data from repeated questionnaire surveys that show that occupants tend to adjust heating setpoints, adjust clothing and operate windows
when feeling thermally uncomfortable.

Nicotine in dust samples collected from children's bedrooms and daycare centers in Denmark

Novel ventilation strategy for reducing the risk of airborne cross infection in hospital rooms
Performance criteria for a personalized indoor environment

**General information**
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Exhausto A/S
Authors: Olesen, B. W. (Intern), Melikov, A. K. (Intern), Grønbæk, H. (Ekstern)
Publication date: 2011

**Host publication information**
Title of host publication: Proceedings of Indoor Air 2011
Main Research Area: Technical/natural sciences
Conference: 12th International Conference on Indoor Air Quality and Climate, Austin, TX, United States, 05/06/2011 - 05/06/2011
Energy, Standards, Occupant control, Comfort, Indoor environment

Electronic versions:
Performance criteria.pdf

Performance of a Streamer Plasma Air Purifier Examined with Sensory Assessments of Air Quality

**General information**
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Fang, L. (Intern), Wargocki, P. (Intern), Targowski, A. (Ekstern), Tanaka, T. (Ekstern), Kagawa, K. (Ekstern)
Publication date: 2011

**Host publication information**
Title of host publication: Proceedings of Indoor Air 2011 : Austin, Texas, USA
Main Research Area: Technical/natural sciences
Conference: 12th International Conference on Indoor Air Quality and Climate, Austin, TX, United States, 05/06/2011 - 05/06/2011

Potential energy savings with personalized ventilation coupled with passive chilled beams

Personalized ventilation (PV) is an individually controlled air distribution system aimed at improving inhaled air quality and thermal comfort of each occupant. Numerous studies have shown that PV may improve occupants' health, comfort and performance in comparison with traditional total volume air distribution used today. The potential of PV for energy saving has been studied little. In this study, the energy saving potential of desk mounted PV in conjunction with either mixing ventilation or a passive chilled beam system is compared to mixing ventilation alone by means of computer simulations. An open plan office in a building, located in a cold and dry climate was simulated. Numerous simulations were performed to study the importance of number of room occupants, occupancy profile in time and room air temperature control. The requirements for indoor environment in office buildings as defined in the present standards were considered. The most effective energy saving strategy with PV in use was to expand the upper room temperature limit as defined in the present standards. When PV was coupled with background mixing ventilation, the possible reduction of the air supplied to the room was approximately 20% (and up to 40% when extending the temperature in the room by 2 °C above the upper limit recommended in the standards) compared to mixing ventilation only. When PV was combined with passive chilled beams, the reduction of the supplied air was up to 80%. This ventilation strategy may lead to energy saving especially in spaces where occupants spend most of the time at their workplace.

**General information**
State: Published
Quantitative measurement of productivity loss due to thermal discomfort

The effects on human performance of elevated temperature causing thermal discomfort were investigated. Recruited subjects performed neurobehavioural tests examining different component skills, and addition and typing tasks that were used to replicate office work. The results show that thermal discomfort caused by elevated air temperature had a negative effect on performance. A quantitative relationship was established between thermal sensation votes and task performance. It can be used for economic calculations pertaining to building design and operation when occupant productivity is considered. The relationship indicates that optimum performance can be achieved slightly below neutral, while thermal discomfort (feeling too warm or too cold) leads to reduced performance. Consequently, it makes sense to set the PMV limits in workplaces in the range between −0.5 and 0 instead of between −0.5 and 0.5 as stipulated in the present standards.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Shanghai Jiao Tong University
Authors: Lan, L. (Ekstern), Wargocki, P. (Intern), Lian, Z. (Ekstern)
Pages: 1057-1062
Publication date: 2011
Main Research Area: Technical/natural sciences
Publication information
Journal: Energy and Buildings
Volume: 43
Issue number: 5
ISSN (Print): 0378-7788
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
Quantitative relationships between occupant satisfaction and aspects of indoor environmental quality and building design

The paper examines which indoor environmental parameters and building features contribute occupants' satisfaction in office buildings. The study analyzed data from a web-based survey administered to 52,980 occupants in 351 office buildings over ten years at the Center for the Built Environment. The survey uses 7-point scale questioning satisfaction with parameters related to the indoor environment, workspace and building features. Building occupants were generally satisfied with their workspaces and their buildings. Proportional odds ordinal logistic regression showed that satisfaction with all parameters listed in the survey contributed to overall workspace satisfaction. The most important parameters were: satisfaction with amount of space (odds ratio OR 1.57), noise (OR 1.27) and visual privacy (OR 1.26). Satisfaction with amount of space was not noticeably affected by size of workspace, and improved by having a private office and sitting close to a window.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, University of California
Authors: Frontczak, M. J. (Intern), Schiavon, S. (Ekstern), Goins, J. (Ekstern), Arens, E. (Ekstern), Zhang, H. (Ekstern), Wargocki, P. (Intern)
Publication date: 2011

Radiant heating and cooling by embedded water-based systems

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Olesen, B. W. (Intern)
Publication date: 2011

Reflections on the State of Research: Indoor Environmental Quality

More than 30 years after the First International Indoor Climate Symposium, ten researchers from the USA, Slovakia, Sweden, and Denmark gathered to review the current status of indoor environmental research. We initiated our review with discussions during the 1-day meeting and followed that with parallel research and writing efforts culminating with internal review and revision cycles. In this paper, we present our choices for the most important research findings on indoor environmental quality from the past three decades followed by a discussion of the most important research questions in our field today. We then continue with a discussion on whether there are research areas for which we can ‘close the book’ and say that we already know what is needed. Finally, we discuss whether we can maintain our identity in the future or it is time to team up with new partners.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Clausen, G. (Intern), Bekö, G. (Intern), Corsi, R. (Ekstern), Gunnarsen, L. (Ekstern), Nazaroff, W. (Ekstern), Olesen, B. W. (Intern), Sigsgaard, T. (Ekstern), Sundell, J. (Intern), Toftum, J. (Intern), Weschler, C. J. (Intern)
Pages: 219-230
Seasonal Ground Solar Thermal Energy Storage - Review of Systems and Applications

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Pavlov, G. K. (Intern), Olesen, B. W. (Intern)
Pages: P-1.2-07
Publication date: 2011

Host publication information
Title of host publication: Proceedings
Main Research Area: Technical/natural sciences
Electronic versions:
SEASONAL GROUND SOLAR.pdf
Source: orbit
Source-ID: 316330
Publication: Research - peer-review › Article in proceedings – Annual report year: 2011

Seasonal solar thermal energy storage through ground heat exchangers – Review of systems and applications

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Pavlov, G. K. (Intern), Olesen, B. W. (Intern)
Publication date: 2011

Host publication information
Title of host publication: Proceedings
Main Research Area: Technical/natural sciences
Electronic versions:
Seasonal solar thermal energy storage.pdf
Source: orbit
Source-ID: 316329
Publication: Research › Article in proceedings – Annual report year: 2011

Seasonal Variation in Monthly Average Air Change Rates Using Passive Tracer Gas Measurements

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Aalborg University
Authors: Frederiksen, M. (Ekstern), Bergsæe, N. C. (Ekstern), Kolarik, B. (Intern), Spilak, M. (Ekstern), Bekö, G. (Intern), Gustavsen, S. (Intern), Clausen, G. (Intern), Gunnarsen, L. (Ekstern)
Pages: Abstract No. 317
Publication date: 2011

Host publication information
Title of host publication: Proceedings of Indoor Air 2011
Main Research Area: Technical/natural sciences
Conference: 12th International Conference on Indoor Air Quality and Climate, Austin, TX, United States, 05/06/2011 - 05/06/2011
ACR, Indoor air quality, Exposure, PFT, Dwelling
Links:
http://www.isiaq.org/events/indoor-air-2011
Source: orbit
Source-ID: 313764
Publication: Research - peer-review › Article in proceedings – Annual report year: 2011
Simulation of energy use, human thermal comfort and office work performance in buildings with moderately drifting operative temperatures

Annual primary energy use in a central module of an office building consisting of two offices separated with a corridor was estimated by means of dynamic computer simulations. The simulations were conducted for conventional all-air VAV ventilation system and thermo active building system (TABS) supplemented with CAV ventilation. Simulations comprised moderate, hot–dry and hot–humid climate. Heavy and light wall construction and two orientations of the building (east–west and north–south) were considered. Besides the energy use, also capability of examined systems to keep a certain level of thermal comfort was examined. The results showed that with the moderate climate, the TABS decreased the primary energy use by about 16% as compared with the VAV. With hot–humid climate, the portion of the primary energy saved by TABS was ca. 50% even with the supply air dehumidification taken into account. The TABS working in a moderate climate kept the predicted percentage of dissatisfied (PPD) 10%; 1.4% in comparison to 17.5% h/yr. The highest estimated loss of occupants' productivity related to their thermal sensation hasn't exceeded 1% in whole year average.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, ALECTIA A/S
Authors: Kolarik, J. (Intern), Toftum, J. (Intern), Olesen, B. W. (Intern), Jensen, K. L. (Ekstern)
Pages: 2988-2997
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication information
Journal: Energy and Buildings
Volume: 43
Issue number: 11
ISSN (Print): 0378-7788
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BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 4.64 SJR 2.093 SNIP 1.965
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.088 SNIP 2.174 CiteScore 4.07
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.123 SNIP 2.936 CiteScore 4.21
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.897 SNIP 2.433 CiteScore 3.79
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.816 SNIP 2.737 CiteScore 3.36
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.506 SNIP 2.536 CiteScore 3.23
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.631 SNIP 2.081
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.564 SNIP 1.79
Squalene and cholesterol in dust from Danish homes and daycare centers

Given the rate at which humans shed their skin (desquamation), skin flakes that contain squalene and cholesterol are anticipated to be major constituents of indoor dust. These compounds have been detected in more than 97% of the dust...
samples collected from 500 bedrooms and 151 daycare centers of young children living in Odense, Denmark. The mass fractions of squalene in dust were approximately log-normally distributed (homes: GM = 32 μg/g, GSD = 4.3; daycare centers: GM = 11.5 μg/g, GSD = 4.3); those of cholesterol displayed a poorer fit to such a distribution (homes: GM = 625 μg/g, GSD = 3.4; daycare centers: GM = 220 μg/g, GSD = 4.0). Correlations between squalene and cholesterol were weak (r = 0.22). Furthermore, the median squalene-to-cholesterol ratio in dust (0.05) was more than an order of magnitude smaller than that in skin oil. This implies sources in addition to desquamation (e.g., cholesterol from cooking) coupled, perhaps, with a shorter indoor lifetime for squalene. Estimated values of squalene’s vapor pressure, while uncertain, suggest meaningful redistribution from dust to other indoor compartments. We estimate that dust containing squalene at 60 μg/g would contribute about 4% to overall ozone removal by indoor surfaces. This is roughly comparable to the fraction of ozone removal that can be ascribed to reactions with indoor terpenes. Squalene containing dust is anticipated to contribute to the scavenging of ozone in all settings occupied by humans.

**General information**

State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Weschler, C. J. (Intern), Langer, S. (Ekstern), Fischer, A. (Ekstern), Bekö, G. (Intern), Toftum, J. (Intern), Clausen, G. (Intern)
Pages: 3872-3879
Publication date: 2011
Main Research Area: Technical/natural sciences

**Publication information**

Journal: Environmental Science & Technology (Washington)
Volume: 45
Issue number: 9
ISSN (Print): 0013-936X
Ratings:
- BFI (2018): BFI-level 2
- Web of Science (2018): Indexed yes
- BFI (2017): BFI-level 2
- Web of Science (2017): Indexed yes
- BFI (2016): BFI-level 2
- Scopus rating (2016): CiteScore 6.26 SJR 2.538 SNIP 1.889
- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 2
- Scopus rating (2015): SJR 2.584 SNIP 1.828 CiteScore 5.61
- Web of Science (2015): Indexed yes
- BFI (2014): BFI-level 2
- Scopus rating (2014): SJR 2.777 SNIP 2.017 CiteScore 5.5
- Web of Science (2014): Indexed yes
- BFI (2013): BFI-level 2
- Scopus rating (2013): SJR 2.956 SNIP 2.103 CiteScore 5.52
- ISI indexed (2013): ISI indexed yes
- Web of Science (2013): Indexed yes
- BFI (2012): BFI-level 2
- Scopus rating (2012): SJR 3.146 SNIP 2.056 CiteScore 5.17
- ISI indexed (2012): ISI indexed yes
- Web of Science (2012): Indexed yes
- BFI (2011): BFI-level 2
- Scopus rating (2011): SJR 3.178 SNIP 1.953 CiteScore 5.16
- ISI indexed (2011): ISI indexed yes
- Web of Science (2011): Indexed yes
- BFI (2010): BFI-level 2
- Scopus rating (2010): SJR 2.964 SNIP 1.729
- Web of Science (2010): Indexed yes
- BFI (2009): BFI-level 2
- Scopus rating (2009): SJR 2.835 SNIP 1.803
- Web of Science (2009): Indexed yes
Squalene and cholesterol in dust samples collected from children's bedrooms and daycare centers in Denmark

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, University of Gothenburg
Authors: Weschler, C. J. (Intern), Langer, S. (Ekstern), Fischer, A. (Ekstern), Bekö, G. (Intern), Toftum, J. (Intern), Clausen, G. (Intern)
Pages: Abstract No. 413
Publication date: 2011

Host publication information
Title of host publication: Proceedings of Indoor Air 2011
Main Research Area: Technical/natural sciences
Conference: 12th International Conference on Indoor Air Quality and Climate, Austin, TX, United States, 05/06/2011 - 05/06/2011
Stratum corneum, Skin surface lipids, Cooking, Ozonolysis, Desquamation
Links:
http://www.isiaq.org/events/indoor-air-2011

Standards for Ventilation and Indoor Air Quality in relation to the EPBD

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Olesen, B. W. (Intern)
Pages: 28-33
Publication date: 2011
Stor dansk delegation til Indoor Air 2011

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Toftum, J. (Intern)
Pages: 24-26
Publication date: 2011
Main Research Area: Technical/natural sciences

Publications information
Journal: H V A C Magasinet
Issue number: 9
ISSN (Print): 1603-6913
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: English
Electronic versions:
Indoor Air 2011.pdf
Links:
http://techmedia.swiflet.com/tm/hvac/59/1/
Source: orbit
Source-ID: 316393
Publication: Communication › Journal article – Annual report year: 2011

Subjective evaluation of mixing and displacement ventilation combined with a radiant floor system

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Krajcik, M. (Intern), Tomasi, R. (Intern), Simone, A. (Intern), Olesen, B. W. (Intern)
Pages: 19-24
Publication date: 2011

Host publication information
Title of host publication: Proceedings of the 22th annual conference Indoor Climate of Buildings 2011
ISBN (Print): 978-80-89216-44-4
Main Research Area: Technical/natural sciences
Electronic versions:
ICB_2011_Slovakia_EN1_as (2)-bwo-1-michal.pdf
Source: dtu
Source-ID: u::6672
Publication: Research - peer-review › Article in proceedings – Annual report year: 2012
Subjective thermal sensation and human body exergy consumption rate: analysis and correlation

The exergy approach to design and operation of climate conditioning systems is relatively well established, while its exploitation in connection to human perception of the indoor environment is relatively rare. As a building should provide healthy and comfortable environment for its occupants, it is reasonable to consider both the exergy flows in building and those within the human body. There is a need to verify the human-body exergy model with the Thermal-Sensation (TS) response of subjects exposed to different combinations of indoor climate parameters (temperature, humidity, etc.). First results available on the relation between human-body exergy consumption rates and subjectively assessed thermal sensation showed that the minimum human body exergy consumption rate is associated with thermal sensation votes close to thermal neutrality, tending to slightly cool side of thermal sensation. By applying the exergy concept to the built indoor environment, additional results are going to be explored. By using the data available so far of operative temperature (to), the human body exergy consumption rates increase as to increases above 24°C or decreases below 22°C at relative humidity (RH) lower than 50%. While, at 85% of RH, the human-body exergy consumption rates decrease when to is increasing above 24 °C.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, University of Ljubljana, Architech Consulting Co., Central Research Institute of Electric Power Industry, Eindhoven University of Technology, Tokyo City University
Authors: Simone, A. (Intern), Dovjak, M. (Ekstern), Kolarik, J. (Intern), Asada, H. (Ekstern), Iwamatsu, T. (Ekstern), Schellen, L. (Ekstern), Shukuya, M. (Ekstern), Olesen, B. W. (Intern)
Publication date: 2011

Ventilation and dampness in dorms and their associations with allergy among college students in China: a case-control study.

Abstract To study the associations between dorm environment and occupants' health, a nested case-control study on 348 college students was carried out in 2006-2007 at Tianjin University, China. Two hundred and twenty-three dorm rooms where the 'cases' and 'controls' resided were inspected. Measured variables were ventilation rate, air temperature, and relative humidity indoors. Allergic symptoms in the last 12 months were self-reported by occupants. Adjusted odds ratios (AORs) of a 'localized moldy smell/moisture indicator' in 'special places' (e.g., in a room corner or close to the radiator under the window) for wheezing was 3.56 [95% Confident Interval (CI): 1.56-8.14] and for rhinitis 2.81 (95% CI: 1.32-5.97). The AOR of a low air change rate (below the median value of 0.7/h) for wheezing was 2.28 (95% CI: 1.38-3.75) and for dry cough 2.26 (95% CI: 1.08-4.75). The prevalence of students with allergic symptoms in dorm rooms decreased with increasing ventilation rate. The combination of a 'localized moldy/moisture indicator' and a low air change rate significantly increased the AOR of case status to 13.35 (95% CI: 3.73-47.83), compared to the reference condition with no-dampness and high ventilation rate (above the median). This supports the hypothesis that ventilation rate is an effect modifier for moisture problems and indoor pollutants. PRACTICAL IMPLICATIONS: Dorm rooms, a kind of residential environment for students, may be more polluted than the home environment. This is especially the case in developing countries like China, where dorms tend to be more crowded. In dorms, a low ventilation rate is a risk factor for asthma and allergy. Sufficient fresh outdoor air should be provided to students' dormitories by controlled ventilation. Mechanical ventilation system are often needed in regions such as north China, as the buildings are now 'tight' and opening of windows is not a solution during the cold winter.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Pennsylvania State University, Tianjin University
Authors: Sun, Y. (Ekstern), Zhang, Y. (Ekstern), Bao, L. (Ekstern), Fan, Z. (Ekstern), Sundell, J. (Intern)
Pages: 277-283
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication information
Journal: Indoor Air
Advanced Methods for Air Distribution in Occupied Spaces for Reduced Risk from Air-Borne Diseases and Improved Air Quality

The current Ph.D. thesis deals with new advanced methods of air distribution in occupied places aimed to improve the inhaled air quality and to reduce the risk from airborne cross infection among the occupants.

The existing ventilation strategies nowadays are not able to provide enough clean air to the occupants and can even enhance the risk from cross-infection from airborne diseases indoors. Clearly new advanced methods are needed to improve the current situation. The subject is especially important because of the energy issue as well as the increased possibility of random mutations of known airborne pathogens. The threat from possible bio-terrorist attacks in the last decade makes the topic quite important.

So far the existing methods of indoor air cleaning rely on several basic strategies: dilution, filtration and Ultra Violet Germicidal Irradiation (UVGI). Dilution utilizes ventilation at high flow rates to reduce the concentration of pollutants/pathogens to levels that would not deteriorate the air quality or be harmful for the occupants. It is also connected to certain energy limitation issues.

Filtration and UVGI are efficient in protecting occupants provided the sources are located outdoors. However, these methods are not very efficient, if the contaminant sources are indoors and especially if the source is a sick individual. The current thesis focuses on two ways to provide reduced risk from airborne infections: by providing personal protection of each individual in an office environment and by protecting medical staff, patients and visitors from cross-infection in hospital wards.

The first part of the thesis focuses on improvement of inhaled air quality and thus reduction in the risk from cross-infection by advanced ventilation, providing clean air close to the occupants with personalized ventilation (PV) by applying control over the airflow interaction at the breathing zone. Two new control methods, namely control over the free convection layer around the human body and control over the personalized flow are studied when applied for different PV designs. The first method aims to reduce the strength of the free convection layer via blocking or local exhausting, and thus make possible its penetration by the personalized flow at low velocity (low flow rate). The second method aims to control the way the PV flow is supplied so that it is less affected by the flow interaction around the human body: by immersing it within the convection flow or by simply substituting the boundary layer with a PV flow adjacent to the body. Both methods helped greatly increase the performance of the employed PV systems with respect to the amount of clean air supplied into the breathing zone of the occupant compared to the case when the PV was used alone. These methods also show great potential for energy savings, due to the reduced PV flow rate. The
suggested designs are easy for implementation in occupied spaces, where people spend most of the time seated, e.g. offices, theaters, cinemas, busses, trains, airplanes, etc.

The second part of the thesis focuses on a novel ventilation strategy for reduction the risk of cross-infection for medical staff, visitors, and patients in hospital wards. The novel ventilation strategy is implemented by a specially developed device, named Hospital Bed Integrated Ventilation Cleansing Unit (the device is part of a patient application in Europe (EP 09165736.1) and in the United States of America (US 61/226,542). The HBIVCU helped to provide improved protection to doctor and other patients, present in a space, from a sick individual with highly contagious airborne transferred disease, by locally evacuating the air coughed by the sick patient. Apart of increased protection the use of the HBIVCU leads to decrease of the background ventilation rate. This technique of local exhaust and cleaning of the coughed air can provide solution to the existing problems in a hospital environment related to control and, handling the spread and treating patients with contagious airborne diseases, as well as problems with insufficient space in hospital wards in times of epidemics and pandemics.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Bolashikov, Z. D. (Intern)
Number of pages: 356
Publication date: 2010

Publication information
Place of publication: Kgs. Lyngby, Denmark
Publisher: Technical University of Denmark, Department of Civil Engineering
ISBN (Print): 9788778773180
Original language: English

Series: DTU Civil Engineering Report
Number: R-239
ISSN: 1601-2917
Main Research Area: Technical/natural sciences
Electronic versions:
Zhecho_Bolashikovs_PhD_f_rdig_fra_Schultz.pdf
Publication: Research › Ph.D. thesis – Annual report year: 2010

Air pollution from residential wood combustion in a Danish village: Indoor-outdoor measurements

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Toftum, J. (Intern)
Publication date: 2010

Publication information
Original language: English
Main Research Area: Technical/natural sciences
Electronic versions:
Indoor_outdoor.pdf
Source: orbit
Source-ID: 272344
Publication: Research › Report – Annual report year: 2010

Analysis on exergy consumption patterns for space heating in Slovenian buildings

Problem of high energy use for heating in Slovenian buildings is analyzed with exergy and energy analysis. Results of both are compared and discussed. Three cases of exterior building walls are located in three climatic zones in winter conditions. Results of energy analyses show that the highest heating energy demand appears in the case with less thermal insulation, especially in colder climate. The comparison is made only on the energy supply and exergy supply, the results of exergy analysis are the same as those of energy analysis. The main difference appears, if the whole chain of supply and demand is taken into consideration. Exergy calculations enable us to analyze how much exergy is consumed in which part, from boiler to building envelope. They also reveal how much energy is supplied for the purpose of heating. Results show that insulation has much bigger effect than effect of boiler efficiency. However, the most effective solution is to improve building envelope together with boiler efficiency. Better thermal insulation also makes an important contribution to the improvement of thermal comfort conditions. It causes higher surface temperatures resulting in a larger warm radiant exergy emission rate and consequently better thermal comfort.

General information
An investigation on the assessed thermal sensation and human body exergy consumption rate

The exergy concept helps to optimize indoor climate conditioning systems to meet the requirements of sustainable building design. While the exergy approach to design and operation of indoor climate conditioning systems is relatively well established, its exploitation in connection to human perception of the indoor environment is rare. As the building should provide healthy and comfortable environment for its occupants, it is reasonable to consider both the exergy flows in the building and within the human body. A relatively new approach of the relation between the exergy concept and the built-environment research has been explored in the present work. The relationship of subjectively assessed thermal sensation data, from earlier thermal comfort studies, to the calculated human-body exergy consumption has been analysed. The results show that the minimum human body exergy consumption rate was related to the thermal sensation votes close to thermal neutrality, tending to the slightly cool side.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Simone, A. (Intern), Kolarik, J. (Intern), Iwamatsu, T. (Ekstern), Asada, H. (Ekstern), Dovjak, M. (Ekstern), Schellen, L. (Ekstern), Shukuya, M. (Ekstern), Olesen, B. W. (Intern)
Publication date: 2010

Host publication information
Title of host publication: Proceedings of Clima 2010 congress: 10th REHVA World Congress "sustainable Energy Use in Buildings"
Volume: Proceedings on CD Rom
Main Research Area: Technical/natural sciences
Conference: 10th Rehva World Congress "Sustainable Energy Use in Buildings", Antalya, Turkey, 09/05/2010 - 09/05/2010
Source: orbit
Source-ID: 262413
Publication: Research - peer-review › Article in proceedings – Annual report year: 2010
Can a photocatalytic air purifier be used to improve the perceived air quality indoors?
The effect of a photocatalytic air purifier on perceived air quality (PAQ) was examined in rooms polluted by typical sources of indoor pollution. The rooms were ventilated at three different outdoor air supply rates. The air quality was assessed by a sensory panel when the purifier was in operation as well as when it was off. Operation of the purifier significantly improved PAQ in the rooms polluted by building materials (used carpet, old linoleum, and old chip-board), and a used ventilation filter as well as a mixture of building materials, used ventilation filter and cathode-ray tube computer monitors. The effect corresponded to approximately doubling the outdoor air supply rate. Operation of the purifier significantly worsened the PAQ in rooms with human bioeffluents, probably due to incomplete oxidation of alcohols which are one of the main pollutants emitted by humans. Present results show that the photocatalytic air purifier can supplement ventilation when the indoor air is polluted by building-related sources, but should not be used in spaces where human bioeffluents constitute the main source of pollution.
Ceiling mounted personalized ventilation system in hot and humid climate-An energy analysis

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Yang, B. (Ekstern), Sekhar, C. (Ekstern), Melikov, A. K. (Intern)
Pages: 2304-2308
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: Energy and Buildings
Volume: 42
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BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 4.64 SJR 2.093 SNIP 1.965
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.088 SNIP 2.174 CiteScore 4.07
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.123 SNIP 2.936 CiteScore 4.21
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.897 SNIP 2.433 CiteScore 3.79
ISI indexed (2013): ISI indexed yes

Sensory panel, Photocatalytic air purifier, Indoor pollution sources, Perceived air quality
DOIs:
10.1111/j.1600-0668.2010.00650.x
Source: orbit
Source-ID: 255552
Publication: Research - peer-review › Journal article – Annual report year: 2010
Ceiling-mounted personalized ventilation system integrated with a secondary air distribution system - a human response study in hot and humid climate

The benefits of thermal comfort and indoor air quality with personalized ventilation (PV) systems have been demonstrated in recent studies. One of the barriers for wide spread acceptance by architects and HVAC designers has been attributed to challenges and constraints faced in the integration of PV systems with the work station. A newly developed ceiling-mounted PV system addresses these challenges and provides a practical solution while retaining much of the apparent benefits of PV systems. Assessments of thermal environment, air movement, and air quality for ceiling-mounted PV system were performed with tropically acclimatized subjects in a Field Environmental Chamber. Thirty-two subjects performed normal office work and could choose to be exposed to four different PV airflow rates (4, 8, 12, and 16 L/s), thus offering themselves a reasonable degree of individual control. Ambient temperatures of 26 and 23.5 degrees C and PV air temperatures of 26, 23.5, and 21 degrees C were employed. The local and whole body thermal sensations were reduced when PV airflow rates were increased. Inhaled air temperature was perceived cooler and perceived air quality and air freshness improved when PV airflow rate was increased or temperature was reduced.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Thermal comfort, Indoor air quality, Ceiling-mounted air terminal devices, Personalized ventilation, Tropically acclimatized
Central automatic control or distributed occupant control for better indoor environment quality in the future
Based on a database accumulated from several recent surveys of office buildings located in a temperate climate (Denmark), the effect on occupant perceptions and symptom prevalence was compared in buildings with natural and with mechanical ventilation in which earlier studies have shown a discrepancy in the degree of perceived control. The database was composed of 1272 responses obtained in 24 buildings of which 15 had mechanical ventilation (997 responses) and 9 had natural ventilation (275 responses). The number of occupant-reported control opportunities was higher in buildings with natural ventilation. Analysis of occupant responses, after grouping according to categories determined by the degree of satisfaction with the perceived control, showed that it was more likely the degree of control satisfaction that affected the prevalence of adverse perceptions and symptoms. Thus, the degree of control, as perceived by occupants, seemed more important for the prevalence of adverse symptoms and building-related symptoms than the ventilation mode per se. This result indicates that even though the development and application of new indoor environment sensors and HVAC control systems may allow for fully automated IEQ control, such systems should not compromise occupants' perception of having some degree of control of their indoor environment.
Characterization and optimized control by means of multi-parameter controllers

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling, Section for Indoor Environment, Department of Civil Engineering, Teknologisk Institut, Businessminds
Authors: Jensen, S. Ø. (Ekstern), Andersen, P. H. D. (Intern), Heerup, C. (Ekstern), Larsen, S. (Ekstern), Olsen, L. (Ekstern), Toftum, J. (Intern), Trombe, P. (Intern)
Number of pages: 276
Publication date: 2010

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Classroom ventilation must be improved for better health and learning

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Wyon, D. P. (Intern), Wargocki, P. (Intern), Toftum, J. (Intern), Clausen, G. (Intern)
Pages: 35-39
Publication date: 2010
Main Research Area: Technical/natural sciences
Control of the Free Convective Flow around the Human Body for Enhanced Inhaled Air Quality: Application to a Seat-Incorporated Personalized Ventilation Unit

This paper reports on methods for control of the free convective flow around the human body, with the aim of improving inhaled air quality. The methods were studied with sea-incorporated personalized ventilation (PV)-two PV nozzles placed sideways at the head level of a seated occupant supplied the clean air. Another pair of control nozzles below the PV nozzles, the height of the shoulders, either provided an additional amount of clean PV air or exhausted part of the air from the free convective flow. The effectiveness of the methods for enhancing the quality of the inhaled air was studied in full-scale room experiments. A thermal manikin with a realistic free convective flow was used to resemble an occupant in a state of thermal neutrality at a sedentary activity level. Numerous experiments comprising different combinations of nozzle sizes, supply and exhaust flow rates, and direction of the supplied PV flows and of the control flows, etc., were performed under isothermal conditions at 20 degrees C (68 degrees F) and 26 degrees C (78.8 degrees F). The methods of control proved to be efficient and made it possible to increase the amount of clean air into inhalation at reduced personalized flow rate and to reduce the risk of draft.
Culturable mold in indoor air and its association with moisture-related problems and asthma and allergy among Swedish children

In a nested case-control study with 198 children with asthmatic and allergic symptoms (cases) and 202 healthy controls in Varmland, Sweden, we have investigated the relationship between mold spore exposure (mean colony-forming unit) indoor and (i) different indexes of moldy odor indoor (observed by professional inspectors and reported by parents), (ii) visible signs of dampness in the homes of the children (observed and reported), and (iii) doctor-diagnosed asthma/allergy in children. No association was found between the spore concentration indoor and moldy odor and signs of visible dampness in the homes. When a semi-quantitative method in distinguishing between moldy houses or non-moldy houses was used, there were no significant differences between the observed indexes of moldy odor or visible signs of dampness (both observed and reported). No association could be found between the spore concentration in indoor air and asthma/allergy in the children.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Holme, J. (Ekstern), Hagerhed-Engman, L. (Ekstern), Mattsson, J. (Ekstern), Sundell, J. (Intern), Bornehag, C. (Intern)
Pages: 329-340
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: Indoor Air
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ISSN (Print): 0905-6947
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
Design of an individually controlled system for an optimal thermal microenvironment

Individually controlled microenvironment has potential to satisfy more occupants in a space compared to a total volume uniform environment typically used at present. The performance of an individually controlled system comprising a convection-heated chair, an under-desk radiant heating panel, a floor radiant heating panel, an under-desk air terminal device supplying cool air, and a desk-mounted personalized ventilation as used and identified by 48 human subjects was studied using a thermal manikin at room temperatures of 20 °C, 22 °C and 26 °C. At a room air temperature of 20 °C, the maximum whole-body heating effect of the heating chair, the under-desk heating panel, and the floor heating panel corresponded to the effect of a room temperature increase of 5.2 °C, 2.8 °C, and 2.1 °C, respectively. The effect was 5.9 °C for the combination of the three heating options. The higher the room air temperature, the lower the heating effect of each heating option or heating combination. The maximum whole-body cooling effect of the tested system was only −0.8
°C at a room air temperature of 26 °C. The heating and cooling capacity of the individually controlled system were identified. These results, analyzed together with results obtained from human subject experiments, reveal that both the heating and the cooling capacity of the individually controlled system need to be increased in order to satisfy most occupants in practice.

**General information**

State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Watanabe, S. (Ekstern), Melikov, A. K. (Intern), Knudsen, G. L. (Ekstern)
Pages: 549-558
Publication date: 2010
Main Research Area: Technical/natural sciences

**Publication information**
Journal: Building and Environment
Volume: 45
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BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.51 SJR 2.015 SNIP 2.198
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 2.093 SNIP 2.49 CiteScore 4.37
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.938 SNIP 2.797 CiteScore 4.14
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.581 SNIP 2.602 CiteScore 3.57
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.331 SNIP 2.875 CiteScore 3.06
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.144 SNIP 2.255 CiteScore 2.76
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.235 SNIP 2.001
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.028 SNIP 1.865
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.924 SNIP 1.38
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.788 SNIP 1.778
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.03 SNIP 1.63
Scopus rating (2005): SJR 0.955 SNIP 1.225
Determination of material emission signatures by PTR-MS and their correlations with odor assessments by human subjects

The objectives of this study were to determine volatile organic compound (VOC) emission signatures of nine typical building materials by using proton transfer reaction-mass spectrometry (PTR-MS) and to explore the correlation between the PTR-MS measurements and the measurements of acceptability by human subjects. VOC emissions from each material were measured in a 50-l small-scale chamber. Chamber air was sampled by PTR-MS to determine emission signatures. Sorbent tube sampling and TD-GC/MS analysis were also performed to identify the major VOCs emitted and to compare the resulting data with the PTR-MS emission signatures. The data on the acceptability of air quality assessed by human subjects were obtained from a previous experimental study in which the emissions from the same batch of materials were determined under the same area-specific ventilation rates as in the case of the measurements with PTR-MS. Results show that PTR-MS can be an effective tool for establishing VOC emission signatures of material types and that there were reasonable correlations between the PTR-MS measurements and the acceptability of air quality for the nine materials tested when the sum of selected major individual VOC odor indices was used to represent the emission level measured by PTR-MS.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Syracuse University, Aalborg University
Pages: 341-354
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: Indoor Air
Volume: 20
Issue number: 4
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.55
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 3.88
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 4.57
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Determination of the integral characteristics of an asymmetrical thermal plume from air speed/velocity and temperature measurements

A method, named the Approximate Distributions Integration Method (ADI-method), is proposed for calculation of parameters of the asymmetrical thermal plume above a heat source, such as maximum air temperature excess and velocity, their position in the plume cross-section, the widths of the temperature and velocity profiles, asymmetry parameters of the plume cross-section, and the integral characteristics. The method is based on an approximation of the measured profiles of air velocity and air temperature excess in the plume cross-section. A procedure for conversion of the air speed measured by omnidirectional sensors into air velocity is incorporated with the ADI-method. Experiments were performed in a climate chamber with air temperature of 23 °C, radiant temperature equal to the air temperature and upward airflow with velocity of less than 0.05 m/s. Air speed and temperature in a thermal plume, generated by a thermal manikin resembling the complex body shape and heat generated by a sitting person, were measured. Using the measured data, the integral characteristics of the generated asymmetrical thermal plume were calculated by the ADI-method, and the uncertainty in determination of the characteristics was identified. At a height of 0.7 m above the manikin head, the mean integral characteristics of the plume and their 95% certainty range (in parentheses) were: volume flux 258 m$^3$/h (1.8%), momentum flux 0.0087 N (2.0%), buoyancy force density 0.0038 kg/s$^2$ (3.8%) and enthalpy flux 16 W (2.8%).

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Silesian University of Technology
Authors: Zukowska, D. (Intern), Popiolek, Z. (Ekstern), Melikov, A. K. (Intern)
Pages: 1205-1216
Differences between young adults and elderly in thermal comfort, productivity and thermal physiology in response to a moderate temperature drift

Results from naturally ventilated buildings show that allowing the indoor temperature to drift does not necessarily result in thermal discomfort and may allow for a reduction in energy use. However, for stationary conditions, several studies indicate that the thermal neutral temperature and optimum thermal condition differ between young adults and elderly. There is a lack of studies that describe the effect of aging on thermal comfort and productivity during a moderate temperature drift. In this study, the effect of a moderate temperature drift on physiological responses, thermal comfort, and productivity of eight young adults (age 22–25 year) and eight older subjects (age 67–73 year) was investigated. They were exposed to two different conditions: S1-a control condition; constant temperature of 21.5°C; duration: 8 h; and S2-a transient condition; temperature range: 17–25°C, duration: 8 h, temperature drift: first 4 h: +2 K/h, last 4 h: −2 K/h. The results indicate that thermal sensation of the elderly was, in general, 0.5 scale units lower in comparison with their younger counterparts. Furthermore, the elderly showed more distal vasoconstriction during both conditions. Nevertheless, TS of the elderly was related to air temperature only, while TS of the younger adults also was related to skin temperature. During the constant temperature session, the elderly preferred a higher temperature in comparison with the young adults.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Technische Universiteit Eindhoven
Authors: Schellen, L. (Ekstern), Lichtenbelt, W. V. M. (Ekstern), Loomans, M. (Ekstern), Toftum, J. (Intern), de Wit, M. (Ekstern)
Pages: 273-283
Publication date: 2010
Main Research Area: Technical/natural sciences

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Journal: Indoor Air
Volume: 20
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Web of Science (2018): Indexed yes
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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.55
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 3.88
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 4.57
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 3.63
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 2.72
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 2.42
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Does increased ventilation help reduce cross-infection in isolation hospital wards?

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Section for Building Physics and Services
Authors: Melikov, A. K. (Intern), Bolashikov, Z. D. (Intern), Kierat, W. (Ekstern), Popiolek, Z. (Ekstern), Brand, M. (Intern)
Publication date: 2010

Host publication information
Title of host publication: Proceedings of CLIMA 2010 : Paper R7-TS39-OP02
Main Research Area: Technical/natural sciences
Conference: 10th Rehva World Congress "Sustainable Energy Use in Buildings", Antalya, Turkey, 09/05/2010 - 09/05/2010
Source: orbit
Source-ID: 272844
Publication: Research - peer-review › Article in proceedings – Annual report year: 2010

Editorial in the "Buildings and Environment " journal

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Kim, K. W. (ed.) (Intern), Olesen, B. W. (Intern)
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: Building and Environment
Volume: 45
Issue number: 9
ISSN (Print): 0360-1323
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
Effect of warm air supplied facially on occupants' comfort

Human response to air movement supplied locally towards the face was studied in a room with an air temperature of 20 °C and a relative humidity of 30%. Thirty-two human subjects were exposed to three conditions: calm environment and facially supplied airflow at 21 °C and at 26 °C. The air was supplied with a constant velocity of 0.4 m/s by means of personalized ventilation towards the face of the subjects. The airflow at 21 °C decreased the subjects' thermal sensation...
and increased draught discomfort, but improved slightly the perceived air quality. Heating of the supplied air by 6 K (temperature increase by 4 K at the target area) above the room air temperature decreased the draught discomfort, improved subjects' thermal comfort and only slightly decreased the perceived air quality. Elevated velocity and temperature of the localized airflow caused an increase of nose dryness intensity and number of eye irritation reports. Results suggest that increasing the temperature of the air locally supplied to the breathing zone by only a few degrees above the room air temperature will improve occupants' thermal comfort and will diminish draught discomfort. This strategy will extend the applicability of personalized ventilation aiming to supply clean air for breathing at the lower end of the temperature range recommended in the standards. Providing individual control is essential in order to avoid discomfort for the most sensitive occupants.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Kaczmarczyk, J. (Ekstern), Melikov, A. K. (Intern), Sliva, D. (Ekstern)
Pages: 848-855
Publication date: 2010
Main Research Area: Technical/natural sciences

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Journal: Building and Environment
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Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.51 SJR 2.015 SNIP 2.198
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 2.093 SNIP 2.49 CiteScore 4.37
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.938 SNIP 2.797 CiteScore 4.14
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.581 SNIP 2.602 CiteScore 3.57
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.331 SNIP 2.875 CiteScore 3.06
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.144 SNIP 2.255 CiteScore 2.76
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.235 SNIP 2.001
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.028 SNIP 1.865
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.924 SNIP 1.38
Web of Science (2008): Indexed yes
Effects of prenatal exposure to surface-coated nanosized titanium dioxide (UV-Titan). A study in mice

Background: Engineered nanoparticles are smaller than 100 nm and designed to improve or achieve new physicochemical properties. Consequently, also toxicological properties may change compared to the parent compound. We examined developmental and neurobehavioral effects following maternal exposure to a nanoparticulate UV-filter (UV-titan L181). Methods: Time-mated mice (C57BL/6BomTac) were exposed by inhalation 1h/day to 42 mg/m(3) aerosolized powder (1.7.10(6) n/cm(3); peak-size: 97 nm) on gestation days 8-18. Endpoints included: maternal lung inflammation; gestational and litter parameters; offspring neurofunction and fertility. Physicochemical particle properties were determined to provide information on specific exposure and deposition. Results: Particles consisted of mainly elongated rutile titanium dioxide (TiO2) with an average crystallite size of 21 nm, modified with Al, Si and Zr, and coated with polyalcohols. In exposed adult mice, 38 mg Ti/kg was detected in the lungs on day 5 and differential cell counts of bronchoalveolar lavage fluid revealed lung inflammation 5 and 26-27 days following exposure termination, relative to control mice. As young adults, prenatally exposed offspring tended to avoid the central zone of the open field and exposed female offspring displayed enhanced prepulse inhibition. Cognitive function was unaffected (Morris water maze test). Conclusion: Inhalation exposure to nano-sized UV Titan dusts induced long term lung inflammation in time-mated adult female mice. Gestationally exposed offspring displayed moderate neurobehavioral alterations. The results are discussed in the light of the observed particle size distribution in the exposure atmosphere and the potential pathways by which nanoparticles may impart changes in fetal development.

General information
State: Published
Organisations: Division of Food Chemistry, Division of Toxicology and Risk Assessment, National Food Institute, Section for Indoor Environment, Department of Civil Engineering, National Research Center for Working Environment
Pages: 16
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: Particle and Fibre Toxicology
Volume: 7
ISSN (Print): 1743-8977
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 9.4 SJR 2.742 SNIP 2.165
Energy analysis of the personalized ventilation system in hot and humid climates

Personalized ventilation (PV) is an individually controlled air distribution system aimed at improving the quality of inhaled air and the thermal comfort of each occupant. Numerous studies have shown that PV in comparison with traditional mechanical ventilation systems may improve occupants' health, inhaled air quality, thermal comfort, and self-estimated productivity. Little is known about its energy performance. In this study, the energy consumption of a personalized ventilation system introduced in an office building located in a hot and humid climate (Singapore) has been investigated by means of simulations with the empirically tested IDA-ICE software. The results reveal that the use of PV may reduce the energy consumption substantially (up to 51%) compared to mixing ventilation when the following control strategies are applied: (a) reducing the airflow rate due to the higher ventilation effectiveness of PV; (b) increasing the maximum allowed room air temperature due to PV capacity to control the microclimate; (c) supplying the outdoor air only when the occupant is at the desk. The strategy to control the supply air temperature does not affect the energy consumption in a hot and humid climate.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Schiavon, S. (Ekstern), Melikov, A. K. (Intern), Sekhar, C. (Ekstern)
Experimental investigation of performance of a novel ventilation method for hospital patient rooms
A novel hospital bed integrated ventilation and cleaning unit (HBIVCU) was developed to reduce the exposure of medical staff, visitors, etc. to coughed air from a sick patient. The performance efficiency of the unit was studied in a full-scale mock-up of a hospital room with two beds with patients and a doctor. Four HBIVCUs were placed along the two sides of the two beds. The room was ventilated by mixing air distribution (ceiling installed supply air terminals) at room air temperature of 22 °C. The coughing patient and the second exposed patient were simulated by two heated dummies with simplified geometry. Thermal manikin with realistic body shape and surface temperature distribution was used to mimic the doctor standing beside the bed of the coughing patient. The doctor and the coughing patient were facing each other. The coughing dummy was equipped with a cough generator. The cough produced consisted of 100% CO2. The performance of the developed unit at background ventilation rates equivalent to 3 h⁻¹ and 6 h⁻¹ was evaluated by measuring the excess CO2 concentration at the mouth of the doctor and at the mouth of the exposed patient. When the novel method was not used, the measured Peak Concentration Level of CO2 was 10288 ppm and 5518 ppm for the doctor and for the exposed patient respectively. With the HBIVCUs installed and operational no significant increase in the CO2 concentration above the background room level was measured. The performance of the unit at 3 and 6 h⁻¹ was the same suggesting possible energy savings when operated at the lower background ventilation rate.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Melikov, A. K. (Intern), Bolashikov, Z. D. (Intern), Brand, M. (Intern)
Number of pages: 9
Publication date: 2010

Host publication information
Title of host publication: Proceedings of the 21st Congress of International Federation of Hospital Engineering (IFHE)
Main Research Area: Technical/natural sciences
Conference: 21st Congress of International Federation of Hospital Engineering (IFHE), Tokyo, Japan, 17/11/2010 - 17/11/2010
Source: PublicationPreSubmission
Source-ID: 102349085
Publication: Research - peer-review › Article in proceedings – Annual report year: 2010

Experimental study of air distribution and ventilation effectiveness in a room heated by warm air and/or floor heating
The levels of required ventilation depend on the criteria for indoor air quality in existing standards and guidelines. On top of that, the resulting ventilation in air changes per hour is depending on the ventilation effectiveness. In the standard CR 1752 the recommended values for ventilation effectiveness depend on position of supply and exhaust device and on the difference between supply and room air temperature. Among other, for warm air heating the ventilation effectiveness is always less than 1 and it can be as low as 0.4. This would then require increased amount of ventilation. But how much higher ventilation rate is needed? And will it be sufficient to heat a low energy house alone with warm air heating? The performance of an experimental residential room, heated by only a warm air system or by a combination of a ventilation system and floor heating, has been studied.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Slovak University of Technology, Uponor Wirsbo A/S
Authors: Simone, A. (Intern), Olesen, B. W. (Intern), Krajčík, M. (Ekstern), Hansen, J. J. (Ekstern)
Number of pages: 8
Publication date: 2010

Host publication information
Exposure of health care workers to coughed airborne pathogens in a hospital room with overhead mixing ventilation: impact of the ventilation rate and the distance downstream from the coughing patient

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Bolashikov, Z. D. (Intern), Melikov, A. K. (Intern), Kierat, W. (Ekstern), Popiołek, Z. (Ekstern)
Pages: 126
Publication date: 2010

Host publication information
Title of host publication: Proceedings of ASHRAE IAQ 2010
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 272842
Publication: Research - peer-review › Article in proceedings – Annual report year: 2010

Exposure to coughed airborne pathogens in a double bed hospital patient room with overhead mixing ventilation: impact of posture of coughing patient and location of doctor
The exposure of a doctor and a patient to air coughed by a second infected patient was studied in a mock-up of two-bed hospital infectious ward with mixing ventilation at 22°C (71.6 F) room air temperature. The effect of posture of the coughing patient lying sideways or on back), position of the doctor (either facing the coughing patient or standing sideways) at three ventilation rates (3 h⁻¹, 6 h⁻¹ and 12 h⁻¹) was examined. Thermal manikin with realistic body shape and surface temperature distribution was used to resemble the doctor. The coughing patient was simulated by a heated dummy with a cough generator. Another heated dummy was used to simulate the second patient in the second bed. The cough consisted of 100% CO₂. The Peak Cough Time was 4 s, when the doctor was close to coughing patient and increased more than twice for the exposed patient. The level of exposure (Peak Concentration Level) depends on the positioning relative to the cough direction: lying or standing still, facing or turned sideways and changed varied 194 to 10228 ppm. Ventilation rates of 12 h⁻¹ (recommended by present hospital standards) resulted in increased background exposure levels and may suggest risk from airborne cross-infection.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Section for Building Physics and Services
Authors: Kierat, W. (Ekstern), Bolashikov, Z. D. (Intern), Melikov, A. K. (Intern), Popiołek, Z. (Ekstern), Brand, M. (Intern)
Number of pages: 16
Publication date: 2010

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Title of host publication: Proceedings of ASHRAE IAQ 2010
Article number: TOPC-00128-2010
Main Research Area: Technical/natural sciences
Electronic versions:
TOPC_00128_2010_Assembled.pdf
Source: orbit
Source-ID: 272840
Publication: Research - peer-review › Article in proceedings – Annual report year: 2010

Fine particles and carbon monoxide from wood burning in 17th-19th century Danish kitchens: Measurements at two reconstructed farm houses at the Lejre Historical-Archaeological Experimental Center
Carbon monoxide (CO) and particulate matter (PM2.5) were measured in two reconstructed Danish farmhouses (17-19th century) during two weeks of summer. During the first week intensive measurements were performed while test cooking fires were burned, during the second week the houses were monitored while occupied by guest families. A masonry hearth was located in the middle of each house for open cooking fires and with heating stoves. One house had a chimney leading to the outside over the hearth; in the other, a brickwork hood led the smoke into an attic and through holes in the...
During the first week the concentration of PM2.5 averaged daily between 138 and 1650 μg m⁻³ inside the hearths and 21-160 μg m⁻³ in adjacent living rooms. CO averaged daily between 0.21 and 1.9 ppm in living areas, and up to 12 ppm in the hearths. Highest concentrations were measured when two fires were lit at the same time, which would cause high personal exposure for someone working in the kitchens. 15 min averages of up to 25 400 μg m⁻³ (PM2.5) and 260 ppm CO were recorded. WHO air quality guidelines were occasionally exceeded for CO and constantly for PM2.5. However, air exchange and air distribution measurements revealed a large draw in the chimney, which ensured a fast removal of wood smoke from the hearth area. The guest families were in average exposed to no more than 0.21 ppm CO during 48 h. Based on a hypothetical time-activity pattern, however, a woman living in this type of house during the 17-19th century would be exposed to daily averages of 1.1 ppm CO and 196 μg m⁻³ PM2.5, which exceeds WHO guideline for PM2.5, and is comparable to what is today observed for women in rural areas of developing countries.
Floor heating and cooling combined with displacement ventilation: Possibilities and limitations

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, TEBE Research Group, Department of Energetics, University of Padua, TEBE Research Group, Department of Energetics
Authors: Causone, F. (Ekstern), Baldin, F. (Ekstern), Olesen, B. W. (Intern), Corgnati, S. (Ekstern)
Pages: 2338-2352
Publication date: 2010
Main Research Area: Technical/natural sciences

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Journal: Energy and Buildings
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 4.64 SJR 2.093 SNIP 1.965
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.088 SNIP 2.174 CiteScore 4.07
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.123 SNIP 2.936 CiteScore 4.21
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Floor Heating with Displacement Ventilation: An Experimental and Numerical Analysis

The effect of floor heating combined with displacement ventilation (DV) on thermal indoor environments and indoor air quality (IAQ) was studied by means of CFD. The numerical model was validated with experimental data. A typical office room was simulated, and one of the occupants was considered to be the contaminant source. The CFD model reliably simulated air velocities and temperatures. Also ventilation effectiveness values were coherent with experimental data. The model made it possible to understand the effect of a cold window on the dissemination of contaminant in the room. Although ventilation effectiveness at seated breathing height was always higher than one, it was not possible to visualize a defined contaminant stratification in the room. Only when the windows were not assumed to be cold, a clearly stratified flow pattern could be detected. The numerical model was then used to simulate different kinds of contaminant sources, under the same boundary conditions. It was found that DV does not guarantee a better IAQ than full mixing when contaminant sources are not linked to heat sources, even when floor heating is used. Contaminants produced by powerful heat sources require high ventilation flow rates to guarantee high values of ventilation effectiveness.

General information

State: Published
Fra Laboratoriet for Opvarmnning og Ventilation til Internationalt Center for Indeklima og Energi

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Langkilde, G. (Intern)
Number of pages: 19
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Publication information
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Publisher: DTU Byg, Danmarks Tekniske Universitet
Original language: Danish
Series: DTU Byg Sagsrapport
Number: SR 10-07 (DK)
Main Research Area: Technical/natural sciences
Electronic versions:
Lab-historie-da-2.pdf
Source: orbit
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Publication: Communication › Report – Annual report year: 2011

From Laboratory of Heating and Ventilation to International Centre for Indoor Environment and Energy
A historical overview on the occasion of 125-years for an independent chair in Heating and Ventilation and 75th anniversary of the Laboratory of Heating and Ventilation

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Langkilde, G. (Intern)
Number of pages: 19
Publication date: 2010

Publication information
Place of publication: Kgs. Lyngby
Publisher: DTU Byg, Danmarks Tekniske Universitet
Original language: English
Series: DTU Civil Engineering Technical Report
Number: SR 10-08 (UK)
Main Research Area: Technical/natural sciences
Electronic versions:
Lab-historie-uk-2.pdf
Source: orbit
Source-ID: 278387
Publication: Communication › Report – Annual report year: 2011

Health-based ventilation criteria

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, REHVA
Authors: Wargocki, P. (Intern), Seppanen, O. (Ekstern)
Pages: 51-55
History of Radiant Heating & Cooling Systems: Part 1

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Bean, R. (Ekstern), Olesen, B. W. (Intern), Kim, K. W. (Ekstern)
Pages: 40-41
Publication date: 2010
Main Research Area: Technical/natural sciences

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Journal: A S H R A E Journal
Volume: 52
Issue number: 1
ISSN (Print): 0001-2491
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
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Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.16 SJR 0.277 SNIP 0.772
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.236 SNIP 0.454 CiteScore 0.21
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.279 SNIP 0.443 CiteScore 0.2
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.312 SNIP 0.651 CiteScore 0.16
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.481 SNIP 1.066 CiteScore 0.19
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.292 SNIP 0.957 CiteScore 0.23
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.452 SNIP 1.051
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.518 SNIP 0.882
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.33 SNIP 0.904
Web of Science (2008): Indexed yes
History of Radiant Heating & Cooling Systems: Part 2

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Bean, R. (Ekstern), Olesen, B. W. (Intern), Kim, K. W. (Ekstern)
Pages: 50-55
Publication date: 2010
Main Research Area: Technical/natural sciences

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Journal: A S H R A E Journal
Volume: 52
Issue number: 2
ISSN (Print): 0001-2491
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.16 SJR 0.277 SNIP 0.772
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.236 SNIP 0.454 CiteScore 0.21
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.279 SNIP 0.443 CiteScore 0.2
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.312 SNIP 0.651 CiteScore 0.16
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.481 SNIP 1.066 CiteScore 0.19
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.292 SNIP 0.957 CiteScore 0.23
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
How one should perform sensory measurements of perceived air quality

The purpose of the present experiment was to study different aspects of sensory evaluations of air quality made by human subjects. The sensory panel of 40 subjects assessed the quality of the air polluted by 6 different building materials commonly used indoors. Both low- and high polluting materials were chosen for the study, including carpet, linoleum, PVC, ceiling and two different paints. The assessments were performed in the small-scale in 20 glass chambers called CLIMPAQs. Each CLIMPAQ was loaded with single material. Each material was examined at three different area specific ventilation rates, obtained by changing the material loading and keeping the airflow through CLIMPAQ at 0.9 L/s unchanged. Different scales and procedures of the sensory evaluation were used while performing the experiment. The results show that: 1. There were no differences between sensory ratings taken after 1 inhalation or 3 inhalations of air extracted from the chambers; 2. There were no differences between sensory ratings whether the materials in the chamber were visible or not visible to subjects; 3. There were no differences in sensory assessments taken with 3-minute break between assessments and with 3 inhalations of unpolluted air between assessments; and 4. There were no changes in the sensory assessments of the same exposure during the 3-week of experiments. The relationship between acceptability and the percentage of dissatisfied with the air quality as well as odor intensity and the percentage of dissatisfied with air quality. They were developed using independent assessments on the continuous acceptability scale and category intensity scale, as well as dichotomous (yes/no) acceptability scale; the ratings on the latter were used to estimate the percentage of dissatisfied. These relationships can be used when ventilation requirements are set in indoor environments.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Aalborg University, Technical University of Denmark
Authors: Wargocki, P. (Intern), Knudsen, H. N. (Ekstern), Krzyzanowska, J. (Ekstern)
Pages: R7-TS15-OP05
Publication date: 2010

Host publication information
Title of host publication: How one should perform sensory measurements of perceived air quality
Main Research Area: Technical/natural sciences
Conference: 10th Rehva World Congress "Sustainable Energy Use in Buildings", Antalya, Turkey, 09/05/2010 - 09/05/2010
Source: orbit
Source-ID: 262417
Publication: Research - peer-review › Article in proceedings – Annual report year: 2010
Impact of boundary conditions on the development of the thermal plume above a sitting human body

The phenomenon of the thermal plume above a heat source has been reported in the literature as being influenced by a large number of factors. The objective of the present study is to identify the impact of the boundary conditions on the characteristics and development of the thermal plume above a sitting occupant. CFD predictions were performed to explain the reason for a skewness in the thermal plume above a sitting thermal manikin with realistic body shape, size, and surface temperature distribution, measured in a climate chamber with mean radiant temperature equal to the room air temperature, no radiant temperature asymmetry, and air velocity lower than 0.05 m/s. The results of the CFD predictions showed that even a small non-uniformity in the temperature field (±0.01°C) or in the velocity field (±0.005 m/s) of the surrounding environment affects the development of the thermal plume above a sitting person and causes a skewness of the plume cross-section.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Silesian University of Technology
Authors: Zukowska, D. (Intern), Popiolek, Z. J. (Ekstern), Melikov, A. K. (Intern)
Pages: R7-TS55-PP05
Publication date: 2010

Impact of individually controlled facially applied air movement on perceived air quality at high humidity

The effect of facially applied air movement on perceived air quality (PAQ) at high humidity was studied. Thirty subjects (21 males and 9 females) participated in three, 3-h experiments performed in a climate chamber. The experimental conditions covered three combinations of relative humidity and local air velocity under a constant air temperature of 26 degrees C, namely: 70% relative humidity without air movement, 30% relative humidity without air movement and 70% relative humidity with air movement under isothermal conditions. Personalized ventilation was used to supply room air from the front toward the upper part of the body (upper chest, head). The subjects could control the flow rate (velocity) of the supplied air in the vicinity of their bodies. The results indicate an airflow with elevated velocity applied to the face significantly improves the acceptability of the air quality at the room air temperature of 26 degrees C and relative humidity of 70%.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Skwarczynski, M. (Intern), Melikov, A. K. (Intern), Kaczmarczyk, J. (Ekstern), Lyubenova, V. (Ekstern)
Pages: 2170-2176
Publication date: 2010
Main Research Area: Technical/natural sciences

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Journal: Building and Environment
Volume: 45
Issue number: 10
ISSN (Print): 0360-1323
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.51 SJR 2.015 SNIP 2.198
Web of Science (2016): Indexed yes
Indeklima i danske boliger og børneinstitutioner

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Toftum, J. (Intern), Bekö, G. (Intern), Clausen, G. (Intern)
Pages: 32-34
Indeklima i danske boliger og daginstitutioner

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Toftum, J. (Intern), Bekö, G. (Intern), Clausen, G. (Intern)
Pages: 32-34
Publication date: 2010
Main Research Area: Technical/natural sciences

Indeklima og børns sundhed

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Clausen, G. (Intern), Bekö, G. (Intern), Toftum, J. (Intern)
Pages: 28-30
Publication date: 2010
Main Research Area: Technical/natural sciences
Influence on Occupant Responses of Behavioral Modification of Clothing Insulation in Nonsteady Thermal Environments (RP-1269)

This paper presents climate chamber experiment results in which subjects were exposed to increasing and decreasing dynamic temperature drifts while being allowed to adjust their clothing insulation as desired. The objective of the study was to substantiate the scientific basis of the recommendations on drifting temperatures as stated in ASHRAE Standard 55-2004, Thermal Environmental Conditions for Human Occupancy (ASHRAE 2004) and to extend the scope of the recommendations to cover not only thermal comfort, but also the perception of air quality, health, and performance. The experiments addressed both the summer and winter comfort ranges of temperature, and subjects were exposed to rates of temperature change of -1.2 K/h (-2.2 degrees F/h), 0 K/h (0 degrees F/h), 1.2 K/h (2.2 degrees F/h), and 2.4 K/h (4.3 degrees F/h). Exposure duration was 4 h, except for the 2.4 K/h (4.3 degrees F/h) condition when it was 2 h. Thermal sensation responses observed with adjustable clothing insulation did not differ from those observed with fixed clothing insulation, which were reported in an earlier paper. However, with fixed clothing insulation, longer exposures (>4 h) seemed to aggravate general sick-building syndrome (SBS) symptoms, an effect that was not observed with adjustable clothing insulation. In addition, the study did not detect any systematic influence on the performance of operative temperature ramps, regardless of the clothing adjustment opportunity. Although the current study focused on thermal comfort and SBS symptoms and performance, the recommendations on drifting temperatures, as stated in ASHRAE Standard 55 (ASHRAE 2004), were generally verified. But, longer exposures to increasing temperatures may increase the intensity of general SBS symptoms when no opportunity to adjust clothing insulation is available.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Toftum, J. (Intern), Kolarik, J. (Intern), Belkowska, D. (Ekstern), Olesen, B. W. (Intern)
Pages: 59-74
Publication date: 2010
Main Research Area: Technical/natural sciences

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Journal: HVAC & R Research
Volume: 16
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ISSN (Print): 2374-4731
Ratings:
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.01
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.514 SNIP 0.731
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.561 SNIP 0.891
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.544 SNIP 1.104
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.498 SNIP 0.742
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.93 SNIP 0.956
Komfort, symptomer og præstation med varierende temperaturer

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Toftum, J. (Intern), Kolarik, J. (Intern), Olesen, B. W. (Intern)
Pages: 36-37
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: H V A C Magasinet
Issue number: 6
ISSN (Print): 1603-6913
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: English
Source: orbit
Source-ID: 262952
Publication: Research - peer-review › Journal article – Annual report year: 2010

Ny REHVA anvisning om skolers indeklima og energieffektivitet

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Toftum, J. (Intern)
Pages: 10-11
Publication date: 2010
Main Research Area: Technical/natural sciences
Performance of "ductless" personalized ventilation in conjunction with displacement ventilation: Impact of disturbances due to walking person(s)

The performance of the novel "ductless" personalized ventilation in conjunction with displacement ventilation (DV) was compared with the performance of DV alone under realistic conditions involving disturbances due to walking of one or two persons. An office room with two workstations was arranged in a full-scale test room. Two thermal manikins were used as sedentary occupants at the workstations. Two pollution sources, namely exhaled air by one of the manikins and passive pollution on the table in front of the same manikin were simulated. The performance of the ventilation systems was evaluated with regard to the quality of inhaled air and thermal comfort of the seated "occupants". The walking person(s) caused mixing of the clean and cool air near the floor with the polluted and warmer air at higher levels and disturbed the displacement principle which resulted in a decrease of the inhaled air quality. The performance of the "ductless" PV under the tested conditions was better as opposed to DV alone. Thus in practice the "ductless" PV will be superior to DV alone as regards perceived quality of inhaled air. The location of a walking person was found to be important. Person(s) walking close to the displacement diffuser will cause greater disturbance.
The importance of the intake positioning height above the floor level on the performance of "ductless" personalized ventilation ("ductless" PV) in conjunction with displacement ventilation (DV) was examined with regard to the quality of inhaled air and the thermal comfort provided. A typical office room with two workstations positioned one behind the other was arranged in a full-scale room. Each workstation consisted of a table with an installed "ductless" PV system, PC, desk lamp and seated breathing thermal manikin. The "ductless" PV system sucked the clean and cool displacement air supplied over the floor at four different heights, i.e. 2, 5, 10 and 20 cm and transported it direct to the breathing level. Moreover, two displacement airflow rates were used with a supply temperature adjusted in order to maintain an exhaust air temperature of 26 °C. Two pollution sources, namely air exhaled by one of the manikins and passive pollution on the table in front of the same manikin were simulated by constant dosing of tracer gases. The results show that the positioning of a "ductless" PV intake height up to 0.2 m above the floor will not significantly influence the quality of inhaled air and thermal comfort.
The performance of a new personalized ventilation system, referred to as ductless personalized ventilation (DPV), was studied in full-scale room experiments in conjunction with displacement ventilation (DV). The idea behind DPV is to utilize clean and cool air supplied via DV. In the experiment, the DPV, consisting of an air supply terminal device, a small fan, and a short duct, sucked clean air from floor level near the desk. The performance of the DPV system was evaluated under various arrangements of two identical workstations. Two breathing thermal manikins were used to simulate seated occupants. Two tracer gases, one mixed with the air exhaled by one of the manikins and the other generated on the table in front of the same manikin, were used to simulate pollution. When the DPV system was operational, the inhaled air was as clean as the air inhaled using only the DV alone and even cleaner for some of the layouts studied. The use of DPV in conjunction with DV substantially decreased the temperature of the inhaled air and increased the body cooling in comparison with use of DV alone, i.e., DPV also had potential for improving occupants' perceived air quality and thermal comfort.
Personalized Ventilation integrated with under-floor air distribution system - Protection of occupants from indoor airborne agents

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Li, R. (Ekstern), Sekhar, S. (Ekstern), Melikov, A. K. (Intern)
Pages: 165
Publication date: 2010

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Main Research Area: Technical/natural sciences
Conference: IAQ 2010, Kuala Lumpur, 01/01/2010
Source: orbit
Source-ID: 272838
Publication: Research - peer-review › Article in proceedings – Annual report year: 2010

Phthalate and PAH concentrations in dust collected from Danish homes and daycare centers

As part of the Danish Indoor Environment and Children's Health (IECH) study, dust samples were collected from 500 bedrooms and 151 daycare centers of children (ages 3 to 5) living on the island of Fyn. The present paper reports results from the analyses of these samples for five phthalate esters (diethyl phthalate (DEP), di(n-butyl) phthalate (DnBP), di(isobutyl) phthalate (DiBP), butyl benzyl phthalate (BBzP), di(2-ethylhexyl) phthalate (DEHP)) and three PAHs (pyrene, benz[a]anthracene (BaA) and benzo[a]pyrene (BaP)). The three PAHs and DEHP were detected in dust samples from all sites, while DEP, DnBP, DiBP and BBzP were detected in more than 75% of the bedrooms and more than 90% of the daycare centers. The dust mass-fractions of both phthalates and PAHs were log-normally distributed. With the exception of DEP, the mass-fractions of phthalates in dust were higher in daycare centers than homes; PAH mass-fractions in dust were similar in the two locations. There was no correlation among the different phthalates in either homes or daycare centers. In contrast, the PAH were correlated with one another more strongly so in homes (R² = 0.80-0.90) than in daycare centers (R² = 0.28-0.45). The dust levels of several phthalates (BBzP, DnBP and DEHP) were substantially lower than those measured in a comparable study conducted 6-7 years earlier in Sweden. Although usage patterns in Denmark differ from those in Sweden, the current results may also reflect a change in the plasticizers that are used in common products including toys. PAH levels were roughly an order of magnitude lower than those measured in Berlin and Cape Cod residences, suggesting that the Danish sites are less impacted by motor vehicle emissions.
Solar radiation and cooling load calculation for radiant systems: Definition and evaluation of the Direct Solar Load

The study of the influence of solar radiation on the built environment is a basic issue in building physics and currently it is extremely important because glazed envelopes are widely used in contemporary architecture. In the present study, the removal of solar heat gains by radiant cooling systems is investigated. Particular attention is given to the portion of solar radiation converted to cooling load, without taking part in thermal absorption phenomena due to the thermal mass of the room. This specific component of the cooling load is defined as the Direct Solar Load. A simplified procedure to correctly calculate the magnitude of the Direct Solar Load in cooling load calculations is proposed and it is implemented with the Heat Balance method and the Radiant Time Series method. The F ratio of the solar heat gains directly converted to cooling load, in the case of a low thermal mass radiant ceiling, is calculated for different kinds of office rooms with a large glazed external surface. An example of cooling load calculation developed with the proposed procedure is given.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Politecnico di Torino
Authors: Causone, F. (Ekstern), Corgnati, S. P. (Ekstern), Filippi, M. (Ekstern), Olesen, B. W. (Intern)
Pages: 305-314
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: Energy and Buildings
Volume: 42
Issue number: 3
ISSN (Print): 0378-7788
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 4.64 SJR 2.093 SNIP 1.965
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.088 SNIP 2.174 CiteScore 4.07
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.123 SNIP 2.936 CiteScore 4.21
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.897 SNIP 2.433 CiteScore 3.79
ISI indexed (2013): ISI indexed yes

DOIs:
10.1016/j.enbuild.2009.09.008

Source: orbit
Source-ID: 257008
Publication: Research - peer-review › Journal article – Annual report year: 2010

Special Issue: Ventilation for Better Productivity, Comfort and Health (Roomvent Conference 2009)

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Kim, K. (Ekstern), Olesen, B. W. (Intern)
Pages: 1905-1905
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: Building and Environment
Volume: 45
Issue number: 9
ISSN (Print): 0360-1323
Ratings:
Strategy for good perceived air quality in sustainable buildings
Source control has been shown to be an effective strategy for improving air quality. The objective of the present study was to investigate and compare the potential for achieving an improved perceived indoor air quality by selecting less-polluting building materials or by increasing the ventilation rate in real rooms. Relationships between ventilation rate and perceived indoor air quality were established for differently polluting materials in real rooms. The results showed that the use of low-polluting materials reduced the ventilation rate required to achieve an acceptable level of perceived air quality and thereby prevented unnecessary use of energy for ventilation. For some high-polluting materials it will not be realistic in practice to provide enough ventilation to achieve an acceptable level of perceived air quality. Therefore, the use of low-polluting materials should be part of a strategy for good perceived air quality in sustainable buildings.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Aalborg University
Authors: Knudsen, H. N. (Ekstern), Wargocki, P. (Intern)
Pages: R7-TS7-OP03
Publication date: 2010

SVOC partitioning between the gas phase and settled dust indoors
Semivolatile organic compounds (SVOCs) are a major class of indoor pollutants. Understanding SVOC partitioning between the gas phase and settled dust is important for characterizing the fate of these species indoors and the pathways by which humans are exposed to them. Such knowledge also helps in crafting measurement programs for epidemiological studies designed to probe potential associations between exposure to these compounds and adverse health effects. In this paper, we analyze published data from nineteen studies that cumulatively report measurements of dustborne and airborne SVOCs in more than a thousand buildings, mostly residences, in seven countries. In aggregate, measured median data are reported in these studies for 66 different SVOCs whose octanol-air partition coefficients (K-oa) span more than five orders of magnitude. We use these data to test a simple equilibrium model for estimating the partitioning of an SVOC between the gas phase and settled dust indoors. The results demonstrate, in central tendency, that a compound's octanol-air partition coefficient is a strong predictor of its abundance in settled dust relative to its gas phase concentration. Using median measured results for each SVOC in each study, dustborne mass fractions predicted using K-oa and gas-phase concentrations correlate reasonably well with measured dustborne mass fractions ($R^2 = 0.76$). Combined with theoretical understanding of SVOC partitioning kinetics, the empirical evidence also suggests that for SVOCs with high K-oa values, the mass fraction in settled dust may not have sufficient time to equilibrate with the gas phase concentration.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Weschler, C. J. (Intern), Nazaroff, W. W. (Ekstern)
Pages: 3609-3620
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: Atmospheric Environment
Volume: 44
Issue number: 30
ISSN (Print): 1352-2310
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.01 SJR 1.466 SNIP 1.593
Original language: English

Octanol-air partitioning, Pesticides, Flame retardants, Plasticizers, Exposure pathways, Indoor environment

DOIs: 10.1016/j.atmosenv.2010.06.029

Source: orbit

Source-ID: 269616

Publication: Research - peer-review › Journal article – Annual report year: 2010
TEMPERATURE DISTRIBUTION MONITORING AND ANALYSES AT DIFFERENT HEATING CONTROL PRINCIPLES

In the last decades significant efforts have been made to reduce energy use in buildings. Heating, cooling and ventilation systems are responsible for 30-40% of the energy consumption in buildings. Although they are evaluated based on the energy performance they should guarantee the desired thermal comfort conditions for the building occupants. During the winter and spring of 2009 a study based on analyses of the local temperatures distribution in a room was performed. The purpose was to compare the temperature distribution in the room with the temperature measured and logged by the heating system control sensor which was already installed. The room was heated by means of electrical radiators, which should be able to control the indoor environment to guarantee the desired thermal conditions for the occupants and to supply heat according to desired load patterns. Five series of experiments were done under different control strategies of the heating system (Pseudo Random Binary Sequence signal controlling all the heaters (PRBS) or thermostatic control of the heaters (THERM)). A comparison of the measured temperatures within the room, for the five series of experiments, shows a better correlation when temperature control strategy THERM was used. Notable vertical temperature gradients were monitored in the occupied zone (especially for the PRBS control strategy) when there were high solar gains.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Section for Building Physics and Services
Authors: Simone, A. (Intern), Rode, C. (Intern), Olesen, B. W. (Intern)
Number of pages: 6
Publication date: 2010

Host publication information
Title of host publication: Indoor Climate of Buildings 2010 : Indoor Environment, Energy Auditing and certification of buildings
Main Research Area: Technical/natural sciences
Conference: Indoor Climate of Buildings 2010, Slovakia, 01/01/2010
Source: orbit
Source-ID: 272591
Publication: Research - peer-review › Article in proceedings – Annual report year: 2010

The effect of a photocatalytic air purifier on indoor air quality quantified using different measuring methods

The effect on indoor air quality of an air purifier based on photocatalytic oxidation (PCO) was determined by different measuring techniques: sensory assessments of air quality made by human subjects, Proton-Transfer-Reaction Mass Spectrometry (PTR-MS) and chromatographic methods (Gas Chromatography/Mass Spectrometry and High-Pressure Liquid Chromatography with UV detection). The experiment was conducted in a simulated office, ventilated with 0.6 h(-1), 2.5 h(-1) and 6 h(-1), in the presence of additional pollution sources (carpet, chipboard and linoleum). At the lowest air change rate, additional measurements were made with no pollution sources present in the office. All conditions were tested with the photocatalytic air purifier turned on and off. The results show that operation of the air purifier in the presence of pollutants emitted by building materials and furniture improves indoor air quality, as documented by sensory assessments made by human subjects. It also reduces concentrations of many chemical compounds present in the air as documented by the PTR-MS technique. For the lowest ventilation, results from measurements using the chromatographic methods have similar tendency, however many of the 50 compounds that were targeted for analysis were not detected at all, independent of whether the purifier was on or off. For the two conditions with higher ventilation the results were inconclusive.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Kolarik, B. (Intern), Wargocki, P. (Intern), Skorek-Osikowska, A. (Ekstern), Wisthaler, A. (Ekstern)
Pages: 1434-1440
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: Building and Environment
Volume: 45
Issue number: 6
ISSN (Print): 0360-1323
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
The influence of human behaviour on the energy consumption in buildings

Occupant behaviour influences the amount of energy consumed to sustain a comfortable indoor environment. However, the extent to which occupant behaviour affects building energy consumption is largely unknown. The purpose of this study was to investigate the extent of this influence. This paper describes two studies using dynamic computer simulations of occupant behaviour in dwellings. The first study included simulations of a naïve and a rational behaving occupant. The naïve occupant controlled the indoor climate using an energy expensive behaviour, while the rational occupant controlled
the indoor climate in an energy efficient way. The simulated occupant could manipulate six controls, such as turning on or off the heat and adjusting clothing. All control actions were carried out with the aim of keeping the PMV value within predefined limits. An energy consuming and an energy efficient behavioural mode were simulated. A reference simulation was made during which the occupant had no control over the environment. The occupant was able to keep the thermal indoor environment close to neutral when he/she had the possibility to manipulate the controls. The indoor environment was similar within each behavioural mode regardless of the PMV limits. However, the energy consumption in the energy consuming behavioural mode was up to 330 % higher than in the energy efficient behavioural mode. The second study was based on the results from simultaneous measurement of occupant behaviour, indoor and outdoor environment in 15 dwellings in Denmark during the period from January to August 2008. Based on the measurements occupant behavioural patterns were defined and implemented in the building simulation program IDA ICE. A case and a reference simulation were carried out. In the case, the behaviour patterns derived from the measurements were used while the reference used simulated behaviour patterns defined like they might have been by a consultant engineer. The simulated behaviour patterns resulted in large differences in indoor environmental variables between the two simulations. The heat consumption was more than three times as high in the case as in the reference simulation. This underlines the importance of considering the behaviour of the occupants in the design process of buildings.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Andersen, R. V. (Intern), Olesen, B. W. (Intern)
Publication date: 2010

Host publication information
Title of host publication: Proceedings of PALENC 2010: Passive &low energy cooling for the built environment
Main Research Area: Technical/natural sciences
Conference: Passive & low energy cooling for the built environment, Rhodes Island, Greece, 01/01/2010
Source: orbit
Source-ID: 274586
Publication: Research - peer-review › Article in proceedings – Annual report year: 2010

Thermal comfort and IAQ assessment of under-floor air distribution system integrated with personalized ventilation in hot and humid climate
The potential for improving occupants’ thermal comfort with personalized ventilation (PV) system combined with under-floor air distribution (UFAD) system was explored through human response study. The hypothesis was that cold draught at feet can be reduced when relatively warm air is supplied by UFAD system and uncomfortable sensation as "warm head" can be reduced by the PV system providing cool and fresh outdoor air at the facial level. A study with 30 human subjects was conducted in a Field Environmental Chamber. The chamber was served by two dedicated systems a primary air handling unit (AHU) for 100% outdoor air that is supplied through the PV air terminal devices and a secondary AHU for 100% recirculated air that is supplied through UFAD outlets. Responses of the subjects to the PV-UFAD system were collected at various room air and PV air temperature combinations. The analyses of the results obtained reveal improved acceptability of perceived air quality and improved thermal sensation with PV-UFAD in comparison with the reference case of UFAD alone or mixing ventilation with ceiling supply diffuser. The local thermal sensation at the feet was also improved when warmer UFAD supply air temperature was adopted in the PV-UFAD system.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Li, R. (Ekstern), Sekhar, S. (Ekstern), Melikov, A. K. (Intern)
Pages: 1906-1913
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: Building and Environment
Volume: 45
Issue number: 9
ISSN (Print): 0360-1323
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.51 SJR 2.015 SNIP 2.198
Thermal comfort and Indoor Air Quality in Rooms with Integrated Personalized Ventilation and Under-Floor Air Distribution System, HVA&R Research

General information
State: Accepted/In press
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Li, R. (Ekstern), Sekhar, C. (Ekstern), Melikov, A. K. (Intern)
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: HVAC & R Research
ISSN (Print): 2374-4731
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.01
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.514 SNIP 0.731
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.561 SNIP 0.891
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.544 SNIP 1.104
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.498 SNIP 0.742
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.93 SNIP 0.956
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.614 SNIP 1.187
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.791 SNIP 0.903
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.677 SNIP 1.639
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.843 SNIP 1.29
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.4 SNIP 1.26
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.054 SNIP 2.001
Scopus rating (2003): SJR 1.055 SNIP 1.28
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.917 SNIP 1.739
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.637 SNIP 2.271
Scopus rating (2000): SJR 0.67 SNIP 2.027
Scopus rating (1999): SJR 0.357 SNIP 0.753
THERMISCHE BEHAGLICHKEIT UND ENERGIEAUFWAND BEI FLÄCHENHEIZUNGEN IN BÜROGEBÄUDEN

General information
State: Published
Organisations: Section for Building Physics and Services, Department of Civil Engineering, Section for Indoor Environment
Authors: Behrendt, B. (Intern), Olesen, B. W. (Intern)
Publication date: 2010

Host publication information
Title of host publication: BAUSIM 2010
Main Research Area: Technical/natural sciences
Conference: BAUSIM 2010, September 22 - 24, Vienna University of Technology, 01/01/2010
Source: orbit
Source-ID: 272463
Publication: Research - peer-review › Article in proceedings – Annual report year: 2010

Towards sustainable buildings with holistic consideration of high building exergy consumption in Slovenia

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Dovjak, M. (Ekstern), Shukuya, M. (Ekstern), Olesen, B. W. (Intern), Krainer, A. (Ekstern)
Publication date: 2010

Host publication information
Title of host publication: Clima 2010 congress : 10th REHVA World Congress "Sustainable Energy Use in Buildings"
Volume: Proceedings on CDRom
Main Research Area: Technical/natural sciences
Conference: 10th Rehva World Congress "Sustainable Energy Use in Buildings", Antalya, Turkey, 09/05/2010 - 09/05/2010
Source: orbit
Source-ID: 262415
Publication: Research - peer-review › Article in proceedings – Annual report year: 2010

Use of Heat-pipe for Energy Efficiency Improvement of Personalized Ventilation System Combined with Under-floor Air Distribution System in a Hot and Humid Climate

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Sekhar, C. (Ekstern), Li, R. (Ekstern), Melikov, A. K. (Intern)
Pages: R5-TS53-OP06
Publication date: 2010

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Title of host publication: Proceedings of CLIMA 2010
Main Research Area: Technical/natural sciences
Conference: 10th Rehva World Congress "Sustainable Energy Use in Buildings", Antalya, Turkey, 09/05/2010 - 09/05/2010
Source: orbit
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2010

Vellykket energirenovering afhænger af brugernes adfærd

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Ventilation filters may pollute the indoor air: Part 2 – economic impact and solutions

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Bekö, G. (Intern)
Pages: 32-35
Publication date: 2010
Main Research Area: Technical/natural sciences

Ventilation rates in the bedrooms of 500 Danish children
The ongoing “Indoor Environment and Children’s Health” (IECH) study investigates the environmental risk factors in homes and their association with asthma and allergy among children aged 1-5 years. As part of the study, the homes of 500 children between 3 and 5 years of age were inspected. The selected children included 200 symptomatic children (cases) and 300 randomly selected children (bases). As part of the inspection, the concentration of carbon dioxide in the bedrooms of the children was continuously measured over an average of 2.5 days. The ventilation rates in the rooms during the nights when the children were sleeping in the room were calculated using a single-zone mass balance for the occupant-generated CO2. The calculated air change rates were log-normally distributed (R-2 > 0.98). The geometric mean of the air change rates in both the case and the base group was 0.46 air changes per hour (h(-1); geom. SD = 2.08 and 2.13, respectively). Approximately 57% of both cases and bases slept at a lower ventilation rate than the minimum required ventilation rate of 0.5 h(-1) in new Danish dwellings. Only 32% of the bedrooms had an average CO2 concentration below 1000 ppm during the measured nights. Twenty-three percent of the rooms experienced at least a 20-minute period during the night when the CO2 concentration was above 2000 ppm and 6% of the rooms experienced concentrations above 3000 ppm. The average air change rate was higher with more people sleeping in the room. The air change rate did not change with the increasing outdoor temperature over the 10-week experimental period. The calculation method provides an estimate of the total airflow into the bedroom, including airflows both from outdoors and from adjacent spaces. To study the accuracy of the calculated air change rates and their deviation from the true outside air change rates, we calculated CO2 concentrations at different given air change rates using an indoor air quality and ventilation model (Contam). Subsequently we applied our calculation procedure to the obtained data. The air change rate...
calculated from the generated CO2 concentrations was found to be between 0% and 51% lower than the total air change rate defined in the input variables for the model. It was, however, higher than the true outside air change rate. The relative error depended on the position of the room in relation to the adjacent rooms, occupancy in the adjacent room, the nominal air change rate and room-to-room airflows.

**General information**

**State:** Published

**Organisations:** Section for Indoor Environment, Department of Civil Engineering, Manufacturing Engineering, Department of Mechanical Engineering

**Authors:** Bekö, G. (Intern), Lund, T. (Intern), Nors, F. (Ekstern), Toftum, J. (Intern), Clausen, G. (Intern)

**Pages:** 2289-2295

**Publication date:** 2010

**Main Research Area:** Technical/natural sciences

**Publication information**

**Journal:** Building and Environment

**Volume:** 45

**Issue number:** 10

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- BFI (2018): BFI-level 1
- Web of Science (2018): Indexed yes
- BFI (2017): BFI-level 1
- Web of Science (2017): Indexed yes
- BFI (2016): BFI-level 1
- Scopus rating (2016): CiteScore 4.51 SJR 2.015 SNIP 2.198
- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 1
- Scopus rating (2015): SJR 2.093 SNIP 2.49 CiteScore 4.37
- Web of Science (2015): Indexed yes
- BFI (2014): BFI-level 1
- Scopus rating (2014): SJR 1.938 SNIP 2.797 CiteScore 4.14
- Web of Science (2014): Indexed yes
- BFI (2013): BFI-level 1
- Scopus rating (2013): SJR 1.581 SNIP 2.602 CiteScore 3.57
- ISI indexed (2013): ISI indexed yes
- Web of Science (2013): Indexed yes
- BFI (2012): BFI-level 1
- Scopus rating (2012): SJR 1.331 SNIP 2.875 CiteScore 3.06
- ISI indexed (2012): ISI indexed yes
- Web of Science (2012): Indexed yes
- BFI (2011): BFI-level 1
- Scopus rating (2011): SJR 1.144 SNIP 2.255 CiteScore 2.76
- ISI indexed (2011): ISI indexed yes
- Web of Science (2011): Indexed yes
- BFI (2010): BFI-level 1
- Scopus rating (2010): SJR 1.235 SNIP 2.001
- Web of Science (2010): Indexed yes
- BFI (2009): BFI-level 1
- Scopus rating (2009): SJR 1.028 SNIP 1.865
- Web of Science (2009): Indexed yes
- BFI (2008): BFI-level 1
- Scopus rating (2008): SJR 0.924 SNIP 1.38
- Web of Science (2008): Indexed yes
- Scopus rating (2007): SJR 0.788 SNIP 1.778
- Web of Science (2007): Indexed yes
- Scopus rating (2006): SJR 1.03 SNIP 1.63
Occupant Behaviour with regard to Control of the Indoor Environment

A large proportion of the world’s energy consumption is spent in an effort to maintain a comfortable and healthy indoor environment. As a consequence, reductions in the energy consumed to climatise buildings are instrumental to the efforts of reducing energy-related CO2 emissions and alleviating the European energy import dependencies. Whole building simulations of indoor environment and energy consumption are becoming more and more used in the design phase of buildings. Previously, the simulation of physical factors such as transmission and ventilation heat losses has received a lot of attention. As a consequence, most programs are capable of accurate simulations of the physical properties of a building. However, even though the occupants’ control of the various systems in the building has a significant impact on the energy consumption and the indoor environment, only few studies have focused on the behaviour of their occupants. As a consequence, there is a need to investigate occupants’ interactions with building controls, such as opening of windows, adjustments of heating set-points, use of solar shading, etc. Some models of occupants’ interactions with
Development of a model to calculate the economic implications of improving the indoor climate

The present Ph.d.-thesis constitutes the summary of a three year project period during which a methodology to estimate the effects of the indoor environment on performance of office work and the consequences for total building economy of modifying the indoor environment was developed. During the past decades several laboratory and field studies have documented an effect of the indoor environment on performance, but so far no calculation methodology or tool has been developed in order to utilise this knowledge. In the present project two models based on Bayesian Network (BN) probability theory have been developed: one model estimating the effects of indoor temperature on mental performance and one model estimating the effects of air quality on mental performance. Combined with dynamic building simulations and dose-response relationships, the derived models were used to calculate the total building economy consequences of improving the indoor environment. The Bayesian Network introduces new possibilities to create practical tools to assess the effects of the indoor environment on performance. The method evaluates among others the inherent uncertainty that exist when dealing with human beings in the indoor environment. Office workers exposed to the same indoor environment conditions will in many cases wear different clothing, have different metabolic rates, experience micro environment differences etc. all factors that make it difficult to estimate the effects of the indoor environment on performance. The Bayesian Network uses a probabilistic approach by which a probability distribution can take this variation of the different indoor variables into account. The result from total building economy calculations indicated that depending on the indoor environmental change (improvement of temperature or air quality), location of building and design of building a difference in the pay back time was observed. In a modern building located in a temperate climate zone, improving the air quality seemed more cost-beneficial than investment in mechanical cooling. In a hot climate, investment in cooling resulted in shorter pay back periods. Still several challenges exist before a tool to assess performance can be used on a daily basis in the building design phase. But the results from the present Ph.d.-thesis establishes the framework for a performance calculation tool that with further development has the possibility to help improve indoor environment conditions to the benefit of office workers and employers.
A Bayesian Network approach to the evaluation of building design and its consequences for employee performance and operational costs

A Bayesian Network approach has been developed that can compare different building designs by estimating the effects of the thermal indoor environment on the mental performance of office workers. A part of this network is based on the compilation of subjective thermal sensation data and the associated objective thermal measurements from 12,000 office occupants from different parts of the world. A Performance Index (P) is introduced that can be used to compare directly the different building designs and furthermore to assess the total economic consequences of the indoor climate with a specific building design. In this paper, focus will be on the effects of temperature on mental performance and not on other indoor climate factors. A total economic comparison of six different building designs, four located in northern Europe and two in Los Angeles, USA, was performed. The results indicate that investments in improved indoor thermal conditions can be justified economically in most cases. The Bayesian Network provides a reliable platform using probabilities for modelling the complexity while estimating the effect of indoor climate factors on human beings, due to the different ways in which humans are affected by the indoor climate.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Coastal, Maritime and Structural Engineering, Department of Mechanical Engineering
Authors: Jensen, K. L. (Intern), Toftum, J. (Intern), Friis-Hansen, P. (Intern)
Pages: 456-462
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: Building and Environment
Volume: 44
Issue number: 3
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Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.51 SJR 2.015 SNIP 2.198
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 2.093 SNIP 2.49 CiteScore 4.37
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.938 SNIP 2.797 CiteScore 4.14
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
A case-base study of residential IEQ related risk factors and parental reports of asthma and allergy among 500 Danish children – IECH

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Center for Microbial Biotechnology, Department of Systems Biology, BioChemical Engineering
Authors: Toftum, J. (Intern), Clausen, G. (Intern), Callesen, M. (Ekstern), Bekö, G. (Intern), Weschler, C. J. (Intern), Langer, S. (Ekstern), Andersen, B. (Intern), Høst, A. (Ekstern)
Pages: 617
Publication date: 2009

Host publication information
Title of host publication: Proceedings of Healthy Buildings
Main Research Area: Technical/natural sciences
Air movement preference and acceptability with personalized ventilation in conjunction with under-floor air supply

**General information**
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Li, R. (Ekstern), Sekhar, C. (Ekstern), Melikov, A. K. (Intern)
Publication date: 2009

**Host publication information**
Title of host publication: *Proceedings of Healthy Buildings 2009*
Main Research Area: Technical/natural sciences
Source: orbit
Publication date: 2009

An experimental study of thermal comfort at different combinations of air and mean radiant temperature

It is often discussed if a person prefers a low air temperature (ta) and a high mean radiant temperature (tr), vice-versa or it does not matter as long as the operative temperature is acceptable. One of the hypotheses is that it does not matter for thermal comfort but for perceived air quality, a lower air temperature is preferred. This paper presents an experimental study with 30 human subjects exposed to three different combinations of air- and mean radiant temperature with an operative temperature around 23 °C. The subjects gave subjective evaluations of thermal comfort and perceived air quality during the experiments. The PMV-index gave a good estimation of thermal sensation vote (TSV) when the air and mean radiant temperature were the same. In the environment with different air- and mean radiant temperatures, a thermal comfort evaluation shows an error up to 1 scale unit on the 7-point thermal sensation scale. The study could not confirm any preference regarding air and mean radiant temperature.

**General information**
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Simone, A. (Intern), Olesen, B. W. (Intern)
Pages: 842
Publication date: 2009

**Host publication information**
Title of host publication: *Proceedings of Healthy Buildings 2009*
Main Research Area: Technical/natural sciences
Conference: An experimental study of thermal comfort at different combinations of air and mean radiant temperature, Syracuse, N.Y., 01/01/2009
thermal comfort, human thermal sensation, mean radiant temperature
Source: orbit
Publication date: 2009

Annual Report 2008

**General information**
State: Published
Organisations: Department of Civil Engineering, Section for Structural Engineering, Section for Indoor Environment, Section for Construction Materials, Section for Building Physics and Services, Section for Geotechnics and Geology, Section for Building Design, Arctic Technology Centre
Number of pages: 38
Publication date: 2009

**Publication information**
Aquecimento a baixa temperatura e arrefecimento a temperatura elevada

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Babiak, J. (Ekstern), Olesen, B. W. (Intern), Petras, D. (Ekstern)
Publication date: 2009

Publication information
Place of publication: Lisboa
Volume: REHVA Guidebook 7
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 257019
Publication: Research - peer-review › Book – Annual report year: 2009

A questionnaire survey on dwelling characteristics and the prevalence of asthma and allergy among Danish children – IECH

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Toftum, J. (Intern), Clausen, G. (Intern), Bekö, G. (Intern), Callesen, M. (Ekstern), Sundell, J. (Intern), Bornehag, C. (Intern), Høst, A. (Ekstern)
Pages: 613
Publication date: 2009

Host publication information
Title of host publication: Proc. of Healthy Buildings 2009
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 256084
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009

Assessment of Thermal comfort with the novel Enhanced Displacement Ventilation System in the tropics

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Li, Q. (Ekstern), Cheong Kok Wai, D. (Ekstern), Sun, W. (Ekstern), Melikov, A. K. (Intern)
Publication date: 2009

Host publication information
Title of host publication: Healthy Buildings 2009
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 256167
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009
Associations between indoor environmental factors and parental-reported autistic spectrum disorders in children 6-8 years of age

Potential contributions of environmental chemicals and conditions to the etiology of Autism Spectrum Disorders are the subject of considerable current research and speculation. The present paper describes the results of a study undertaken as part of a larger project devoted to the connection between properties of the indoor environment and asthma and allergy in young Swedish children. The larger project, The Dampness in Buildings and Health (DBH) Study, began in the year 2000 with a questionnaire distributed to parents of all children 1-6 years of age in one Swedish county (DBH-I). A second, follow-up questionnaire (DBH-III) was distributed in 2005. The original survey collected information about the child, the family situation, practices such as smoking, allergic symptoms, type of residence, moisture-related problems, and type of flooring material, which included polyvinyl chloride (PVC). The 2005 survey, based on the same children, now 6-8 years of age, also asked if, during the intervening period, the child had been diagnosed with Autism, Asperger's syndrome, or Tourette's syndrome. From a total of 4779 eligible children, 72 (60 boys, 12 girls) were identified with parentally reported autism spectrum disorder. A random sample of 10 such families confirmed that the diagnoses had been made by medical professionals, in accordance with the Swedish system for monitoring children's health. An analysis of the associations between indoor environmental variables in 2000 as well as other background factors and the ASD diagnosis indicated five statistically significant variables: (1) maternal smoking; (2) male sex; (3) economic problems in the family; (4) condensation on windows, a proxy for low ventilation rate in the home; (5) PVC flooring, especially in the parents' bedroom. In addition, airway symptoms of wheezing and physician-diagnosed asthma in the baseline investigation (2000) were associated with ASD 5 years later. Results from the second phase of the DBH-study (DBH-II) indicate PVC flooring to be one important source of airborne phthalates indoors, and that asthma and allergy prevalence are associated with phthalate concentrations in settled dust in the children's bedroom. Because these associations are among the few linking ASD with environmental variables, they warrant further and more extensive exploration.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Karlstad University, University of Rochester
Authors: Larsson, M. (Ekstern), Weiss, B. (Ekstern), Janson, S. (Ekstern), Sundell, J. (Intern), Bornehag, C. (Ekstern)
Pages: 822-831
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: NeuroToxicology
Volume: 30
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 1.121 SNIP 1.059 CiteScore 3.11
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.244 SNIP 1.06 CiteScore 3.3
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.262 SNIP 1.083 CiteScore 3.28
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.991 SNIP 0.998 CiteScore 2.99
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.954 SNIP 1.043 CiteScore 2.78
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.184 SNIP 1.14 CiteScore 3.21
ISI indexed (2011): ISI indexed yes
Polyvinyl chloride (PVC), Phthalates, Allergy, Autism spectrum disorders, Asthma

DOIs:
10.1016/j.neuro.2009.01.011
Source: orbit
Source-ID: 260657
Publication: Research - peer-review › Journal article – Annual report year: 2009

Beboeradfærdens indflydelse på indeklima og energiforbrug

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Andersen, R. V. (Intern)
Publication date: 2009

Publication information
Original language: Danish
Main Research Area: Technical/natural sciences
Links:
Source: orbit
Source-ID: 255800
Publication: Research › Sound/Visual production (digital) – Annual report year: 2009

Building characteristics associated with moisture related problems in 8,918 Swedish dwellings
Moisture problems in buildings have in a number of studies been shown to increase the risk for respiratory symptoms. The study Dampness in Buildings and Health (DBH) was initiated with the aim to identify health relevant exposures related to dampness in buildings. A questionnaire study about home environment with a focus on dampness problems and health was conducted in one county of Sweden (8,918 homes, response rate 79%). Building characteristics that were associated with one or more of the dampness indicators were for single-family houses, older houses, flat-roofed houses built in the 1960s and 1970s, houses with a concrete slab on the ground that were built before 1983. Moreover, tenancy and earlier renovation due to mould or moisture problems was strongly associated with dampness. A perception of dry air was associated with windowpane condensation, e. g. humid indoor air.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Hagerhed-Engman, L. (Ekstern), Bornehag, C. (Intern), Sundell, J. (Ekstern)
Pages: 251-265
Publication date: 2009
Main Research Area: Technical/natural sciences
Publication information
Buildings: consuming and conserving energy

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Section for Building Physics and Services
Authors: Olesen, B. W. (Intern), Rode, C. (Intern)
Pages: 72-81
Publication date: 2009

residences, questionnaire, moisture, dampness, building characteristics, indoor air quality

DOI: 10.1080/09603120802527653
Source: orbit
Source-ID: 248813
Publication: Research - peer-review › Journal article – Annual report year: 2009
Calculation of the yearly energy performance of heating systems based on the European Building Directive and related CEN Standards

In 2003 the European Commission (EC) issued a directive, 2002/91/EC [1]. The objective of this directive is to promote the improvement of the energy performance of buildings within the community, taking into account outdoor climatic and local conditions, as well as indoor climate requirements and cost-effectiveness. For new and existing buildings this requires a calculation of the energy performance of the building including heating, ventilation, cooling and lighting systems, based on primary energy. Each building must have an energy certificate and regular inspections of heating, cooling and ventilation systems must be performed. The present paper will present the method for calculating the energy performance for heating systems. The relevant CEN-standards are presented and a sample calculation of energy performance is made for a small family house in different geographical locations: Stockholm, Brussels, and Venice.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Olesen, B. W. (Intern), Langkilde, G. (Intern)
Publication date: 2009

Carbon dioxide concentrations and ventilation rates in 500 Danish homes: Indoor Environment and Children’s Health (IECH) study

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Technical University of Denmark
Authors: Bekö, G. (Intern), Nors, F. (Ekstern), Toftum, J. (Intern), Clausen, G. (Intern)
Publication date: 2009

Host publication information
Title of host publication: Proceedings of Healthy Buildings 2009
Volume: CD, paper No.: 383
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 253851
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009
Changes in indoor pollutants since the 1950s

Over the past half-century there have been major changes in building materials and consumer products used indoors. Composite-wood, synthetic carpets, polymeric flooring, foam Cushioning, plastic items and scented cleaning agents have become ubiquitous. The same is true for mechanical and electrical appliances such as washer/dryers, TVs and Computers. These materials and products emit an array of chemicals including solvents, unreacted monomers, and additives. The consequent changes in emission profiles for indoor pollutants have been accompanied by modifications in building operations. Residences and non-residences are less ventilated than they were decades ago. Air-conditioned buildings are more numerous, especially in certain parts of the World. Most of these recirculate a high fraction of their air. The personal habits of building occupants, including the fraction who smoke indoors, have also changed. Taken together, these changes have altered the kind and concentrations of chemicals that occupants are exposed to in their homes, workplaces and schools. Since the 1950s, levels of certain indoor Pollutants (e.g., formaldehyde, aromatic and chlorinated solvents, chlorinated pesticides, PCBs) have increased and then decreased. Levels of other indoor pollutants have increased and remain high (e.g., phthalate esters, brominated flame-retardants, nonionic surfactants and their degradation products). Many of the chemicals presently found in indoor environments, as well as in the blood and urine of occupants, were not present 50 years ago. Given the public's exposure to such species, there would be exceptional Value in monitoring networks that provided cross-sectional and longitudinal information regarding Pollutants found in representative buildings.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Weschler, C. J. (Intern)
Pages: 153-169
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: Atmospheric Environment
Volume: 43
Issue number: 1
ISSN (Print): 1352-2310
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.01 SJR 1.466 SNIP 1.593
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.759 SNIP 1.597 CiteScore 3.73
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.593 SNIP 1.67 CiteScore 3.55
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.753 SNIP 1.63 CiteScore 3.52
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.968 SNIP 1.699 CiteScore 3.47
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.982 SNIP 1.78 CiteScore 3.84
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.894 SNIP 1.489
Control of the free convection around a seated occupant for better air quality performance of personalized ventilation

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Bolashikov, Z. D. (Intern), Melikov, A. K. (Intern), Kranek, M. (Ekstern)
Publication date: 2009

Host publication information
Title of host publication: 11th International conference on air distribution in Rooms – Roomvent 2009
Main Research Area: Technical/natural sciences
Conference: 11th International Conference on Air Distribution in Rooms, Busan, Korea, Republic of, 24/05/2009 - 24/05/2009
Source: orbit
Source-ID: 256164
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009

Control of the free convection around occupant body by optimised furniture design

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Bolashikov, Z. D. (Intern), Melikov, A. K. (Intern), Kranek, M. (Ekstern)
Publication date: 2009

Host publication information
Control of the free convection flow around human body by radiant cooling

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Melikov, A. K. (Intern), Dzhartov, V. (Ekstern)
Publication date: 2009

Host publication information
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 256138
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009

Control of the Free Convection Flow within the Breathing Zone by Confluent Jets for Improved Performance of Personalized Ventilation: Part 1 – Thermal influence
A new method for improvement the performance of personalized ventilation (PV) by control of the free convection flow based of confluent plane jets was studied. The confluent upward plane jets were generated close to the front of human body by openings at the front edge of a desk. The inner jet supplied controlled air while the assisting outer jet supplied room air. The mixing between the two jets was minimized by control of the shear stress between the two flows. Thus the air of the inner jet was transported upward to the face. In this paper, manikin-based equivalent temperatures were analyzed under the condition with this PV method and there was no thermal influence by the flow except for the back of neck.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Nagano, H. (Ekstern), Bolashikov, Z. D. (Intern), Melikov, A. K. (Intern), Kato, S. (Ekstern), Meyer, K. E. (Intern)
Number of pages: 3
Publication date: 2009

Host publication information
Title of host publication: Proceedings of Healthy Buildings 2009
Main Research Area: Technical/natural sciences
Electronic versions: Control_of_the_free_convection.pdf
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009

Control of the Free Convection Flow within the Breathing Zone by Confluent Jets for Improved Performance of Personalized Ventilation: Part 2 – Inhaled Air Quality

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Publication date: 2009

Host publication information
Title of host publication: Proceedings of Healthy Buildings 2009
Main Research Area: Technical/natural sciences
Cooling effect of ceiling mounted personalized ventilation system

**General information**
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Yang, B. (Ekstern), Sekhar, C. (Ekstern), Melikov, A. K. (Intern)
Publication date: 2009

**Host publication information**
Title of host publication: Proceedings of the 11th International conference on air distribution in Rooms – Roomvent 2009
Main Research Area: Technical/natural sciences
Conference: 11th International Conference on Air Distribution in Rooms, Busan, Korea, Republic of, 24/05/2009 - 24/05/2009
Source: orbit
Source-ID: 256153
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009

Costs and Benefits of Particle Filtration

**General information**
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Bekö, G. (Intern)
Publication date: 2009

**Publication information**
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 253853
Publication: Research › Sound/Visual production (digital) – Annual report year: 2009

Criteria used in international standards for specifying the required ventilation rates

**General information**
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Olesen, B. W. (Intern)
Publication date: 2009

**Host publication information**
Title of host publication: 11 International Conference on Air Distribution in Rooms : Roomvent 2009
Main Research Area: Technical/natural sciences
Conference: 11th International Conference on Air Distribution in Rooms, Busan, Korea, Republic of, 24/05/2009 - 24/05/2009
Source: orbit
Source-ID: 247829
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009

Dampness at dorm and its associations with allergy and airways infection among college students in China: a cross-sectional study

A cross-sectional study was carried out at Tianjin University campus, China, from February 21 to June10, 2006, to survey the association between dampness in dorms and allergy and airways infection among college students. The health and dampness condition were self-reported by 3436 students living in 1511 dorm rooms located in 13 buildings on the campus. The buildings were selected according to their positions, construction periods and occupant densities. The allergy and airways infection symptoms involved wheezing, dry cough during night, rhinitis, eczema, cold/flu, ear inflammation, pneumonia and tuberculosis. The indoor moisture signs were mould/damp spots on walls, ceilings and floors; suspected or ever happened water damage; condensation on windowpane in winter and odours perceived by subjects themselves. This study showed there was significantly positive association between condensation and dry cough. Eczema was often reported in rooms with suspected moisture problem. Dampness was a significantly risk factor for common cold. This paper
indicated that dampness problem at dorms of Chinese students was a risk factor in irritating allergic symptoms, and hence there is a need for dorm environment improvement. The ventilation and microbiology problems in dorm environment corresponding to dampness should be further studied, especially when it is associated to occupants' health.

**General information**

**State:** Published  
**Organisations:** Section for Indoor Environment, Department of Civil Engineering, Tianjin University  
**Authors:** Sun, Y. (Ekstern), Zhang, Y. (Ekstern), Sundell, J. (Intern), Fan, Z. (Ekstern), Bao, L. (Ekstern)  
**Pages:** 174-182  
**Publication date:** 2009  
**Main Research Area:** Technical/natural sciences

**Publication information**

**Journal:** Indoor Air  
**Volume:** 19  
**Issue number:** 2  
**ISSN (Print):** 0905-6947  
**Ratings:**  
BFI (2018): BFI-level 2  
Web of Science (2018): Indexed yes  
BFI (2017): BFI-level 1  
Web of Science (2017): Indexed yes  
BFI (2016): BFI-level 1  
Scopus rating (2016): CiteScore 3.55  
Web of Science (2016): Indexed yes  
BFI (2015): BFI-level 1  
Scopus rating (2015): CiteScore 3.88  
Web of Science (2015): Indexed yes  
BFI (2014): BFI-level 1  
Scopus rating (2014): CiteScore 4.57  
Web of Science (2014): Indexed yes  
BFI (2013): BFI-level 1  
Scopus rating (2013): CiteScore 3.63  
ISI indexed (2013): ISI indexed yes  
Web of Science (2013): Indexed yes  
BFI (2012): BFI-level 1  
Scopus rating (2012): CiteScore 2.72  
ISI indexed (2012): ISI indexed yes  
Web of Science (2012): Indexed yes  
BFI (2011): BFI-level 1  
Scopus rating (2011): CiteScore 2.42  
ISI indexed (2011): ISI indexed yes  
Web of Science (2011): Indexed yes  
BFI (2010): BFI-level 2  
Web of Science (2010): Indexed yes  
BFI (2009): BFI-level 2  
Web of Science (2009): Indexed yes  
BFI (2008): BFI-level 1  
Scopus rating (2008): SJR 0.757 SNIP 2.168  
Web of Science (2008): Indexed yes  
Scopus rating (2007): SJR 0.933 SNIP 3.724  
Web of Science (2007): Indexed yes  
Scopus rating (2006): SJR 0.637 SNIP 2.622  
Web of Science (2006): Indexed yes  
Scopus rating (2005): SJR 0.347 SNIP 1.283  
Web of Science (2005): Indexed yes  
Web of Science (2004): Indexed yes
Dampness at dorm and its associations with allergy and airways infections among college students in China: a cross-sectional study

A cross-sectional study was carried out at Tianjin University campus, China, from February 21 to June 10, 2006, to survey the association between dampness in dorms, and allergy and airways infections among college students. The health and dampness conditions were self-reported by 3436 students living in 1511 dorm rooms located in 13 buildings on the campus. The buildings were selected according to their positions, construction periods and occupant densities. The symptoms involved wheezing, dry cough during night, rhinitis, eczema, cold/flu, ear inflammation, pneumonia and tuberculosis. The indoor moisture signs were mould/damp spots on walls, ceilings and floors; suspected or ever happened water damage; condensation on windowpane in winter and odours perceived by subjects themselves. There was a significant positive association between condensation and dry cough. Eczema was often reported in rooms with moisture problem. Dampness was a significant risk factor for common cold. Practical Implications Dampness problems in dorms of Chinese students are a risk factor for allergic symptoms, and hence there is a need for dorm environment improvement. Health problems related to ventilation and microbiology problems in dorms should be further studied.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Sun, Y. (Ekstern), Zhang, Y. (Ekstern), Sundell, J. (Intern), Fan, Z. (Ekstern), Bao, L. (Ekstern)
Pages: 348-356
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: Indoor Air
Volume: 19
Issue number: 4
ISSN (Print): 0905-6947
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.55
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 3.88
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 4.57
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 3.63
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 2.72
Energy-saving strategies with personalized ventilation in cold climates

In this study the influence of the personalized supply air temperature control strategy on energy consumption and the energy-saving potentials of a personalized ventilation system have been investigated by means of simulations with IDA-ICE software. GenOpt software was used to determine the optimal supply air temperature. The simulated office room was located in a cold climate. The results reveal that the supply air temperature control strategy has a marked influence on energy consumption. The energy consumption with personalized ventilation may increase substantially (in the range: 61–268%) compared to mixing ventilation alone if energy-saving strategies are not applied. The results show that the best supply air temperature control strategy is to provide air constantly at 20 °C. The most effective way of saving energy with personalized ventilation is to extend the upper room operative temperature limit (saving up to 60% compared to the reference case). However, this energy-saving strategy can be recommended only in a working environment where the occupants spend most of their time at their workstation. Reducing the airflow rate does not always imply a reduction of energy consumption. Supplying the personalized air only when the occupant is at the desk is not an effective energy-saving strategy.
Evaluation of the Cooling Fan Efficiency index for a desk fan and a computer fan

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Schiavon, S. (Ekstern), Melikov, A. K. (Intern)
Publication date: 2009

Host publication information
Title of host publication: Proceedings of the 11th International conference on air distribution in Rooms – Roomvent 2009
Main Research Area: Technical/natural sciences
Conference: 11th International Conference on Air Distribution in Rooms, Busan, Korea, Republic of, 24/05/2009 - 24/05/2009

Experimental evaluation of heat transfer coefficients between radiant ceiling and room
The heat transfer coefficients between radiant surfaces and room are influenced by several parameters: surfaces temperature distributions, internal gains, air movements. The aim of this paper is to evaluate the heat transfer coefficients between radiant ceiling and room in typical conditions of occupancy of an office or residential building. Internal gains were therefore simulated using heated cylinders and heat losses using cooled surfaces. Evaluations were developed by means of experimental tests in an environmental chamber. Heat transfer coefficient may be expressed separately for radiation and convection or as one total parameter, but this choice may lead to different considerations about thermal performance of the system. In order to perform correct evaluations, it is therefore extremely important to use the proper reference temperature. The obtained values confirm tendencies found in the literature, indicating limitations and possibilities of radiant ceiling systems improvement.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Politecnico di Torino
Authors: Causone, F. (Ekstern), Corgnati, S. P. (Ekstern), Filippi, M. (Ekstern), Olesen, B. W. (Intern)
Pages: 622-628
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: Energy and Buildings
Volume: 41
Issue number: 6
ISSN (Print): 0378-7788
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 4.64 SJR 2.093 SNIP 1.965
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.088 SNIP 2.174 CiteScore 4.07
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.123 SNIP 2.936 CiteScore 4.21
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.897 SNIP 2.433 CiteScore 3.79
Experimental Study of Dispersion and Deposition of Expiratory Aerosols in Aircraft Cabins and Impact on Infectious Disease Transmission

The dispersion and deposition characteristics of polydisperse expiratory aerosols were investigated in an aircraft cabin mockup to study the transmission of infectious diseases. The airflow was characterized by particle image velocimetry (PIV) measurements. Aerosol dispersion was measured by the Interferometric Mie Imaging (IMI) method combined with an aerosol spectrometer. Deposition was investigated using the fluorescent dye technique. Downward air currents were observed near the seats next to the side walls while upward airflows were observed near other seats. The downward airflow showed some effects on suppressing the dispersion of aerosols expelled by the passenger sitting in the window seat. Results show that the cough jet could bring significant amount of aerosols forward to the row of seats ahead of the cougher and the aerosols were then dispersed by the bulk air movements in the lateral direction. The aerosols expelled from a cough took 20-30 s to reach the breathing zones of the passengers seated within two rows from the cougher. Increasing the ventilation rate improved the dilution and reduced the aerosol exposure to passengers seated close to the source, but the aerosol dispersion increased, which heightened the exposure to passengers seated further away. 60-70% of expiratory aerosols in mass were deposited, with significant portions on surfaces close to the source, suggesting that disease transmission risk via indirect contact in addition to airborne risk is possible. The physical transport processes of expiratory aerosols could be used to shed insights on some epidemiological observations on in-flight transmission of certain infectious diseases.
Finger temperature as a predictor of thermal comfort for sedentary passengers in a simulated aircraft cabin

Experiments were carried out in a simulated aircraft cabin with 21 seats installed in a climate chamber, to determine the extent to which passengers’ perception of cabin air quality is affected by air temperature. The temperature inside the cabin was set at three different levels, 20.6, 23.3 and 26.1°C. A total of 68 subjects were exposed to each of the three conditions. The subjects completed questionnaires to provide subjective assessments of air quality, cabin environment, intensity of symptoms commonly experienced during flight, and thermal comfort. Objective physiological measurements that were made included finger temperature. The purpose of the present paper is to show that mean finger temperature is a good predictor of mean thermal vote (MTV) on the seven-point scale of thermal sensation. The results indicate that women and younger subjects have slightly colder fingers.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment, Technical University of Denmark
Authors: Strøm-Tejsen, P. (Intern), Wyon, D. P. (Intern), Zukowska, D. (Intern), Jama, A. (Ekstern)
Pages: Paper 382
Publication date: 2009

Host publication information
Title of host publication: Proceedings of the 9th International Healthy Buildings Conference and Exhibition
Volume: Paper 382
Main Research Area: Technical/natural sciences
Thermal comfort, Thermal sensation, Aircraft cabin environment, Finger temperature

Relations
Activities:
9th International Healthy Building Conference and Exhibition 2009
Source: orbit
Source-ID: 242307
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009

Glem aldrig brugeren

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Toftum, J. (Intern)
Pages: 6
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: H V A C Magasinet
Volume: 7
ISSN (Print): 1603-6913
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: Danish
Source: orbit
Source-ID: 256089
Publication: Communication › Journal article – Annual report year: 2009

Healthy Buildings 2009

General information
Human perception relation between thermal sensation and air movement for ceiling mounted personalized ventilation system

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Yang, B. (Ekstern), Sekhar, C. (Ekstern), Melikov, A. K. (Intern)
Pages: 794
Publication date: 2009
Host publication information
Title of host publication: Healthy Buildings 2009
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 256178
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009

Human response to the thermal environment served by personalized ventilation combined with under-floor air distribution system

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Li, R., R. (Ekstern), Sekhar, C. (Ekstern), Melikov, A. K. (Intern)
Publication date: 2009
Host publication information
Title of host publication: Proceedings of the 11th International conference on air distribution in Rooms – Roomvent 2009, Main Research Area: Technical/natural sciences
Conference: 11th International Conference on Air Distribution in Rooms, Busan, Korea, Republic of, 24/05/2009 - 24/05/2009
Source: orbit
Source-ID: 256145
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009

Impact of intake positioning height on performance of "ductless" personalized ventilation

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Halvovonova, B. (Ekstern), Melikov, A. K. (Intern)
Improved Performance of Personalized Ventilation by Control of the Convection Flow around Occupant Body

This paper reports on methods of control of the free convection flow around human body aiming at improvement of inhaled air quality for occupants at workstations with personalized ventilation (PV). Two methods of control were developed and explored: passive - blocking the free convection development by modifications in desk design, and active - by local suction below the desk. The effectiveness of the two methods in enhancing the performance of PV was studied when applied separately and combined, and was compared with the reference case of PV alone. The experiments were performed in a full-scale test room with background mixing ventilation. Thermal manikin with realistic free convection flow was used. The PV supplied air from front/above towards the face. All measurements were performed under isothermal conditions at 20 °C and 26 °C. The air in the test room was mixed with tracer gas, while personalized air was free of it. Tracer gas concentration measurements were used to identify the effect of controlling the free convection flow on inhaled air quality. The use of both methods improved the performance of PV and made it possible to bring more than 90% clean air in inhalation at substantially reduced PV supply flow rate.
Indoor Environment and Children's Health (IECH) - An ongoing epidemiological investigation on the association between indoor environmental factors in homes and kindergartens and children's health and wellbeing

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Center for Microbial Biotechnology, Department of Systems Biology
Authors: Clausen, G. (Intern), Høst, A. (Ekstern), Toftum, J. (Intern), Bekö, G. (Intern), Weschler, C. J. (Intern), Callesen, M. (Ekstern), Buhl, S. (Ekstern), Ladegaard, M. B. (Ekstern), Langer, S. (Ekstern), Andersen, B. (Intern), Sundell, J. (Intern), Bornehag, C. (Intern), Sigsgaard, T. (Ekstern)
Pages: 603
Publication date: 2009

Host publication information
Title of host publication: Proceedings of Healthy Buildings 2009
Place of publication: Syracuse
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 256075
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009

Indoor environment and children's health in 151 Danish kindergartens

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Clausen, G. (Intern), Nors, F. (Ekstern), Nielsen, T. (Ekstern), Buhl, S. (Ekstern), Ladegaard, M. B. (Ekstern), Callesen, M. (Ekstern), Toftum, J. (Intern)
Pages: 619
Publication date: 2009

Host publication information
Title of host publication: Proceedings of Healthy Buildings
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 256077
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009

Influence on occupant responses of behavioral modification of clothing insulation in non-steady thermal environments

General information
State: Published
Introduction of a Cooling-Fan Efficiency Index

In a warm environment, air movement with elevated velocity is a well-known cooling strategy. The local air movement is typically generated by cooling fans (e.g., ceiling fan, table fans, etc.). Appearance, power input, and price are the main parameters considered today when purchasing cooling fans, while cooling capacity and efficiency of energy use are unknown. To address this knowledge gap, this paper introduces the cooling-fan efficiency (CFE) index, defined as the ratio between the cooling effect (measured with a thermal manikin) generated by the device and its power consumption. The index was determined for a ceiling fan, a desk fan, standing fan, and a tower fan in a real office at three room air temperatures and at different fan speed levels. The results reveal that the index is sensitive enough to identify differences in the performance of the cooling devices. A standard method for testing fan cooling effect and an index for determining fan efficiency, such as the CFE index proposed in this study, need to be developed. The cooling fans generate a nonuniform velocity field around occupants, which cannot be described with a single air-velocity value. Therefore, it is not clear how to apply in practice the recommended elevated velocities in warm environments presented in the present standards. The standards need to be revised.
Long term monitoring of window opening behaviour in Danish dwellings

ABSTRACT: During the first eight months of 2008, measurements of occupant behaviour and eight environmental variables was carried out in 15 dwellings. Logistical regression was applied to infer the probability of open window as a function of the outdoor temperature. The results were compared with the findings in the literature. The measured variables just prior to an opening/closing event were compared to variables where no events occurred. Indoor air quality and solar radiation where found to be the main drivers in the occupants' determination of when to open a window. The indoor air quality and outdoor temperature affected when the window was closed and finally the time of day had an impact on the window opening behaviour of the occupants.
Low home ventilation rate in combination with moldy odor from the building structure increase the risk for allergic symptoms in children

There are consistent findings on associations between asthma and allergy symptoms and residential mold and moisture. However, definitions of 'dampness' in studies are diverse because of differences in climate and building construction. Few studies have estimated mold problems inside the building structure by odor assessments. In a nested case-control study of 400 Swedish children, observations and measurements were performed in their homes by inspectors, and the children were examined by physicians for diagnoses of asthma, eczema, and rhinitis. In conclusion, we found an association between moldy odor along the skirting board and allergic symptoms among children, mainly rhinitis. No associations with any of the allergic symptoms were found for discoloured stains, 'floor dampness' or a general mold odor in the room. A moldy odor along the skirting board can be a proxy for hidden moisture problem inside the outer wall construction or in the foundation construction. There are indications that such dampness problems increase the risk for sensitization but the interpretation of data in respect of sensitization is difficult as about 80% of the children with rhinitis were sensitized. Furthermore, low ventilation rate in combination with moldy odor along the skirting board further increased the risk for three out of four studied outcomes, indicating that the ventilation rate is an effect modifier for indoor pollutants. This study showed that mold odor at the skirting board level is strongly associated with allergic symptoms among children. Such odor at that specific place can be seen as a proxy for some kind of hidden moisture or mold problem in the building structure, such as the foundation or wooden ground beam. In houses with odor along the skirting board, dismantling of the structure is required for an investigation of possible moisture damage, measurements, and choice of actions. In homes with low ventilation in combination with mold odor along the skirting board, there was even a higher risk of health effects. This emphasizes the need for the appropriate remediation as this is an ever increasing problem in poorly ventilated houses that are damp.
Masseeksperiment 2009: Indeklima i klasselokaler

General information
State: Published
Organisations: Center for Microbial Biotechnology, Department of Systems Biology, Section for Indoor Environment, Department of Civil Engineering
Authors: Andersen, B. (Intern), Clausen, G. (Intern), Larsen, E. M. (Ekstern), Menå, H. R. (Ekstern)
Publication date: 2009

Publication information
Methods for air cleaning and protection of building occupants from airborne pathogens

This article aims to draw the attention of the scientific community towards the elevated risks of airborne transmission of diseases and the associated risks of epidemics or pandemics. The complexity of the problem and the need for multidisciplinary research is highlighted. The airborne route of transmission, i.e. the generation of pathogen laden droplets originating in the respiratory tract of an infected individual, the survivability of the pathogens, their dispersal indoors and their transfer to a healthy person are reviewed. The advantages and the drawbacks of air dilution, filtration, ultraviolet germicidal irradiation (UVGI), photocatalytic oxidation (PCO), plasmacluster ions and other technologies for air disinfection and purification from pathogens are analyzed with respect to currently used air distribution principles. The importance of indoor air characteristics, such as temperature, relative humidity and velocity for the efficiency of each method is analyzed, taking into consideration the nature of the pathogens themselves. The applicability of the methods to the different types of total volume air distribution used at present indoors, i.e. mixing, displacement and underfloor ventilation, as well as advanced air distribution techniques (such as personalized ventilation) is discussed.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Bolashikov, Z. D. (Intern), Melikov, A. K. (Intern)
Pages: 1378-1385
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: Building and Environment
Volume: 44
Issue number: 7
ISSN (Print): 0360-1323
Ratings: BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.51 SJR 2.015 SNIP 2.198
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 2.093 SNIP 2.49 CiteScore 4.37
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.938 SNIP 2.797 CiteScore 4.14
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.581 SNIP 2.602 CiteScore 3.57
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.331 SNIP 2.875 CiteScore 3.06
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.144 SNIP 2.255 CiteScore 2.76
Modeling the Fate of Expiratory Aerosols and the Associated Infection Risk in an Aircraft Cabin Environment

The transport and deposition of polydispersed expiratory aerosols in an aircraft cabin were simulated using a Lagrangian-based model validated by experiments conducted in an aircraft cabin mockup. Infection risk by inhalation was estimated using the aerosol dispersion data and a model was developed to estimate the risk of infection by contact. The environmental control system (ECS) in a cabin creates air circulation mainly in the lateral direction, making lateral dispersions of aerosols much faster than longitudinal dispersions. Aerosols with initial sizes under 28 m in diameter can...
stay airborne for comparatively long periods and are favorable for airborne transport. Using influenza data as an example, the estimated risk of infection by inhalation are at least two orders of magnitude higher than the risk of infection by contact. An increase in the supply airflow rate enhances ventilation removal and the dispersion of these aerosols. It reduces the risk of infection by inhalation for passengers seated within one row and one column from the index patient but it increases the risk for passengers seated further away. The deposition fraction increases with aerosol size. The ECS supply airflow rate has insignificant impact on the deposition behavior of these large aerosols, making the impact on the risk of infection by contact insignificant. Comparatively, the contact behavior of passengers is highly influential to the contact infection risk. Passengers seated within one row from the index patient are subject to contact risks that are one to two orders of magnitude higher than are passengers seated further away.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Wan, M. (Ekstern), To, G. (Ekstern), Chao, C. (Ekstern), Fang, L. (Intern), Melikov, A. K. (Intern)
Pages: 322-343
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: Aerosol Science and Technology
Volume: 43
Issue number: 4
ISSN (Print): 0278-6826
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 1.88 SJR 0.943 SNIP 0.853
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.284 SNIP 1.009 CiteScore 2.42
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.365 SNIP 1.099 CiteScore 2.74
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.521 SNIP 1.514 CiteScore 2.94
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.408 SNIP 1.038 CiteScore 2.58
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.137 SNIP 0.927 CiteScore 2.51
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.132 SNIP 0.742
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.568 SNIP 0.871
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.813 SNIP 1.106
Scopus rating (2007): SJR 1.99 SNIP 1.189
Scopus rating (2006): SJR 1.638 SNIP 1.197
Scopus rating (2005): SJR 1.234 SNIP 0.93
Scopus rating (2004): SJR 1.825 SNIP 1.447
Web of Science (2004): Indexed yes
Nitric oxide in exhaled and aspirated nasal air as an objective measure of human response to indoor air pollution

The concentration of nitric oxide (NO) in exhaled and aspirated nasal air was used to objectively assess human response to indoor air pollutants in a climate chamber exposure experiment. The concentration of NO was measured before exposure, after 2, and 4.5 h of exposure, using a chemiluminescence NO analyzer. Sixteen healthy female subjects were exposed to two indoor air pollutants and to a clean reference condition for 4.5 h. Subjective assessments of the environment were obtained by questionnaires. After exposure (4.5 h) to the two polluted conditions a small increase in NO concentration in exhaled air was observed. After exposure to the reference condition the mean NO concentration was significantly reduced compared to pre-exposure. Together these changes resulted in significant differences in exhaled NO between exposure to reference and polluted conditions. NO in nasal air was not affected by the exposures. The results may indicate an association between polluted indoor air and subclinical inflammation. Measurement of nitric oxide in exhaled air is a possible objective marker of subclinical inflammation in healthy adults.
Occupant movement analysis of ceiling mounted personalized ventilation system

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Yang, B. (Ekstern), Melikov, A. K. (Intern), Sekhar, C. (Ekstern)
Publication date: 2009

Host publication information
Title of host publication: 5th International Workshop on Energy and Environment of Residential Buildings and the 3rd International Conference on Built Environment and Public Health (EERB-BEPH)
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 256179
Publication: Research » Article in proceedings – Annual report year: 2009

Occupant performance and building energy consumption with different philosophies of determining acceptable thermal conditions
Based on building energy and indoor environment simulations, this study uses a recently developed method relying on Bayesian Network theory to estimate and compare the consequences for occupant performance and energy consumption of applying temperature criteria set according to the adaptive model of thermal comfort and the more conventional PMV model. Simulations were carried out for an example building with two configurations (with and without mechanical cooling) located in tropical, subtropical, and temperate climate regions. Even though indoor temperatures differed significantly between building configurations, especially in the tropical climate, the estimated performance differed only modestly between configurations. However, energy consumption was always lower in buildings without mechanical cooling, particularly so in the tropical climate. The findings indicate that determining acceptable indoor thermal environments with
the adaptive comfort model may result in significant energy savings and at the same time will not have large consequences for the mental performance of occupants.
Occupant Responses and Office Work Performance in Environments with Moderately Drifting Operative Temperatures (RP-1269)

Fifty-two experimental subjects (50% female) were seated in a climate chamber and exposed to operative temperature ramps with different slopes, directions, and durations during two related experiments. The first experiment covered a temperature range of 22°C–26.8°C (71.6°F–80.2°F) and subjects wore light clothing (0.5 clo). The operative temperature was increased in rates of 0.6 K/h (1.1°F/h) (for 8 h), 1.2 K/h (2.2°F/h) (for 4 h), 2.4 K/h (4.3°F/h) (for 2 h), and 4.8 K/h (8.6°F/h) (for 1 h), respectively. In one session, subjects were exposed to a constant temperature of 24.4°C (75.9°F) (for 4 h). The second experiment covered a temperature range of 17.8°C–25°C (64°F–77°F), and subjects wore heavier clothing (0.7 clo). Temperature ramps of 0.6 K/h (1.1°F/h) (for 8 h), 1.2 K/h (2.2°F/h) (for 6 h), 0.6 K/h (–1.1°F/h) (for 8 h), and –1.2 K/h (–2.2°F/h) (for 6 h) and exposure to a constant temperature of 21.4°C (70.5°F) (for 6 h) were examined. Subjects assessed their thermal sensation, acceptability of the thermal environment, perceived air quality, and intensity of sick building syndrome (SBS) symptoms. Subjects' performance was measured by simulated office work, including tasks such as addition, proofreading, reading and comprehension, and text typing. Results of the experiments showed that even moderately changing operative temperature ramps were sensed by sedentary subjects when exposure times exceeded 4 h. No significant effects on SBS symptoms related to local irritation of mucous membranes were found, while intensity of headache, concentration ability, and general well-being were significantly affected in most of the ramps. Linear dependence of perceived air quality on operative temperature was noted. No significantly consistent effects of individual temperature ramps on office work performance were found.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Technion-Israel Institute of Technology
Authors: Kolarik, J. (Intern), Toftum, J. (Intern), Olesen, B. W. (Intern), Shitzer, A. (Ekstern)
Pages: 931
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: H V A C & R Research
Volume: 15
Issue number: 5
ISSN (Print): 2374-4731
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.01
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.514 SNIP 0.731
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Performance evaluation of ceiling mounted personalized ventilation system

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Yang, B. (Ekstern), Melikov, A. K. (Intern), Sekhar, C. (Ekstern)
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: A S H R A E Transactions
Volume: 115
ISSN (Print): 0001-2505
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Performance of “ductless” personalized ventilation in conjunction with displacement ventilation: impact of walking occupant

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Halvonova, B. (Ekstern), Melikov, A. K. (Intern)
Publication date: 2009

Host publication information
Title of host publication: Proceedings of Healthy Buildings 2009
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 256142
Publication: Research - peer-review » Article in proceedings – Annual report year: 2009

Praxishandbuch der technischen Gebäudeausrüstung (TGA): Installationssysteme, Flächenheiz- und -kühlsysteme
Vertragsrecht für Architekten und Ingenieure
**Prediction of the volume flux of the thermal plume above a sitting person**

The paper presents a verification of a relatively simple method of volume flux calculation applied to the asymmetrical thermal plume generated by a sitting person in a condition of an upward piston flow. The method is based on a model of a thermal plume above a point heat source in an unbounded space. The plume volume flux, V, can be calculated based on the following equation: \( V = k_v Q \exp\left(\frac{1}{3}(z_t-z_v)\exp\left(\frac{5}{3}\right)\right) \). In the equation \( z_t \) is the distance from the measuring plane to the top of the heat source and \( Q_c \) is the convective part of the heat loss. A value of the entrainment coefficient, \( k_v \), equal to 0.006 was used. The position of the virtual origin of the plume to the heat source top, \( z_v \), was optimized for seven different cases of thermal plumes above a sitting thermal manikin and the best agreement between the measured and calculated volume fluxes, not exceeding ±20%, was obtained for \( z_v = -1.66 \) m.

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**Preferred velocities with individually controlled facially applied air movement at high humidity**

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**Rakennusten pintalämmitys-jäähdytys: REHVA Guidebook**
Reduced exposure to coughed air by advanced air distribution

Sensory pollution from a conventional bag-type fiberglass ventilation filter and fiberglass bag filters containing various amounts of activated carbon

Sensory pollution from bag-type fiberglass ventilation filters: Conventional filter compared with filters containing various amounts of activated carbon
months of service, the air downstream of each of the combination filters was judged to be significantly better than the air downstream of the 6-month-old F7 filter, and was comparable to that from an unused F7 filter. Additionally, the combination filters removed more ozone from the air than the F7 filter, with their respective fractional removal efficiencies roughly scaling with their carbon content.

**General information**

State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Bekö, G. (Intern), Fadeyi, M. (Ekstern), Clausen, G. (Intern), Weschler, C. J. (Intern)
Pages: 2114-2120
Publication date: 2009
Main Research Area: Technical/natural sciences

**Publication information**

Journal: Building and Environment
Volume: 44
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ISSN (Print): 0360-1323
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.51 SJR 2.015 SNIP 2.198
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 2.093 SNIP 2.49 CiteScore 4.37
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.938 SNIP 2.797 CiteScore 4.14
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.581 SNIP 2.602 CiteScore 3.57
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.331 SNIP 2.875 CiteScore 3.06
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.144 SNIP 2.255 CiteScore 2.76
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.235 SNIP 2.001
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.028 SNIP 1.865
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.924 SNIP 1.38
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.788 SNIP 1.778
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.03 SNIP 1.63
Scopus rating (2005): SJR 0.955 SNIP 1.225
Sensory Pollution from Different Ventilation Filters

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Bekö, G. (Intern)
Publication date: 2009

Publication information
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 248822
Publication: Research - peer-review › Journal article – Annual report year: 2009

Simulated performance of the Thermo Active Building System (TABS) with respect to the provided thermal comfort and primary energy use

The central module of an office building conditioned by a Thermo Active Building System (TABS) coupled with constant volume ventilation was evaluated by means of dynamic computer simulations. Additionally, the same building model was simulated with a conventional all air VAV ventilation system for comparison. The results showed that with the moderate climate, the TABS decreased the primary energy use by about 16% as compared with the VAV. With hot-humid climate, the portion of the primary energy saved by TABS was ca. 50% even with the supply air dehumidification taken into account. The TABS working in a moderate climate kept the Predicted Percentage of Dissatisfied (PPD) 10%; 1.4% in comparison to 17.5% hours/year.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Kolarik, J. (Intern), Olesen, B. W. (Intern), Toftum, J. (Intern)
Publication date: 2009

Host publication information
Title of host publication: Proceedings of Healthy Buildings 2009
Volume: CD, paper No.: 309
Main Research Area: Technical/natural sciences
Thermo Active Building System, Energy Consumption, Thermal Comfort
Source: orbit
Source-ID: 255535
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009
Simulation of the effects of window opening and heating set-point behaviour on indoor climate and building energy performance

Simultaneous measurement of occupant behaviour, indoor and outdoor environment was carried out in 15 dwellings in Denmark during the period from January to August 2008. Based on the measurements occupant behavioural patterns were defined and implemented in the building simulation program IDA ICE. A case and a reference simulation were carried out. In the case, the behaviour patterns derived from the measurements were used while the reference used simulated behaviour patterns defined like they might have been by a consultant engineer. The simulated behaviour patterns resulted in large differences in indoor environmental variables between the two simulations. The heat consumption was more than three times as high in the case as in the reference simulation. This underlines the importance of considering the behaviour of the occupants in the design process of buildings.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Andersen, R. V. (Intern), Toftum, J. (Intern), Olesen, B. W. (Intern)
Pages: 610
Publication date: 2009

Host publication information
Title of host publication: Proceedings of the 9th international conference - Healthy Buildings 2009
Main Research Area: Technical/natural sciences
Occupant behaviour, Energy, Simulation, Window opening, heating set-point
Electronic versions:
HB2009_Full_Paper 2.pdf
Source: orbit
Source-ID: 255797
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009

Skolerne igen, igen

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Toftum, J. (Intern)
Pages: 6
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: H V A C Magasinet
Volume: 12
ISSN (Print): 1603-6913
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: Danish
Source: orbit
Source-ID: 256088
Publication: Communication › Journal article – Annual report year: 2009

Strategi for udvikling af integrerede lavenergiløsninger til nye bygninger

General information
State: Published
Organisations: Section for Building Physics and Services, Department of Civil Engineering, Section for Indoor Environment, Aalborg University, Teknologisk Institut
Authors: Tommerup, H. M. (Intern), Svendsen, S. (Intern), Furbo, S. (Intern), Olesen, B. W. (Intern), Heiselberg, P. (Ekstern), Østergaard Jensen, S. (Ekstern), Holm Christiansen, C. (Ekstern), Johansen, K. (Ekstern)
Number of pages: 139
Publication date: 2009
Subjective assessment of thermal comfort in rooms served by the novel enhanced displacement ventilation system with different airflow discharge angles

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Pages: 9
Publication date: 2009

Host publication information
Title of host publication: Healthy Buildings 2009
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 256062
Publication: Research › Report – Annual report year: 2009

Subjective assessments of air movement for ceiling mounted personalized ventilation system

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Yang, B. (Ekstern), Sekhar, C. (Ekstern), Melikov, A. K. (Intern)
Publication date: 2009

Host publication information
Title of host publication: Proceedings of the 11th International conference on air distribution in Rooms – Roomvent 2009
Main Research Area: Technical/natural sciences
Conference: 11th International Conference on Air Distribution in Rooms, Busan, Korea, Republic of, 24/05/2009 - 24/05/2009
Source: orbit
Source-ID: 256149
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009

Subjective assessments of indoor environmental quality for ceiling mounted personalized ventilation system

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Yang, B. (Ekstern), Sekhar, C. (Ekstern), Melikov, A. K. (Intern)
Pages: 791
Publication date: 2009

Host publication information
Title of host publication: Healthy Buildings 2009
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 256175
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009
Subjective assessments of thermal sensation for ceiling mounted personalized ventilation system

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Yang, B. (Ekstern), Sekhar, C. (Ekstern), Melikov, A. K. (Intern)
Publication date: 2009

Host publication information
Title of host publication: 5th International Workshop on Energy and Environment of Residential Buildings and the 3rd International Conference on Built Environment and Public Health (EERB-BEPH)
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 256180
Publication: Research › Article in proceedings – Annual report year: 2009

Survey of occupant behaviour and control of indoor environment in Danish dwellings
Repeated surveys of occupant control of the indoor environment were carried out in Danish dwellings from September to October 2006 and again from February to March 2007. The summer survey comprised 933 respondents and the winter survey 636 respondents. The surveys were carried out by sending out invitations to addresses obtained from a Danish register along with information on dwelling characteristics. Meteorological data was obtained from the Danish Meteorological Institute. Four control mechanisms (window open/closed, heating on/off, lighting on/off and solar shading in/ not in use) were analysed separately by means of multiple logistic regression in order to quantify factors influencing occupants’ behaviour. The window opening behaviour was strongly related to the outdoor temperature. The perception of the environment and factors concerning the dwelling also impacted the window opening behaviour. The proportion of dwellings with the heating turned on was strongly related to the outdoor temperature and the presence of a wood burning stove. The solar radiation, dwelling ownership conditions and the perception of the indoor environment also affected the use of heating. The results of the statistical analyses form a basis for a definition of standard behaviour patterns which can be used to make calculation of energy consumption of buildings more accurate.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Andersen, R. V. (Intern), Toftum, J. (Intern), Andersen, K. K. (Intern), Olesen, B. W. (Intern)
Pages: 11-16
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: Energy and Buildings
Volume: 41
Issue number: 1
ISSN (Print): 0378-7788
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 4.64 SJR 2.093 SNIP 1.965
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.088 SNIP 2.174 CiteScore 4.07
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.123 SNIP 2.936 CiteScore 4.21
Web of Science (2014): Indexed yes
Temperature distribution in Risø Flexhouse Room 3 with different heating control principles

This report presents the measurements of local thermal conditions in one room ("Room 3") of the so-called "Flexouse" located at Risø DTU. The house is part of Risø DTU’s SYSLAB facility used to study the interaction of different facilities that supply and use energy. The facility has been used in winter and spring 2009 to study the distribution of local temperatures in the room – particularly with the purpose to compare with the temperature measured and logged by the heating control sensor which was already installed in the room. The measured data shall be used together with mathematical models to predict the overall dynamic thermal properties of the building. The project is part of a wider complex of projects on predicting the electricity and heating energy consumption in dwellings.

General information
State: Published
The Effect of Ventilation, Filtration and Passive Sorption on Indoor Air Quality in Museum Storage Rooms

A study was conducted in five storage rooms at the National Museum of Denmark, in which the effect on indoor air quality of mechanical ventilation, filtration and passive sorption was investigated. Mechanical ventilation and recirculation/filtration was initiated by introducing new ventilation and filtration units. Passive sorption was initiated by hanging sheets of sorptive materials on walls. The control strategies were evaluated in terms of their ability to lower the concentration of internally generated pollutants, and the indoor-to-outdoor concentration ratio of outdoor pollutants. The overall environmental impact for each method was evaluated by the use of material dosimeters. It was found that passive sorption performed better in a small room compared to a large room. Mechanical ventilation and filtration with activated charcoal gave a high protection against ozone, but were less effective in reducing nitrogen dioxide. Increased ventilation rates were expected to dilute internally generated pollutants, but ambiguous results imply that the emission rate of organic acids may also vary. Recirculation/filtration was generally the most efficient method. A cautious conclusion is that a combination of a low air exchange rate and internal recirculation with filtration will be most beneficial to the indoor air quality for such low-activity storage buildings.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Ryhl-Svendsen, M. (Ekstern), Clausen, G. (Intern)
Pages: 35-48
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: Studies in Conservation
Volume: 54
Issue number: 1
ISSN (Print): 0039-3630
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): SJR 0.401 SNIP 1.107 CiteScore 0.55
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 0.259 SNIP 0.533 CiteScore 0.3
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.386 SNIP 0.995 CiteScore 0.54
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 0.226 SNIP 0.367 CiteScore 0.23
ISI indexed (2013): ISI indexed yes
The effects of non-environmental factors on comfort, a literature survey

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Frontczak, M. J. (Intern), Wargocki, P. (Intern)
Pages: 80
Publication date: 2009

Host publication information
Title of host publication: Proceedings of the 9th International Conference & Exhibition Healthy Buildings 2009
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 250576
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009

The impact of recirculation, ventilation and filters on secondary organic aerosols generated by indoor chemistry
This study examined the impact of recirculation rates (7 and 14 h\(^{-1}\)), ventilation rates (1 and 2 h\(^{-1}\)), and filtration on secondary organic aerosols (SOAs) generated by ozone of outdoor origin reacting with limonene of indoor origin. Experiments were conducted within a recirculating air handling system that serviced an unoccupied, 236 m\(^3\) environmental chamber configured to simulate an office; either no filter, a new filter or a used filter was located downstream of where outdoor air mixed with return air. For otherwise comparable conditions, the SOA number and mass concentrations at a recirculation rate of 14 h\(^{-1}\) were significantly smaller than at a recirculation rate of 7 h\(^{-1}\). This was due primarily to lower ozone concentrations, resulting from increased surface removal, at the higher recirculation rate. Increased ventilation increased outdoor-to-indoor transport of ozone, but this was more than offset by the increased dilution of SOA derived from ozone-initiated chemistry. The presence of a particle filter (new or used) strikingly lowered SOA number and mass concentrations compared with conditions when no filter was present. Even though the particle filter in this study had only 35% single-pass removal efficiency for 100 nm particles, filtration efficiency was greatly amplified by recirculation. SOA particle levels were reduced to an even greater extent when an activated carbon filter was in the system, due to ozone removal by the carbon filter. These findings improve our understanding of the influence of commonly
employed energy saving procedures on occupant exposures to ozone and ozone-derived SOA.

**General information**
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Fadeyi, M. (Ekstern), Weschler, C. J. (Intern), Tham, K. (Ekstern)
Pages: 3538-3547
Publication date: 2009
Main Research Area: Technical/natural sciences

**Publication information**
Journal: Atmospheric Environment
Volume: 43
Issue number: 22-23
ISSN (Print): 1352-2310
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.01 SJR 1.466 SNIP 1.593
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.759 SNIP 1.597 CiteScore 3.73
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.593 SNIP 1.67 CiteScore 3.55
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.753 SNIP 1.63 CiteScore 3.52
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.968 SNIP 1.699 CiteScore 3.47
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.982 SNIP 1.78 CiteScore 3.84
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.894 SNIP 1.489
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.945 SNIP 1.466
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.866 SNIP 1.594
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.961 SNIP 1.56
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.874 SNIP 1.587
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.893 SNIP 1.6
Web of Science (2005): Indexed yes
Thermal comfort, physiological responses and performance of elderly during exposure to a moderate temperature drift

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Eindhoven University of Technology
Authors: Schellen, L. (Ekstern), Toftum, J. (Intern)
Pages: 249
Publication date: 2009

Host publication information
Title of host publication: Proc. of Healthy Buildings 2009
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 256085
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009

Used filters and indoor air quality

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Bekö, G. (Intern)
Pages: 64-72
Publication date: 2009

Publication information
Journal: A S H R A E Journal
Volume: 51
Issue number: 3
ISSN (Print): 0001-2491
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.16 SJR 0.277 SNIP 0.772
BFI (2015): BFI-level 1
Ventilation filters may pollute the indoor air: Part 1 – sensory pollution and its sources

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Bekö, G. (Intern)
Pages: 44-47
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: H V A C Magasinet
Volume: 45
Issue number: 12
Removal of Particles from the Supply Air of Ventilation Systems Avoiding the Formation of Sensory Pollution Source: Delivery of Clean Air to Building Occupants

Used ventilation filters can act as sources of strong sensory pollution. The pollutants emitted from loaded particle filters may include irritating products of chemical reactions occurring on the filter surfaces. Most likely oxidation reactions, especially those driven by ozone, seem to play an important role. Sensory pollutants emitted from used filters can have significant adverse impact on occupant performance. Therefore, removal of particles from the supply air of ventilation systems without the subsequent emission of pollutants into the airstream seems to be essential. Correct maintenance of filter banks, including filter replacement in due time, is also important. The aim of this work was to gain more knowledge leading to a better understanding and solving a long recognized indoor environmental problem. The thesis deals with three core areas. Firstly, experiments were conducted to obtain better insight into the chemical processes occurring on the surfaces of used ventilation filters. Secondly, an economic evaluation was made to determine the impact of decreased occupant productivity caused by pollution from used filters on the overall costs and economic benefits associated with filtration. Finally, an experiment was designed to test the effect of different particle filters, activated carbon filters and their combinations on the perceived air quality after several months of continuous use. A commercially available HVAC filter that has low emissions of pollutants, even after substantial time in service, would mean a step forward towards finding an engineering solution to the problem. Additional measurements examined the effect of different pressure sensing techniques and several modifications of an air handling unit on the accuracy of the measurements of pressure drop over ventilation filters. Used and new filters were found to initially remove large amounts of ozone from the air that passed through. The initial ozone removal efficiency (~50%) decreased within an hour to a low and constant value.

A comparison between occupants' and inspectors' reports on home dampness and their association with the health of children: The ALLHOME study

A nonlinear mixed mode model originally developed by Wernersson [Wernersson H. Fracture characterization of wood adhesive joints. Report TVSM-1006, Lund University, Division of Structural Mechanics; 19941, based on nonlinear fracture mechanics, is discussed and applied to model interfacial cracking in a steel-concrete interface. The model is based on the principles of Hillerborg's fictitious crack model, however, the Mode I softening description is modified taking into account the influence of shear. The model couples normal and shear stresses for a given combination of Mode I and II fracture. An experimental set-up for the assessment of mixed mode interfacial fracture properties is presented, applying a bi-material specimen, half steel and half concrete, with an inclined interface and under uniaxial load. Loading the inclined steel-concrete interface under different angles produces load-crack opening curves, which may be interpreted using the nonlinear mixed mode model. The interpretation of test results is carried out in a two step inverse analysis applying numerical optimization tools. It is demonstrated how to perform the inverse analysis, which couples the assumed individual experimental load-crack opening curves. The individual load-crack opening curves are obtained under different combinations of normal and shear stresses. Reliable results are obtained in pure Mode I, whereas experimental data for small mixed mode angles are used to extrapolate the pure Mode II curve. (c) 2008 Elsevier Ltd. All rights reserved.
An Experimental Study on the Fate of Expiratory Droplets in Aircraft Cabin

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering

Scopus rating (2002): SJR 0.998 SNIP 1.39
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.777 SNIP 1.098
Scopus rating (2000): SJR 0.526 SNIP 1.14
Scopus rating (1999): SJR 0.564 SNIP 1.175
Original language: English
DOIs:
10.1016/j.buildenv.2007.10.020
Source: orbit
Source-ID: 231613
Publication: Research - peer-review › Journal article – Annual report year: 2008
Avoiding draught discomfort with personalized ventilation used at the low range of comfortable room air temperature

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Kaczmarczyk, J. (Ekstern), Melikov, A. K. (Intern), Sliva, D. (Ekstern)
Publication date: 2008

Brugernes indflydelse på energiforbrug og indeklima

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Andersen, R. V. (Intern)
Pages: 16-18
Publication date: 2008

Carbon dioxide concentration measured in homes in Bulgaria included in the ALLHOME-2 study

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Environment
Authors: Naydenov, K. (Ekstern), Markov, D. (Ekstern), Melikov, A. K. (Intern), Bornehag, C. (Ekstern), Sundell, J. (Ekstern)
Publication date: 2008
Central automatic control or distributed occupant control for better indoor environment quality in the future

Based on a database accumulated from several recent surveys of office buildings located in a temperate climate (Denmark), the effect on occupant perceptions and symptom prevalence was compared in buildings with natural and mechanical ventilation in which earlier studies have shown a discrepancy in the degree of perceived control. The database was composed of 1353 responses obtained in 25 buildings of which 15 had mechanical ventilation (997 responses) and 9 had natural ventilation (257 responses). Analysis of occupant responses, after grouping according to categories determined by the degree of satisfaction with the perceived control, showed that the degree of control satisfaction, but rarely building category (natural vs. mechanical ventilation), affected the prevalence of adverse perceptions and symptoms. Thus, the degree of control, as perceived by occupants, was more important for the prevalence of adverse symptoms and building related symptoms than the ventilation mode per se. This result indicates that even though the development and application of new indoor environment sensors and HVAC control systems may allow for fully automated IEQ control, such systems should not compromise occupants' perception of having some degree of control of their indoor environment.

Clima interno e produttività negli uffici. Come integrare la produttività nell'analisi del costo del ciclo di vita degli edifici

(Indoor climate and productivity in offices. How to integrate productivity in life cycle costs analysis of building services)
Desiccant wheels as gas-phase absorption (GPA) air cleaners: evaluation by PTR-MS and sensory assessment

Two experiments were conducted to investigate the use of the co- sorption effect of a desiccant wheel for improving indoor air quality. One experiment was conducted in a climate chamber to investigate the co-sorption effect of a desiccant wheel on the chemical removal of indoor air pollutants; another experiment was conducted in an office room to investigate the resulting effect on perceived air quality. A dehumidifier with a silica-gel desiccant wheel was installed in the ventilation system of the test chamber and office room to treat the recirculation airflow. Human subjects, flooring materials and four pure chemicals (formaldehyde, ethanol, toluene and 1,2-dichloroethane) were used as air pollution sources. Proton-Transfer-Reaction - Mass Spectrometry (PTR-MS) and sensory subjects were used to characterize the effectiveness of chemical and sensory pollution removal of the desiccant wheel. The experiments revealed that all the measured VOCs were removed effectively by the desiccant wheel with an average efficiency of 94% or higher; more than 80% of the sensory pollution load was removed and the percentage dissatisfied with the air quality decreased from 70% to 20%. These results indicate that incorporating a regenerative desiccant wheel in a ventilation system is an efficient way of removing indoor VOCs.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Fang, L. (Intern), Zhang, G. (Ekstern), Wisthaler, A. (Ekstern)
Pages: 375-385
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: Indoor Air
Volume: 18
Issue number: 5
ISSN (Print): 0905-6947
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.55
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 3.88
Detecting odorous compounds emitted from building and consumer products within the European Project SysPAQ

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Horn, W. (Ekstern), Jann, O. (Ekstern), Juritsch, E. (Ekstern), Ramalho, O. (Ekstern), Wargocki, P. (Intern), Knudsen, H. (Ekstern), Müller, B. (Ekstern)
Pages: paper ID 230 (on CD-ROM)
Publication date: 2008

Host publication information
Title of host publication: Indoor Air 2008: Proceedings of the 11. International Conference on Indoor Air Quality and Climate
Publisher: Technical University of Denmark (DTU)
Editors: Strøm-Tejsen, P., Olesen, B. W., Wargocki, P., Zukowska, D., Toftum, J.
Main Research Area: Technical/natural sciences
Displacement ventilation in conjunction with personalized ventilation

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Halvonova, B. (Ekstern), Melikov, A. K. (Intern)
Publication date: 2008

Host publication information
Title of host publication: 11th International conference on Indoor Air Quality and Climate - Indoor Air 2008
Volume: Paper 411
Main Research Area: Technical/natural sciences
Conference: 11th International Conference on Indoor Air Quality and Climate, Copenhagen, Denmark, 17/08/2008 - 17/08/2008
Source: orbit
Source-ID: 233814
Publication: Research - peer-review › Article in proceedings – Annual report year: 2008

Distribution of contaminants in the occupied zone of a room served by a novel enhanced displacement ventilation system

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Sun, W. (Ekstern), Melikov, A. K. (Intern), Cheong, D. (Ekstern)
Publication date: 2008

Host publication information
Title of host publication: 29th International Conference AIVC2008
Main Research Area: Technical/natural sciences
Conference: 29th Advanced Building Ventilation and Environmental Technology for Addressing Climate Change Issues, Kyoto, Japan, 14/10/2008 - 14/10/2008
Source: orbit
Source-ID: 231989
Publication: Research - peer-review › Article in proceedings – Annual report year: 2008

Energy analysis of a personalized ventilation system in a cold climate: influence of the supplied air temperature

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Schiavon, S. (Ekstern), Melikov, A. K. (Intern)
Publication date: 2008

Host publication information
Title of host publication: 29th International Conference AIVC 2008 : Advanced building ventilation and environmental technology for addressing climate change issues
Main Research Area: Technical/natural sciences
Conference: 29th Advanced Building Ventilation and Environmental Technology for Addressing Climate Change Issues, Kyoto, Japan, 14/10/2008 - 14/10/2008
Source: orbit
Source-ID: 231982
Publication: Research - peer-review › Article in proceedings – Annual report year: 2008

Energy saving and improved comfort by increasing air movement
In this study, the potential saving of cooling energy by elevated air speed which can offset the impact of increased room air temperature on occupants' comfort, as recommended in the present standards (ASHRAE 55 2004, ISO 7730 2005 and EN 15251 2007), was quantified by means of simulations with EnergyPlus software. Fifty-four cases covering six cities (Helsinki, Berlin, Bordeaux, Rome, Jerusalem and Athens), three indoor environment categories I, II and III (according to
standard EN 152512007) and three air velocities (}
Examination of performance of headset incorporated personalized ventilation unit using CFD method

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Zhu, S. (Ekstern), Bolashikov, Z. D. (Intern), Melikov, A. K. (Intern)
Publication date: 2008

Host publication information
Title of host publication: 11th International conference on Indoor Air Quality and Climate - Indoor Air 2008
Volume: Paper 1018
Main Research Area: Technical/natural sciences
Conference: 11th International Conference on Indoor Air Quality and Climate, Copenhagen, Denmark, 17/08/2008 - 17/08/2008
Source: orbit
Source-ID: 231916
Publication: Research - peer-review › Article in proceedings – Annual report year: 2008

Experimental research on photocatalytic oxidation air purification technology applied to aircraft cabins
The experiment presented in this report was performed in a simulated aircraft cabin to evaluate the air cleaning effects of two air purification devices that used photocatalytic oxidation (PCO) technology. Objective physical, chemical and physiological measurements and subjective human assessments were used for the evaluation. Comparisons were made between conditions with and without the PCO units installed in the re-circulated air system. Four groups of 17 subjects were exposed for 7 h to each test condition. Chemical analysis indicates that ethanol, isoprene and toluene were decomposed by oxidation in the PCO units tested. However, some intermediate products, such as formaldehyde and acetaldehyde, were detected. Physiological measurements did not show any significant effects of the two PCO units except that skin dryness was reduced by operating PCO unit 2. Both positive and negative effects of using PCO units on subjective assessments were observed after the first 3 1/4 hours of exposure. After 6 h of exposure, a positive effect of using either PCO unit on symptoms of dizziness and claustrophobia was observed.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Mechanical Engineering, Department of Civil Engineering, Tianjin University, Leopold-Franzens-Universität
Authors: Sun, Y. (Ekstern), Fang, L. (Intern), Wyon, D. P. (Intern), Wisthaler, A. (Ekstern), Lagercrantz, L. P. (Intern), Strøm-Tejsen, P. (Intern)
Pages: 258-268
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: Building and Environment
Volume: 43
Issue number: 3
ISSN (Print): 0360-1323
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.51 SJR 2.015 SNIP 2.198
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 2.093 SNIP 2.49 CiteScore 4.37
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.938 SNIP 2.797 CiteScore 4.14
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.581 SNIP 2.602 CiteScore 3.57
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.331 SNIP 2.875 CiteScore 3.06
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.144 SNIP 2.255 CiteScore 2.76
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.235 SNIP 2.001
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.028 SNIP 1.865
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.924 SNIP 1.38
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.788 SNIP 1.778
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.03 SNIP 1.63
Scopus rating (2005): SJR 0.955 SNIP 1.225
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 0.548 SNIP 1.266
Scopus rating (2003): SJR 0.948 SNIP 0.921
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.998 SNIP 1.39
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.777 SNIP 1.098
Scopus rating (2000): SJR 0.526 SNIP 1.14
Scopus rating (1999): SJR 0.564 SNIP 1.175
Original language: English
Aircraft cabin environment, Photocatalytic oxidation, Volatile organic compounds, Indoor air quality, Air purification
DOIs:
10.1016/j.buildenv.2006.06.036
Source: orbit
Source-ID: 233936
Publication: Research - peer-review › Journal article – Annual report year: 2008
Human subjects’ perception of indoor environment and their office work performance during exposures to moderate operative temperature ramps

The objective of the presented research work was to study the effects of moderate operative temperature drifts on human thermal comfort, perceived air quality, intensity of SBS symptoms and office work performance. Experimental subjects (52, 50% female) were seated in a climatic chamber and exposed to operative temperature ramps (±0.6 K/h, ±1.2 K/h, +2.4 K/h, +4.8 K/h) of different direction and duration. The studied temperature ranges were 22-26.8°C (light clothing - 0.5 clo) and 17.8-25°C (heavier clothing - 0.7 clo). Exposure to steady temperatures (24.4, 21.4°C) corresponding to a neutral thermal sensation was also included. Subjects filled out questionnaires regarding perception of the environment and intensity of SBS symptoms. Subjects performed simulated office tasks (addition, text typing, proof reading, comprehension and reasoning). Results showed that all tested ramps were recognized by sedentary subjects when the exposure time exceeded four hours. No significant effect on SBS symptoms related to local irritation of mucous membranes was found, while intensity of headache, well feeling and concentration ability was significantly higher at the end of the exposure to the temperature ramps. A linear relation between perceived air quality and temperature (enthalpy) was found. No significant consistent effect of individual temperature ramps on office work performance was found. Increasing operative temperature appeared to slightly decrease speed of addition and text typing regardless the slope of the ramp, when compared to constant temperature condition. With respect to mentioned results it can be recommended to avoid ramp with slopes equal or above 1.1°C/0.25h. Spaces where temperature ramps occur should be properly ventilated to avoid further increase of SBS symptoms caused by aggravation of perceived air quality. Increasing temperature may negatively influence speed of
simple, repetitive tasks of mental work. The significant effect on complex tasks that require concentration, vigilance and logical thinking was not found.

**General information**
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Technion-Israel Institute of Technology
Authors: Kolarik, J. (Intern), Toftum, J. (Intern), Olesen, B. W. (Intern), Shitzer, A. (Ekstern)
Pages: 429
Publication date: 2008

**Host publication information**
Title of host publication: Proceedings of Indoor Air 2008
ISBN (Print): 97-88-77877270-1
Main Research Area: Technical/natural sciences
Conference: 11th International Conference on Indoor Air Quality and Climate, Copenhagen, Denmark, 17/08/2008 - 17/08/2008
Office work performance, Thermal comfort, Temperature ramp
Links:
http://www.indoorair2008.org
Source: orbit
Source-ID: 232895
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2008

**Hygienische Grundlagen**

**General information**
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Olesen, B. W. (Intern), Hellwig, R. (Ekstern)
Number of pages: 1,704
Pages: 88-115
Publication date: 2008

**Host publication information**
Title of host publication: Taschenbuch für Heizung + Klimatechnik
Publisher: De Gruyter Oldenbourg
ISBN (Print): 978-3-8356-3134-2
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 234013
Publication: Research › Book chapter – Annual report year: 2008

**I FILTRI e la qualità dell’aria interna - Parte 2**

**General information**
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Bekö, G. (Intern), Schiavon, S. (Ekstern)
Pages: 56-59
Publication date: 2008
Main Research Area: Technical/natural sciences

**Publication information**
Journal: Installatore Italiano
Issue number: 8
ISSN (Print): 0020-2118
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: Italian
Source: orbit
Source-ID: 231470
Publication: Communication › Journal article – Annual report year: 2008
I filtri possono INQUINARE L’ARIA? – Parte 1

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Bekö, G. (Intern), Schiavon, S. (Ekstern)
Pages: 33-37
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: Installatore Italiano
Issue number: 7
ISSN (Print): 0020-2118
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: Italian
Source: orbit
Source-ID: 231469
Publication: Communication › Journal article – Annual report year: 2008

Impact of air movement on perceived air quality at different level of air pollution and temperature

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Melikov, A. K. (Intern), Kaczmarczyk, J. (Ekstern)
Publication date: 2008

Host publication information
Title of host publication: 11th International conference on Indoor Air Quality and Climate - Indoor Air 2008
Volume: Paper 1033
Main Research Area: Technical/natural sciences
Conference: 11th International Conference on Indoor Air Quality and Climate, Copenhagen, Denmark, 17/08/2008 - 17/08/2008
Source: orbit
Source-ID: 231792
Publication: Research - peer-review › Article in proceedings – Annual report year: 2008

Impact of air movement on perceived air quality at different level of relative humidity

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Melikov, A. K. (Intern), Kaczmarczyk, J. (Ekstern), Sliva, D. (Ekstern)
Publication date: 2008

Host publication information
Title of host publication: 11th International conference on Indoor Air Quality and Climate - Indoor Air 2008
Volume: Paper 1037
Main Research Area: Technical/natural sciences
Conference: 11th International Conference on Indoor Air Quality and Climate, Copenhagen, Denmark, 17/08/2008 - 17/08/2008
Source: orbit
Source-ID: 231788
Publication: Research - peer-review › Article in proceedings – Annual report year: 2008

Impact of Different Types of Fans in a Novel Enhanced Displacement Ventilation System on Vertical Temperature Profile and Air Distribution in a Field Environment Chamber
**Impact of Thermal Plumes Generated by Occupant Simulators with Different Complexity of Body Geometry on Airflow Pattern in Rooms**

The impact of thermal plumes generated by human body simulators with different geometry on the airflow pattern in a full scale room with displacement ventilation (supply air temperature 21.6°C, total flow rate 80 L/s) was studied when two seated occupants were simulated first by two thermal manikins resembling accurately human body shape and then by two heated cylinders. The manikins and the cylinders had the same surface area of 1.63 m² and the same heat generation of 73 W. CO₂ supplied from the top of the heat sources was used for simulating bio-effluents. CO₂ concentration was measured at 16 heights in 9 locations and at 20 points in a horizontal plane 0.2 m below the ceiling. The thermal plumes generated by the manikins had greater volume flux than the plumes above the cylinders and it equalled the supply airflow rate at a lower height than in the case with cylinders. This resulted in substantially different vertical CO₂ concentration distributions in the room. In the lower “cleaner” zone the CO₂ concentration was higher when the occupants were simulated by the thermal manikins than when simulated with the cylinders. The results reveal that simulation of occupants by objects with simplified geometry, such as cylinders, is insufficient for obtaining accurate results when studying airflow in rooms with displacement ventilation.

**Improvement of CFD predictions of air speed turbulence intensity and draught discomfort**

**General information**

State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Popiolek, Z. (Ekstern), Melikov, A. K. (Intern)
Publication date: 2008

**Host publication information**

Title of host publication: Proceedings of the 11th International Conference on Indoor Air Quality and Climate - Indoor Air 2008
Volume: paper 718
Main Research Area: Technical/natural sciences
Conference: 11th International Conference on Indoor Air Quality and Climate, Copenhagen, Denmark, 17/08/2008 - 17/08/2008
Source: orbit
Source-ID: 231965
Publication: Research - peer-review › Article in proceedings – Annual report year: 2008
Improving indoor air quality improves the performance of officework and school work

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Wargocki, P. (Intern)
Publication date: 2008

Host publication information
Title of host publication: ICEBO, the 8. International Conference for Enhanced Building Operation,
Main Research Area: Technical/natural sciences
Conference: International Conference for Enhanced Building Operation, Berlin, Germany, 01/01/2008

Bibliographical note
On CD-ROM
Source: orbit
Source-ID: 233796
Publication: Research - peer-review › Article in proceedings – Annual report year: 2008

Indeklima i danske skoler

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Technical University of Denmark
Authors: Gustafsen, S. (Ekstern), Toftum, J. (Intern)
Pages: 10-12
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: H V A C Magasinet
Volume: 44
Issue number: 12
ISSN (Print): 1603-6913
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: Danish
Source: orbit
Source-ID: 232890
Publication: Communication › Journal article – Annual report year: 2008

Indeklima i klare tal

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Toftum, J. (Intern)
Pages: 52-52
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: H V A C Magasinet
Volume: 44
Issue number: 8
ISSN (Print): 1603-6913
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: Danish
Source: orbit
Indoor climate and productivity in offices. How to integrate productivity in life cycle costs analysis of building services

**General information**
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Wargocki, P. (Intern), Seppanen, O. (Ekstern), Andersson, J. (Ekstern), Boestra, A. (Ekstern), Clements-Croome, D. (Ekstern), Fitzner, K. (Ekstern), Hanssen, S. (Ekstern)
Publication date: 2008

**Publication information**
Publisher: SHASE
Original language: Japanese
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 233859
Publication: Research - peer-review › Book – Annual report year: 2008

Indoor climate and quality of life

**General information**
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Frontczak, M. J. (Intern)
Pages: 1-11
Publication date: 2008
Main Research Area: Technical/natural sciences

**Publication information**
Journal: Indoor Air
Volume: 10
Indoor environmental factors and health effects among children in Bulgaria and Denmark
Is the use of particle air filtration justified? Costs and benefits of filtration with regard to health effects, building cleaning and occupant productivity

Estimates of costs and the corresponding benefits of particle filtration have been derived for a standard office building. Reduction in occupants’ exposure to particles during their workday is anticipated to reduce their morbidity and mortality. Filtration may also reduce the costs associated with building and HVAC cleaning. Conversely, losses of occupant productivity due to sensory offending pollutants emitted from used ventilation filters can lead to significant economic losses. The results of the present analysis are strongly dependent on several key input parameters; consequently, the sensitivity of the results to these parameters was evaluated as part of this study. The study also acknowledges that the benefits-to-costs ratio depends on the perspective of the stakeholder: the employer renting the building is impacted by occupant performance and building energy costs; the building owner is impacted by maintenance of the building and its HVAC system; society is impacted by the employees’ health and welfare. Regardless of perspective, particle filtration is anticipated to lead to annual savings significantly exceeding the running costs for filtration. However, economic losses resulting from even a small decrease in productivity caused by sensory pollutants emitted from used ventilation filters have the potential to substantially exceed the annual economic benefits of filtration. Further studies are required to determine if meaningful benefits can be obtained from more frequent filter replacement or application of different filtration techniques that limit the emission of offending pollutants into the ventilation air.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Bekö, G. (Intern), Clausen, G. (Intern), Weschler, C. J. (Intern)
Pages: 1647-1657
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: Building and Environment
Komfort og energiforbrug

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Toftum, J. (Intern), Kolarik, J. (Intern)
Pages: 12-14
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: HVAC Magasinet
Volume: 44
Issue number: 11
ISSN (Print): 1603-6913
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: Danish
Source: orbit
Source-ID: 232886
Publication: Communication › Journal article – Annual report year: 2008

Local Climate and Heat Loss from Human Body with a Novel Enhanced Displacement Ventilation System

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Sun, W. (Ekstern), Cheong, D. (Ekstern), Melikov, A. K. (Intern)
Publication date: 2008

Host publication information
Title of host publication: 11th International conference on Indoor Air Quality and Climate - Indoor Air 2008
Volume: paper 962
Main Research Area: Technical/natural sciences
Conference: 11th International Conference on Indoor Air Quality and Climate, Copenhagen, Denmark, 17/08/2008 - 17/08/2008
Source: orbit
Source-ID: 231811
Publication: Research - peer-review › Article in proceedings – Annual report year: 2008

Material labelling: Combined material emission tests and sensory evaluations

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Pages: paper ID 1066 (on CD-ROM)
Publication date: 2008

Host publication information
Title of host publication: Indoor Air 2008 : Proceedings of the 11. International Conference on Indoor Air Quality and Climate
Publisher: Technical University of Denmark (DTU)
Editors: Strøm-Tejsen, P., Olesen, B. W., Wargocki, P., Zukowska, D., Toftum, J.
**Measuring perceived air quality and intensity by a Sensor System, the European Project SysPAQ**

*General information*

**State:** Published

**Organisations:** Section for Indoor Environment, Department of Civil Engineering

**Authors:** Müller, B. (Ekstern), Dahms, A. (Ekstern), Knudsen, H. (Ekstern), Afshari, A. (Ekstern), Wargocki, P. (Intern), Olesen, B. W. (Intern), Berglund, B. (Ekstern), Ramalho, O. (Ekstern), Goschnick, J. (Ekstern), Häringer, D. (Ekstern), Jann, O. (Ekstern), Horn, W. (Ekstern), Nesa, D. (Ekstern), Chanie, E. (Ekstern), Ruponen, M. (Ekstern), Müller, D. (Ekstern)

**Pages:** paper ID 530 (on CD-ROM)

**Publication date:** 2008

**Host publication information**

**Title of host publication:** Indoor Air 2008, : Proceedings of the 11. International Conference on Indoor Air Quality and Climate

**Publisher:** Technical University of Denmark (DTU)

**Editors:** Strøm-Tejsen, P., Olesen, B. W., Wargocki, P., Zukowska, D., Toftum, J.

**Main Research Area:** Technical/natural sciences

**Conference:** 11th International Conference on Indoor Air Quality and Climate, Copenhagen, Denmark, 17/08/2008 - 17/08/2008

**Source:** orbit

**Source-ID:** 233821

**Publication:** Research - peer-review › Article in proceedings – Annual report year: 2008

**New method for calculation of integral characteristics of thermal plumes**

A method for calculation of integral characteristics of thermal plumes is proposed. The method allows for determination of the integral parameters of plumes based on speed measurements performed with omnidirectional low velocity thermoanemometers. The method includes a procedure for calculation of the directional velocity (upward component of the mean velocity). The method is applied for determination of the characteristics of an asymmetric thermal plume generated by a sitting person. The method was validated in full-scale experiments in a climatic chamber with a thermal manikin as a simulator of a sitting occupant. The improvement in calculation of the characteristics of the thermal plume achieved with the developed method, in comparison with methods used and reported in the literature, is demonstrated.

*General information*

**State:** Published

**Organisations:** Department of Civil Engineering, Section for Indoor Environment, Silesian University of Technology

**Authors:** Zukowska, D. (Intern), Popiolek, Z. (Ekstern), Melikov, A. K. (Intern)

**Number of pages:** 725

**Publication date:** 2008

**Host publication information**

**Title of host publication:** Indoor Air 2008: Proceedings of the 11th International Conference on Indoor Air Quality and Climate

**Place of publication:** Copenhagen, Denmark

**Publisher:** Technical University of Denmark (DTU)

**Editors:** Strøm-Tejsen, P., Olesen, B. W., Wargocki, P., Zukowska, D., Toftum, J.

**ISBN (Print):** 9788778772701

**Main Research Area:** Technical/natural sciences

**Conference:** 11th International Conference on Indoor Air Quality and Climate, Copenhagen, Denmark, 17/08/2008 - 17/08/2008

**Source:** orbit

**Source-ID:** 233817

**Publication:** Research - peer-review › Article in proceedings – Annual report year: 2008

**Numerical investigation of dispersion and deposition characteristics of expiratory droplets in aircraft cabin**

*Main Research Area: Technical/natural sciences

**Conference:** 11th International Conference on Indoor Air Quality and Climate, Copenhagen, Denmark, 17/08/2008 - 17/08/2008

**Source:** orbit

**Source-ID:** 231483

**Publication:** Research - peer-review › Article in proceedings – Annual report year: 2008
Occupant behaviour and control of indoor environment surveyed in Danish dwellings

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Andersen, R. V. (Intern), Toftum, J. (Intern), Andersen, K. K. (Intern), Olesen, B. W. (Intern)
Pages: 827
Publication date: 2008

Host publication information
Title of host publication: Indoor Air 2008 : The 11th International Conference on Indoor Air Quality and Climate
Volume: 11
Main Research Area: Technical/natural sciences
Conference: 11th International Conference on Indoor Air Quality and Climate, Copenhagen, Denmark, 17/08/2008 - 17/08/2008
Source: orbit
Source-ID: 232080
Publication: Research › Article in proceedings – Annual report year: 2008

Occupant responses and energy use in buildings with moderately drifting temperatures

Earlier studies conducted in climate chambers have examined a large range of temperature ramps from 0.5 K/h to 5 K/h (0.9°F/h to 9°F/h), but their focus was mostly on establishing temperature limits for acceptable thermal comfort with non-steady-state temperatures. Thus, when this ASHRAE funded research was initiated in 2005 knowledge was lacking on how the intensity of building related symptoms, the perception of air quality and the performance of office work were affected by exposure to non-steady-state temperatures. ASHRAE Standard 55 (2004) provides recommendations for maximum rates of temperature change to avoid discomfort, but these recommendations are based mostly on engineering judgment and to some extent on results of earlier thermal comfort research. New approaches to reducing the consumption of energy for climate conditioning in buildings are often associated with indoor temperatures that drift somewhat during the day, and there was a need to extend the scope of the recommendations to cover not only thermal comfort, but also health and productivity. The aim of the proposed research was to carry out human subject experiments and field observations to validate the scientific basis of the recommendations on non-steady-state temperatures as stated in Standard 55 and to evaluate how Sick Building Syndrome symptoms, perceived air quality and performance are affected by such changing temperatures. In addition, the feasibility of non-steady-state temperatures as a means of energy savings and reduction of installed HVAC system capacity was evaluated by dynamic simulation of building energy consumption and indoor environment, taking into account potential effects on occupants of such non-steady thermal environments. Several building HVAC configurations and locations with different outdoor climate conditions were simulated. Two different approaches were used in the human subject experiments; a) exposure of human subjects to temperature ramps with fixed clothing insulation and b) with subjects being allowed to adjust their clothing insulation as desired. In the former experiments, subjects’ thermal sensation was expected to vary along with the drifting temperature, as a basis for the most conservative limits to design temperatures and their maximum permitted rate of change, while in the latter experiments, thermal sensations were expected to remain more stable, justifying wider temperature limits. Experiments covered short-term exposures (1 and 2 hrs) at high rates of temperature change as well as moderate to long-term exposures (4 and 8 hrs) at modest and low rates of temperature change. Temperature ramps spanned the summer and winter comfort ranges of temperature. The experiments were designed to address not only thermal comfort but also to determine whether a range of human symptoms would be affected by increasing and decreasing temperature ramps, and to quantify their effects on the performance of typical office tasks.
Open-plan office environments: A laboratory experiment to examine the effect of office noise and temperature on human perception, comfort and office work performance

Optimal dynamic control of water feed temperature for heated/cooled seats in summer conditions

Partitioning of phthalates among the gas phase, airborne particles and settled dust in indoor environments

A critical evaluation of human exposure to phthalate esters in indoor environments requires the determination of their distribution among the gas phase, airborne particles and settled dust. If sorption from the gas phase is the dominant mechanism whereby a given phthalate is associated with both airborne particles and settled dust, there should be a predictable relationship between its particle and dust concentrations. The present paper tests this for six phthalate esters (DMP, DEP, DnBP, DiBP, BBzP and DEHP) that have been measured in both the air and the settled dust of 30 Berlin apartments. The particle concentration, C-particle, of a given phthalate was calculated from its total airborne concentration and the concentration of airborne particles (PM4). This required knowledge of the particle-gas partition coefficient, Kp, which was estimated from either the saturation vapor pressure (p(s)) or the octanol/air partition coefficient (K-OA). For each phthalate in each apartment, the ratio of its particle concentration to its dust concentration (C-particle/C-Dust) was
calculated. The median values of this ratio were within an order of magnitude of one another for five of the phthalate esters despite the fact that their vapor pressures span four orders of magnitude. This indicates that measurements of phthalate ester concentrations in settled dust can provide an estimate of their concentration in airborne particles. When the latter information is coupled with measurements of airborne particle concentrations, the gas-phase concentrations of phthalates can also be estimated and, subsequently, the contribution of each of these compartments to indoor phthalate exposures.

**General information**

State: Published  
Organisations: Section for Indoor Environment, Department of Mechanical Engineering  
Authors: Weschler, C. J. (Intern), Salthammer, T. (Ekstern), Fromme, H. (Ekstern)  
Pages: 1449-1460  
Publication date: 2008  
Main Research Area: Technical/natural sciences  

**Publication information**

Journal: Atmospheric Environment  
Volume: 42  
Issue number: 7  
ISSN (Print): 1352-2310  
Ratings:  
BFI (2018): BFI-level 1  
Web of Science (2018): Indexed yes  
BFI (2017): BFI-level 1  
Web of Science (2017): Indexed Yes  
BFI (2016): BFI-level 1  
Scopus rating (2016): CiteScore 4.01 SJR 1.466 SNIP 1.593  
Web of Science (2016): Indexed yes  
BFI (2015): BFI-level 1  
Scopus rating (2015): SJR 1.759 SNIP 1.597 CiteScore 3.73  
Web of Science (2015): Indexed yes  
BFI (2014): BFI-level 1  
Scopus rating (2014): SJR 1.593 SNIP 1.67 CiteScore 3.55  
Web of Science (2014): Indexed yes  
BFI (2013): BFI-level 1  
Scopus rating (2013): SJR 1.753 SNIP 1.63 CiteScore 3.52  
ISI indexed (2013): ISI indexed yes  
Web of Science (2013): Indexed yes  
BFI (2012): BFI-level 1  
Scopus rating (2012): SJR 1.968 SNIP 1.699 CiteScore 3.47  
ISI indexed (2012): ISI indexed yes  
Web of Science (2012): Indexed yes  
BFI (2011): BFI-level 1  
Scopus rating (2011): SJR 1.982 SNIP 1.78 CiteScore 3.84  
ISI indexed (2011): ISI indexed yes  
Web of Science (2011): Indexed yes  
BFI (2010): BFI-level 1  
Scopus rating (2010): SJR 1.894 SNIP 1.489  
Web of Science (2010): Indexed yes  
BFI (2009): BFI-level 1  
Scopus rating (2009): SJR 1.945 SNIP 1.466  
Web of Science (2009): Indexed yes  
BFI (2008): BFI-level 1  
Scopus rating (2008): SJR 1.866 SNIP 1.594  
Web of Science (2008): Indexed yes  
Scopus rating (2007): SJR 1.961 SNIP 1.56  
Web of Science (2007): Indexed yes
Potential cooling energy savings of increasing air movement to setoff the increase of operative temperature in office rooms

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Schiavon, S. (Ekstern), Melikov, A. K. (Intern)
Publication date: 2008

Host publication information
Title of host publication: 11th International conference on Indoor Air Quality and Climate - Indoor Air 2008
Volume: Paper 701
Main Research Area: Technical/natural sciences
Conference: 11th International Conference on Indoor Air Quality and Climate, Copenhagen, Denmark, 17/08/2008 - 17/08/2008
Source: orbit
Source-ID: 231918
Publication: Research - peer-review › Article in proceedings – Annual report year: 2008

Proceedings of Indoor Air 2008, the 11th International Conference on Indoor Air Quality and Climate

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Strøm-Tejsen, P. (Intern), Olesen, B. W. (Intern), Wargocki, P. (Intern), Zukowska, D. (Intern), Toftum, J. (Intern)
Publication date: 2008

Publication information
Place of publication: Copenhagen, Denmark
Publisher: Proceedings on CDROM
Original language: English
Main Research Area: Technical/natural sciences

Relations
Activities:
11th International Conference on Indoor Air Quality and Climate
Source: orbit
Source-ID: 233860
Publication: Research - peer-review › Book – Annual report year: 2008
Radiant Floor Cooling Systems
In many countries, hydronic radiant floor systems are widely used for heating all types of buildings such as residential, churches, gymnasiums, hospitals, hangars, storage buildings, industrial buildings, and smaller offices. However, few systems are used for cooling. This article describes a floor cooling system that includes such considerations as thermal comfort of the occupants, which design parameters will influence the cooling capacity and how the system should be controlled. Examples of applications are presented.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Olesen, B. W. (Intern)
Pages: 16-20
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: ASHRAE Journal
Volume: 50
Issue number: 9
ISSN (Print): 0001-2491
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.16 SJR 0.277 SNIP 0.772
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.236 SNIP 0.454 CiteScore 0.21
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.279 SNIP 0.443 CiteScore 0.2
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.312 SNIP 0.651 CiteScore 0.16
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.481 SNIP 1.066 CiteScore 0.19
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.292 SNIP 0.957 CiteScore 0.23
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.452 SNIP 1.051
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.518 SNIP 0.882
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.33 SNIP 0.904
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.528 SNIP 1.019
Scopus rating (2006): SJR 0.37 SNIP 1.239
Web of Science (2006): Indexed yes
Results of the recent Indoor Air 2008 conference: Productivity and schools

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Wargocki, P. (Intern)
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: REHVA Journal
Issue number: September, 11-13
ISSN (Print): 1307-3729
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: English
Source: orbit
Source-ID: 233865
Publication: Research - peer-review › Journal article – Annual report year: 2008

Saving energy for ventilation by careful selection of building materials

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Wargocki, P. (Intern), Knudsen, H. (Ekstern)
Pages: 489-496
Publication date: 2008

Host publication information
Title of host publication: Nordic Symposium on Building Physics : Proceedings
Volume: 1
Publisher: Technical University of Denmark (DTU)
Editor: Rode, C.
Main Research Area: Technical/natural sciences
Conference: 8th Symposium on Building Physics in Nordic Countries, Copenhagen, Denmark, 16/06/2008 - 16/06/2008
Source: orbit
Source-ID: 233800
Publication: Research - peer-review › Article in proceedings – Annual report year: 2008

Secondary organic aerosols from ozone-initiated reactions with emissions from wood-based materials and a "green" paint
This study examined the formation and growth of secondary organic aerosols (SOA) generated when ozone was added to a 1 m³ glass chamber that contained either pine shelving, oriented strand board (OSB), beech boards, or beach boards painted with an “eco” paint. The experiments were conducted at close to real-world conditions; the chamber was ventilated at 0.5 air changes/h; the loadings (exposed surface of building materials to chamber volume) were in the range of 1–2.5 m²m⁻³; and the initial O₃ concentrations were between 15 and 40 ppb. Throughout each experiment
Particles were measured with both a condensation nuclei counter and an optical counter, while terpenes were measured before and after the ozone exposure period using sorbent tubes. The pine boards emitted primarily a-pinene and 3-carene and lesser amounts of 5 other terpenes; when O3 was introduced, the particle counts increased dramatically; the mass concentration reached \( \text{w}15 \text{ mg/m}^3 \) at \( \text{w}20 \text{ ppb} \) O3, and \( \text{w}95 \text{ mg/m}^3 \) at \( \text{w}40 \text{ ppb} \) O3. The OSB emitted primarily limonene and a-pinene. Although the particle counts increased when O3 was introduced, the increase was not as large as anticipated based on the terpene concentrations. The beech boards emitted negligible quantities of terpenes, and the introduction of O3 resulted in almost no increase in the particle concentration. Beech boards painted with an “eco” paint emitted large amounts of limonene and lesser amounts of carvone; upon introduction of O3 the particle counts increased sharply with the mass concentration reaching \( \text{w}20 \text{ mg/m}^3 \) at \( \text{w}15 \text{ ppb} \) O3 and \( \text{w}160 \text{ mg/m}^3 \) at \( \text{w}35 \text{ ppb} \) O3. These experiments demonstrate that the emission of terpenes and potential generation of SOA varies greatly among different types of wood and pressed wood materials. In the case of the pine boards and painted beech boards, the SOA concentrations generated at modest O3 concentrations approach or exceed current guideline levels for PM2.5 established by the US EPA and the World Health Organization.

**General information**

State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Toftum, J. (Intern), Freund, S. (Ekstern), Salthammer, T. (Intern), Weschler, C. J. (Intern)
Pages: 7632-7640
Publication date: 2008
Main Research Area: Technical/natural sciences

**Publication information**

Journal: Atmospheric Environment
Volume: 42
Issue number: 33
ISSN (Print): 1352-2310
Ratings:
  - BFI (2018): BFI-level 1
  - Web of Science (2018): Indexed yes
  - BFI (2017): BFI-level 1
  - Web of Science (2017): Indexed Yes
  - BFI (2016): BFI-level 1
  - Scopus rating (2016): CiteScore 4.01 SJR 1.466 SNIP 1.593
  - Web of Science (2016): Indexed yes
  - BFI (2015): BFI-level 1
  - Scopus rating (2015): SJR 1.759 SNIP 1.597 CiteScore 3.73
  - Web of Science (2015): Indexed yes
  - BFI (2014): BFI-level 1
  - Scopus rating (2014): SJR 1.593 SNIP 1.67 CiteScore 3.55
  - Web of Science (2014): Indexed yes
  - BFI (2013): BFI-level 1
  - Scopus rating (2013): SJR 1.753 SNIP 1.63 CiteScore 3.52
  - ISI indexed (2013): ISI indexed yes
  - Web of Science (2013): Indexed yes
  - BFI (2012): BFI-level 1
  - Scopus rating (2012): SJR 1.968 SNIP 1.699 CiteScore 3.47
  - ISI indexed (2012): ISI indexed yes
  - Web of Science (2012): Indexed yes
  - BFI (2011): BFI-level 1
  - Scopus rating (2011): SJR 1.982 SNIP 1.78 CiteScore 3.84
  - ISI indexed (2011): ISI indexed yes
  - Web of Science (2011): Indexed yes
  - BFI (2010): BFI-level 1
  - Scopus rating (2010): SJR 1.894 SNIP 1.489
  - Web of Science (2010): Indexed yes
  - BFI (2009): BFI-level 1
  - Scopus rating (2009): SJR 1.945 SNIP 1.466
  - Web of Science (2009): Indexed yes
Semivolatile organic compounds in indoor environments

Semivolatile organic compounds (SVOCs) are ubiquitous in indoor environments, redistributing from their original sources to all indoor surfaces. Exposures resulting from their indoor presence contribute to detectable body burdens of diverse SVOCs, including pesticides, plasticizers, and flame retardants. This paper critically examines equilibrium partitioning of SVOCs among indoor compartments. It proceeds to evaluate kinetic constraints on sorptive partitioning to organic matter on fixed surfaces and airborne particles. Analyses indicate that equilibrium partitioning is achieved faster for particles than for typical indoor surfaces; indeed, for a strongly sorbing SVOC and a thick sorptive reservoir, equilibrium partitioning is never achieved. Mass-balance considerations are used to develop physical-science-based models that connect source- and sink-rates to airborne concentrations for commonly encountered situations, such as the application of a pesticide or the emission of a plasticizer or flame retardant from its host material. Calculations suggest that many SVOCs have long indoor persistence, even after the primary source is removed. If the only removal mechanism is ventilation, moderately sorbing compounds (K-oa > 10(10)) may persist indoors for hundreds to thousands of hours, while strongly sorbing compounds (K-oa > 10(12)) may persist for years. The paper concludes by applying the newly developed framework to explore exposure pathways of building occupants to indoor SVOCs. Accumulation of SVOCs as a consequence of direct air-to-human transport is shown to be potentially large, with a maximum indoor-air processing rate of 10-20 m(3)/h for SVOC uptake by human skin, hair and clothing. Levels on human skin calculated with a simple model of direct air-to-skin transfer agree remarkably well with levels measured in dermal hand wipes for SVOCs possessing a wide range of octanol-air partition coefficients.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Weschler, C. J. (Intern), Nazaroff, W. (Ekstern)
Pages: 9018-9040
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: Atmospheric Environment
Volume: 42
Issue number: 40
ISSN (Print): 1352-2310
Ratings:
Sensory Pollution from Bag Filters, Carbon Filters and Combinations

Used ventilation filters are a major source of sensory pollutants in air handling systems. The objective of the present study was to evaluate the net effect that different combinations of filters had on perceived air quality after 5 months of continuous filtration of outdoor suburban air. A panel of 32 subjects assessed different sets of used filters and identical sets consisting of new filters. Additionally, filter weights and pressure drops were measured at the beginning and end of the operation period. The filter sets included single EU5 and EU7 fiberglass filters, an EU7 filter protected by an upstream pre-filter (changed monthly), an EU7 filter protected by an upstream activated carbon (AC) filter, and EU7 filters with an AC filter either downstream or both upstream and downstream. In addition, two types of stand-alone combination filters were evaluated: a bag-type fiberglass filter that contained AC and a synthetic fiber cartridge filter that contained AC. Air that had passed through used filters was most acceptable for those sets in which an AC filter was used downstream of the particle filter. Comparable air quality was achieved with the stand-alone bag filter that contained AC. Furthermore, its pressure drop changed very little during the 5 months of service, and it had the added benefit of removing a large fraction of ozone from the airstream. If similar results are obtained over a wider variety of soiling conditions, such filters may be a viable solution to a long recognized problem.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Mechanical Engineering
Authors: Bekö, G. (Intern), Clausen, G. (Intern), Weschler, C. J. (Intern)
Pages: 27-36
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: Indoor Air
Volume: 18
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Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.55
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 3.88
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 4.57
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 3.63
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 2.72
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 2.42
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Stehen prEN1264 und prEN 15377 im Widerspruch

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Olesen, B. W. (Intern)
Pages: 30-35
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: H L H, Heizung, Lueftung, Klima, Haustechnik
Issue number: 10
ISSN (Print): 1436-5103
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Scopus rating (2005): SJR 0.101
Scopus rating (2004): SJR 0.1 SNIP 0
Scopus rating (2003): SJR 0.103 SNIP 0.055
Scopus rating (2002): SJR 0.1 SNIP 0
Scopus rating (2001): SJR 0.139 SNIP 0.038
Scopus rating (2000): SJR 0.195 SNIP 0.049
Scopus rating (1999): SJR 0.11 SNIP 0
Original language: English
Source: orbit
Source-ID: 231135
Publication: Research - peer-review › Journal article – Annual report year: 2008
The association between phthalates in dust and allergic diseases among Bulgarian children

BACKGROUND: Recent studies have identified associations between the concentration of phthalates in indoor dust and allergic symptoms in the airways, nose, and skin.

OBJECTIVES: Our goal was to investigate the associations between allergic symptoms in children and the concentration of phthalate esters in settled dust collected from children's homes in Sofia and Burgas, Bulgaria.

METHODS: Dust samples from the child's bedroom were collected. A total of 102 children (2-7 Years of age) had symptoms of wheezing, rhinitis, and/or eczema in preceding 12 months (cases), and 82 were nonsymptomatic (controls). The dust samples were analyzed for their content of dimethyl phthalate (DMP), diethyl phthalate (DEP), di-n-butyl phthalate (DnP), butyl benzyl phthalate (BBzP), di(2-ethylhexyl) phthalate (DEHP), and di-n-octyl phthalate (DnOP).

RESULTS: A higher concentration of DEHP was found in homes of case children than in those of controls (1.24 vs. 0.86...
mg/g dust). The concentration of DEHP was significantly associated with wheezing in the preceding 12 months (p = 0.035) as reported by parents. We found a dose-response relationship between DEHP concentration and case status and between DEHP concentration and wheezing in the preceding 12 months.

CONCLUSIONS: This study shows an association between concentration of DEHP in indoor dust and wheezing among preschool children in Bulgaria.
The association of pet keeping at home with symptoms in airways, nose and skin among Bulgarian children

The role of pet exposure in early childhood for allergy/asthma later in life is still controversial. Recently it was shown that ‘avoidance behaviour’ is an important factor for the pet distribution in the population. The aim of the present work is to study the association between self-reported pet keeping at home and symptoms in airways, nose and skin among children 2-7 years of age, in a country where primary prevention strategies regarding allergies are not common. A cross-sectional survey on the association between allergy and asthma symptoms and home environment factors was conducted in two towns in Bulgaria in spring 2004 (the ALLHOME-1 study). Data for 4479 out of 12982 children was obtained. 21.3% of the parents reported having pets at the time of the questionnaire, and 23.3% for pet keeping at index child's birth. Parents of 3.3% of the children got rid of some of the pets and 10.6% refrained from having pets, due in both cases to allergic illness in the family. Keeping dogs or cats at the time of the survey or during the child's first years was associated with most of the symptoms (aOR 1.1-2.2).

General information
State: Published
Organisations: Department of Mechanical Engineering, Section for Indoor Environment, Department of Civil Engineering, Technical University of Denmark
Authors: Naydenov, K. G. (Intern), Popov, T. (Ekstern), Mustakov, T. (Ekstern), Melikov, A. K. (Intern), Bornehag, C. (Ekstern), Sundell, J. (Intern)
Pages: 702-708
Publication date: 2008
Main Research Area: Technical/natural sciences

Publications information
Journal: Pediatric Allergy and Immunology
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 1.217 SNIP 1.101 CiteScore 2.65
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.659 SNIP 1.056 CiteScore 2.63
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.302 SNIP 1.241 CiteScore 2.92
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.359 SNIP 1.333 CiteScore 3.25
The combined effects of many different indoor environmental factors on acceptability and office work performance

Ninety-nine young-adult subjects of both genders were randomly assigned to four groups. One group performed simulated office work for two hours in a set of poor environmental conditions, with overhead fluorescent lighting, recorded traffic noise from a busy street, 27 degrees C (80.6 degrees F) operative temperature, supply air polluted by emissions from linoleum, recorded open office noise, and almost no daylight. The realistic annual cost of improving each of the six conditions was estimated and expressed as a percentage of the total sum of the cost of improving conditions. The modifications included improved lighting, barely audible traffic noise, operative temperature of 22 degrees C (71.6 degrees F), clean air, quiet, and a daylit view out. A second group briefly experienced all 12 conditions and individually selected the improvements they preferred, up to a 50% budget. A third group of subjects was randomly paired with each of the subjects from the second group, and each pair was exposed to the conditions selected by the second-group subjects. A fourth group was exposed to fully-improved (100% budget) conditions. Significant improvements in subjective assessment occurred at higher budget/individual choice levels, and the self-reported performance of office tasks improved, although measured performance could not be shown to differ significantly between treatment groups.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Clausen, G. (Intern), Wyon, D. P. (Intern)
Pages: 103-113
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication Information
Journal: HVAC & R Research
Volume: 14
Issue number: 1
The concentrations of phthalates in settled dust in Bulgarian homes in relation to building characteristic and cleaning habits in the family

Phthalate esters are chemical compounds with a broad range of applications. Recently, we have shown that significantly higher dust concentration of di(2-ethylhexyl) phthalate (DEHP) was found in Bulgarian homes of children with asthma or allergies compared to healthy children. The concentration of DEHP was found to be significantly associated with wheezing in the last 12 months as reported by parents. The objective of the current study was to examine the associations between concentrations of phthalates in settled dust collected in Bulgarian homes and building characteristics and cleaning habits. Dust samples from the child's bedroom were collected in 177 homes and analysed for the content of dimethyl phthalate (DMP), diethyl phthalate (DEP), di-n-butyl phthalate (DnBP), butyl benzyl phthalate (BBzP), di-n-octyl phthalate (DnOP) and DEHP. Information on building characteristics and family habits were collected from parental reports in questionnaires and from inspectors' observations in the homes. Significantly higher concentrations of BBzP, DEHP and DnOP in indoor dust were found in homes where polishing agents were used, compared to homes where such products were not used. The highest concentrations of DEHP, BBzP and DnOP were found in homes with the combination of a low frequency of dusting and the use of polish. There was no difference in phthalate concentrations between inspector-observed balatum flooring (PVC or linoleum) and wood flooring as well as between PVC, as determined by Raman spectra, and wood flooring. However, in a sub-group of homes with no use of polish, the concentration of DEHP was higher in homes with inspector-observed balatum compared with wood flooring but the difference was not significant may be due to a too small sample size.
The cooling capacity of the thermo active building system combined with acoustic ceiling

General information
State: Published
Organisations: Section for Building Physics and Services, Department of Civil Engineering, Section for Indoor Environment
Authors: Weitzmann, P. (Intern), Pittarello, E. (Ekstern), Olesen, B. W. (Intern)
Publication date: 2008

Host publication information
Title of host publication: Nordic Symposium on Building Physics
Publisher: Technical University of Denmark (DTU)
Main Research Area: Technical/natural sciences
Conference: 8th Symposium on Building Physics in Nordic Countries, Copenhagen, Denmark, 16/06/2008 - 16/06/2008
Source: orbit
Source-ID: 234001
Publication: Research - peer-review › Article in proceedings – Annual report year: 2008

The effect of using low-polluting building materials on perceived air quality and ventilation requirements in real rooms

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Knudsen, H. (Ekstern), Wargocki, P. (Intern)
The effects of electrostatic particle filtration and supply-air filter condition in classrooms on the performance of schoolwork by children (RP-1257)

Two independent field intervention experiments involving a total of about 190 pupils were carried out in winter and early spring of 2005 in five pairs of mechanically ventilated classrooms that received 100% outdoor air. Each pair of classrooms was located in a different static air cleaners were installed in classrooms and either operated or disabled to modify particle concentrations while the performance of schoolwork was measured. In one school, the used supply-air filters in a ventilation system without recirculation were also replaced with new ones to modify classroom air quality, while the filters in use in other schools were not changed. The conditions were established for one week at a time in a blind crossover design with repeated measures on ten-to-twelve-year-old children. Pupils performed six exercises exemplifying different aspects of schoolwork as part of normal lessons and indicated their environmental perceptions and the intensity of any symptoms. A sensory panel of adults judged the air quality in the classrooms soon after the pupils left. Operating the electrostatic air cleaners considerably reduced the concentration of particles in the classrooms. The effect was greater the lower the outdoor air supply rate. There were no consistent effects of this reduction on the performance of schoolwork, on the children's perception of the classroom environment, on symptom intensity, or on air quality as perceived by the sensory panel. This suggests there are no short-term (acute) effects of particle effects were inconsistent, removal outside the pollen season. When new filters were installed, the e although this is believed to be due to sequential and unbalanced presentation of filter conditions and to the fact that the used filters retained very little dust.
The influence of ozone on self-evaluation of symptoms in a simulated aircraft cabin

Simulated 4-h flights were carried out in a realistic model of a three-row, 21-seat section of an aircraft cabin that was reconstructed inside a climate chamber. Twenty-nine female subjects, age 19-27 years, were split into two groups; each group was exposed to four conditions: two levels of ozone (}
Theoretical study of simultaneous water and VOCs adsorption and desorption in a silica gel rotor

One-dimensional partial differential equations were used to model the simultaneous water and VOC (Volatile Organic Compound) adsorption and desorption in a silica gel rotor which was recommended for indoor air cleaning. The interaction among VOCs and moisture in the adsorption and desorption process was neglected in the model as the concentrations of VOC pollutants in typical indoor environment were much lower than that of moisture and the adsorbed VOCs occupied only a minor portion of adsorption capacity of the rotor. Consequently VOC transfer was coupled with heat and moisture transfer only by the temperatures of the rotor and the air stream. The VOC transfer equations were solved by discretizing them into explicit up-wind finite differential equations. The model was validated with experimental data. The calculated results suggested that the regeneration time designed for dehumidification may be prolonged to allow complete removal of the VOC pollutants from the rotor. The regeneration temperature designed for dehumidification provides considerable efficiency for indoor air cleaning. The application of the model in estimating the cleaning capacity of the rotor for VOC pollutants was demonstrated.

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Organisations: Section for Indoor Environment, Department of Civil Engineering, Technical University of Denmark
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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.55
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 3.88
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 4.57
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 3.63
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 2.72
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 2.42
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.757 SNIP 2.168
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.933 SNIP 3.724
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.637 SNIP 2.622
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.347 SNIP 1.283
Web of Science (2005): Indexed yes
Web of Science (2004): Indexed yes
Web of Science (2003): Indexed yes
Web of Science (2002): Indexed yes
Web of Science (2001): Indexed yes
Web of Science (2000): Indexed yes
Original language: English
rotor, model, silica gel, adsorption, VOC
The performance of schoolwork by children is not affected by short-term electrostatic particle filtration outside the pollen season

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Wargocki, P. (Intern), Wyon, D. P. (Intern)
Pages: paper ID 120 (on CD-ROM)
Publication date: 2008

Host publication information
Title of host publication: Indoor Air 2008: The 11th International Conference on Indoor Air Quality and Climate
Publisher: Technical University of Denmark (DTU)
Editors: Strøm-Tejsen, P., Olesen, B. W., Wargocki, P., Zukowska, D., Toftum, J.
Main Research Area: Technical/natural sciences
Conference: 11th International Conference on Indoor Air Quality and Climate, Copenhagen, Denmark, 17/08/2008 - 17/08/2008
Source: orbit
Source-ID: 221727
Publication: Research - peer-review › Journal article – Annual report year: 2008

Thermal comfort, physiological responses and performance during exposure to a moderate temperature drift
The objective of this research was to study the effects of a moderate temperature drift on human thermal comfort, physiological responses, productivity and performance. A dynamic thermophysiological model was used to examine the possibility of simulating human thermal responses and thermal comfort under moderate transient conditions. To examine the influence of a moderate temperature ramp, a climate room set-up with experimental subjects was used. Eight subjects visited the climate room on two occasions: 1) exposure to a transient condition (a moderate temperature ramp) and 2) a steady temperature corresponding with a neutral thermal sensation (control situation). During the experiments both physiological responses and thermal sensation were measured. Productivity and performance were assessed with a ‘Remote Performance Measurement’ (RPM) method. Physiological and thermal sensation data indicate significant differences between the transient condition and the control situation. Productivity and performance tests show no significant changes between the two situations. Simulations obtained with the thermophysiological model were in good agreement with the measurements. Possible improvements of the performance and productivity tests and the thermophysiological model will be discussed.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Eindhoven University of Technology
Authors: Schellen, L. (Ekstern), van Marken Lichtenbelt, W. (Ekstern), de Wit, M. (Ekstern), Loomans, M. (Ekstern), Friiis, A. (Ekstern), Toftum, J. (Intern)
Pages: 555
Publication date: 2008

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Title of host publication: Proceedings of the 11th International Conference on Indoor Air Quality and Climate
Place of publication: Copenhagen
Publisher: International Centre for Indoor Environment and Energy
ISBN (Print): 9788777772701
Main Research Area: Technical/natural sciences
Conference: 11th International Conference on Indoor Air Quality and Climate, Copenhagen, Denmark, 17/08/2008 - 17/08/2008
Electronic versions:
PaperID_555.pdf
Source: orbit
Source-ID: 232860
Publication: Research - peer-review › Article in proceedings – Annual report year: 2008
Total building economic consequences of the effect of temperature on mental performance of office workers

A building simulation program called iDbuild has been developed that calculates the consequences for the indoor environment and energy consumption of selected building design parameter variations. The program thus supports the decision process by facilitating the comparison of different building designs. This paper describes the development of a new module to iDbuild, which calculates the overall economic consequences of parameter variations of the air quality and thermal conditions in an office environment, when accounting for the effect on employee performance of the indoor environment.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Jensen, K. L. (Intern), Toftum, J. (Intern)
Publication date: 2008

Trends i indeklimaforskningen

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Toftum, J. (Intern)
Pages: 16-17
Publication date: 2008
Main Research Area: Technical/natural sciences

Ventilation and indoor environmental quality

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Olesen, B. W. (Intern), Bluysen, P. (Ekstern), Roulet, C. (Ekstern)
Pages: 62-104
Publication date: 2008

Host publication information
Title of host publication: Ventilation Systems : Design and Performance
Place of publication: England
Window-opening behaviour when classroom temperature and air quality are manipulated experimentally (ASHRAE 1257-RP)

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Wyon, D. P. (Intern), Wargocki, P. (Intern)
Publication date: 2008

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Title of host publication: Indoor Air 2008 : The 11. International Conference on Indoor Air Quality and Climate
Volume: paper ID 119 (on CD-ROM)
Publisher: Technical University of Denmark (DTU)
Editors: Strøm-Tejsen, P., Olesen, B. W., Wargocki, P., Zukowska, D.
Main Research Area: Technical/natural sciences
Conference: 11th International Conference on Indoor Air Quality and Climate, Copenhagen, Denmark, 17/08/2008 - 17/08/2008
Source: orbit
Source-ID: 233801
Publication: Research - peer-review › Article in proceedings – Annual report year: 2008

The effects of the aircraft cabin environment on passengers during simulated flights
A 3-row, 21-seat section of a simulated Boeing 767 aircraft cabin has been built in a climate chamber, simulating the cabin environment not only in terms of materials and geometry, but also in terms of cabin air and wall temperatures and ventilation with very dry air. This realistic simulation enables subjective assessments of the symptoms commonly experienced by passengers and crew during flights. Six investigations with subject exposure have subsequently been carried out in the aircraft cabin facility covering four environmental areas of study, i.e. humidity, air purification techniques, ozone, and thermal effects. The humidity study, examining the optimum balance between fresh air supply and humidity, showed that increasing relative humidity in the aircraft cabin by reducing outside air flow did not reduce the intensity of symptoms typically experienced in the aircraft cabin but intensified complaints of headache, dizziness and claustrophobia, suggesting that air pollutants rather than low humidity cause the distress reported by airline passengers. Three investigations studying the efficacy of various air purification technologies showed that a gas phase adsorption purification unit performed better than two different photo-catalytic oxidation units, although all three units greatly reduced the concentration of air pollutants in the cabin. Results obtained from the Ozone investigation indicate that the presence of ozone in the aircraft cabin is a principal cause of a number of the symptoms commonly associated with the aircraft cabin. It suggests that it would be beneficial to remove ozone at levels less than currently specified. The last study, investigating the influence of air temperature on passenger comfort and symptoms, showed that cabin air temperature affected the perception of air quality, air freshness, and thermal sensation, improving these perceptions when temperature was lowered.

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Strem-Tejsen, P. (Intern), Olesen, B. W. (Intern), Wargocki, P. (Intern)
Number of pages: 142
Publication date: Nov 2007

Publication information
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Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 199302
Publication: Research › Ph.D. thesis – Annual report year: 2007

Thermal and Indoor Air Quality Effects on Physiological Responses, Perception and Performance of Tropically Acclimatized People
Formation and emissions of carbonyls during and following gas-phase ozonation of indoor materials
Ozone concentrations that are several orders of magnitude greater than typical urban ambient concentrations are necessary for gas-phase ozonation of buildings, either for deodorization or for disinfection of biological agents. However, there is currently no published literature on the interaction of building materials and ozone under such extreme conditions. It would be useful to understand, for example in the case of building re-occupation planning, what types and amounts of reaction products may form and persist in a building after ozonation. In this study, 24 materials were exposed to ozone at concentrations of 1000 ppm in the inlet stream of experimental chambers. Fifteen target carbonyls were selected and measured as building ozonation by-products (BOBPs). During the 36 h that include the 16 h ozonation and 20 h persistence phase, the total BOBP mass released from flooring and wall coverings ranged from 1 to 20 mg m(-2), with most of the carbonyls being of lower molecular weight (C-1-C-4). In contrast, total BOBP mass released from wood-based products ranged from 20 to 100 mg m(-2), with a greater fraction of the BOBPs being heavier carbonyls (C-5-C-9). The total BOBP mass released during an ozonation event is a function of both the total surface area of the material and the BOBP emission rate per unit area of material. Ceiling tile, carpet, office partition, and gypsum wallboard with flat latex paint often have large surface areas in commercial buildings and these same materials exhibited relatively high BOBP releases. The greatest overall BOBP mass releases were observed for three materials that building occupants might have significant contact with: paper, office partition, and medium density fiberboard, e.g., often used in office furniture. These materials also exhibited extended BOBP persistence following ozonation; some BOBPs (e.g., nonanal) persist for months or more at emission rates large enough to result in indoor concentrations that exceed their odor threshold.
Operative Temperature for Control of Radiant Surface Heating and Cooling Systems

General information
State: Published
Organisations: Department of Mechanical Engineering, Section for Indoor Environment, Department of Civil Engineering Authors: Simone, A. (Intern), Olesen, B. W. (Intern), Babiak, J. (Ekstern), Bullo, M. (Ekstern), Langkilde, G. (Intern)
Pages: 233-237
Publication date: 2007

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Volume: 1
Main Research Area: Technical/natural sciences
Conference: 62 Congresso Nazionale, 01/01/2007
Source: orbit
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Sensory Pollution from Bag Filters, Carbon Filters and Combinations

General information
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Organisations: Indoor Environment, Department of Mechanical Engineering, Section for Indoor Environment, Department of Civil Engineering
Authors: Bekö, G. (Intern), Clausen, G. (Intern), Weschler, C. J. (Intern)
Publication date: 2007
Main Research Area: Technical/natural sciences
Electronic versions:
- gb_Clima2007 Helsinki.pdf
Source: orbit
Source-ID: 207175
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2007

The effects of outdoor air supply rate and supply air filter condition in classrooms on the performance of schoolwork by children (RP-1257)

Two independent field intervention experiments were carried out in mechanically ventilated classrooms receiving 100% outdoor air. Outdoor air supply rate and filter condition were manipulated to modify indoor air quality, and the performance of schoolwork was measured. The conditions were established for one week at a time in a blind crossover design with repeated measures on 10- to 12-year-old children in two classes. Seven exercises exemplifying different aspects of schoolwork (numerical or language-based) were performed as part of normal lessons by pupils who also marked visual analogue scales to indicate their environmental perceptions and the intensity of any symptoms. The children indicated that the air was fresher but otherwise perceived little difference when the outdoor air supply rate increased from 3.0 to 8.5 L/s (6.4-18 cfm) per person, while the speed at which they performed two numerical and two language-based tasks improved significantly. A significant effect of ventilation rate was observed in 70% of all the statistical tests for an effect on work rate, but there were no significant effects on errors. The effects were probably due to improved air quality in the classrooms as judged by a sensory panel of adults blind to conditions, as perceived by children, and as indicated by the reduction in the average CO2 concentration from 1300 to 900 ppm, taking this as a marker of reduced bioeffluent concentration. It was not possible to test the effect of replacing a soiled filter with a new one because very little dust had been retained by the "used" filter and because of an incompletely balanced design. The unbalanced design also made it impossible to test for an interaction between filter condition and ventilation rate. These results indicate the importance of improving indoor air quality and ventilation in classrooms.

General information
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Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Wargocki, P. (Intern), Wyon, D. P. (Intern)
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Publication date: 2007
Main Research Area: Technical/natural sciences

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BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.01
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.514 SNIP 0.731
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.561 SNIP 0.891
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.544 SNIP 1.104
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.498 SNIP 0.742
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.93 SNIP 0.956
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.614 SNIP 1.187
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.791 SNIP 0.903
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.677 SNIP 1.639
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.843 SNIP 1.29
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.4 SNIP 1.26
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.054 SNIP 2.001
Scopus rating (2003): SJR 1.055 SNIP 1.28
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.917 SNIP 1.739
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.637 SNIP 2.271
Scopus rating (2000): SJR 0.67 SNIP 2.027
Scopus rating (1999): SJR 0.357 SNIP 0.753

Original language: English
Vigtigt med et godt indeklima: Clima 2007 konference

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering
Authors: Jensen, K. L. (Intern), Andersen, R. V. (Intern)
Pages: 46-47
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: H V A C Magasinet
Volume: 8
ISSN (Print): 1603-6913
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: Danish
Links:
http://www.swiflet.com/tm/hvac/8/1/

Sensation of "Dryness" humidity of air, comfort and health

General information
State: Published
Organisations: Department of Mechanical Engineering, Section for Indoor Environment, Department of Civil Engineering
Authors: Lagercrantz, L. P. (Intern), Sundell, J. (Intern)
Publication date: Feb 2006

Publication information
Place of publication: Kgs. Lyngby, Denmark
Publisher: Technical University of Denmark (DTU)
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 269463
Publication: Communication › Journal article – Annual report year: 2007

Air filtration and indoor air quality

Demands for better indoor air quality are increasing, since we spend most of our time indoors and we are more and more aware of indoor air pollution. Field studies in different parts of the world have documented that high percentage of occupants in many offices and buildings find the indoor air quality (IAQ) unacceptable and suffer from Sick Building Syndrome (SBS) symptoms (e.g. respiratory, headache, fatigue, etc.). In addition, prevalence of asthma and other respiratory and allergic diseases have increased during the past decades. The effect is most likely related to the environment. Without decent ventilation and air cleaning/air filtration, high indoor air quality cannot be accomplished. The need for effective air filtration has increased with increasing evidence on the hazardous effects of fine particles. Moreover, the air contains gaseous pollutants, removal of which requires various air cleaning techniques. Supply air filter is one of the key components in the ventilation system. Studies have shown that used ventilation filters themselves can be a significant source of indoor air pollution with consequent impact on perceived air quality, sick building syndrome symptoms and performance. Usually, increasing the ventilation rate improves the air quality, however in the case of used ventilation filters the benefits from increasing the airflow are smaller than usual. Moreover, the ever-increasing pressure drop of bag filters tends to raise energy costs of ventilation systems. These contradictions should motivate manufacturers and researchers to develop new efficient filtration techniques and/or improve the existing ones. Development of low polluting filtration techniques, which are at the same time easy and inexpensive to maintain is the way forward in the future.
Air Filtration as Protection against Fouling of Ventilation and Air Conditioning Units

Currently, air filters are one of the most critical components of air treatment systems as they decontaminate the air delivered to living space. During the operation, however, the level of harmful surface deposits increases, and at certain times, an uncleaned filter can itself become a source of undesirable contaminants influencing negatively the IAQ of a living space. This is the phenomenon that has been a subject of the current research. The article presents a new, alternative view on indoor air contaminants and filtration requirements. It describes alternative means of filtration and assesses issues of inadequate maintenance and/or long term use of applied air filters. An experimental method of evaluating the air quality by means of chemical analysis and state-of-the-art spectrometer is also described.

Ultra-fine particles as indicators of the generation of oxidized products on the surface of used air filters

Currently, air filters are one of the most critical components of air treatment systems as they decontaminate the air delivered to living space. During the operation, however, the level of harmful surface deposits increases, and at certain times, an uncleaned filter can itself become a source of undesirable contaminants influencing negatively the IAQ of a living space. This is the phenomenon that has been a subject of the current research. The article presents a new, alternative view on indoor air contaminants and filtration requirements. It describes alternative means of filtration and assesses issues of inadequate maintenance and/or long term use of applied air filters. An experimental method of evaluating the air quality by means of chemical analysis and state-of-the-art spectrometer is also described.

Ultra-fine particles as indicators of the generation of oxidized products on the surface of used air filters

Currently, air filters are one of the most critical components of air treatment systems as they decontaminate the air delivered to living space. During the operation, however, the level of harmful surface deposits increases, and at certain times, an uncleaned filter can itself become a source of undesirable contaminants influencing negatively the IAQ of a living space. This is the phenomenon that has been a subject of the current research. The article presents a new, alternative view on indoor air contaminants and filtration requirements. It describes alternative means of filtration and assesses issues of inadequate maintenance and/or long term use of applied air filters. An experimental method of evaluating the air quality by means of chemical analysis and state-of-the-art spectrometer is also described.
Human Perception, SBS Symptoms and Performance of Office Work during Exposure to Air Polluted by Building Materials and Personal Computers

The present thesis deals with the impact of polluted air from building materials and personal computers on human perception, Sick Building Syndrome (SBS) symptoms and performance of office work. These effects have been studied in a series of experiments that are described in two different chapters, each of them with one type of pollution source.

Ventilation filters as sources of air pollution – Processes occurring on surfaces of used filters

Ozone concentrations were monitored upstream and downstream of used filter samples following 24 hours of ventilation with ozone-filtered air. The ozone concentration in the air upstream of the filters was maintained at ~75 ppb while the concentration downstream of the filters was initially between ~35 and 55 ppb and slowly increased over time. Within an hour the ozone concentration downstream of the filter had increased to ~70 ppb. In contrast, no change in ozone removal efficiency over time was observed for a new filter. The used filter samples were then placed for 24 hours in ambient air (ozone concentration < 5 ppb); ambient air at an elevated temperature (100°C); or nitrogen. When subsequently placed in the air stream containing 75 ppb of ozone partial regeneration of the filter’s ozone removal capabilities was observed. Regeneration was greatest for the sample that had sat at an elevated temperature. The process or processes responsible for regeneration remain to be determined.
Chemical emission rates from personal computers

Chemical emission measurements from different brands of personal computers (PCs) were conducted in a 1 m³ glass chamber. Eight PCs were tested individually. Each consisted of the same brand of PC tower and one of the 4 different brands of PC monitors. Within each brand both cathode-ray tube (CRT) and thin-film transistor (TFT) flat panel monitors were evaluated. Volatile organic compounds (VOCs) and aldehydes were quantified using GC/MS and HPLC, respectively. Compared with PCs with TFT monitors, PCs with CRT monitors had slightly higher emission rates of formaldehyde and acetaldehyde, emitted greater quantities of C₃-C₆ aldehydes having low odor thresholds and had higher emissions of aromatic hydrocarbons. Emission rates of aliphatic hydrocarbons were low for both PCs with CRT and TFT monitors. However, estimated concentrations of these chemicals in a normal office space based on the measured emission rates were much lower than the odor thresholds.

Initial studies of oxidation processes on filter surfaces and their impact on perceived air quality

Ozone concentrations were monitored up- and downstream of used filter samples at airflows of 1.0 and 0.2 L s⁻¹. The ozone concentration in the air upstream of the filters was ~75 ppb, while the concentration downstream of the filter was initially ~35% lower at 1 L s⁻¹ and ~55% lower at 0.2 L s⁻¹. Within an hour the removal efficiency had decreased to roughly 5% at 1 L s⁻¹ and 10% at 0.2 L s⁻¹. These filter samples were then placed in either nitrogen or ambient air for 48 hours. Afterwards it was found that there was partial regeneration of the filter's ozone removal capabilities. In companion studies, human subjects assessed air passing through various filter samples. This occurred when samples were first placed in the test rig (each of 3 filters equivalent); immediately after the samples had sat for 48 hours in ozone, nitrogen or air (ozone-treated worse than air-treated worse than nitrogen-treated); and after ambient air had passed through the treated filters for 2 hours. In the last case all filters were more acceptable than they had been right after the 48-hour treatments. However, the ozonized filter was still the most polluting of the three.
The influence of typical ways of operating and air-handling unit on the sensory pollution load from used bag filters

An experiment was performed to determine whether the sensory pollution emitted from a bag filter that had been used for 3 months in a suburban area in Denmark was influenced by different ways of operating the air-handling unit (AHU). Samples of the used filter were pre-conditioned to simulate three operating conditions: 1) switched off overnight; 2) airflow reduced to 10% overnight; and 3) continuous 100% operation. Outside air passed through the samples and the acceptability of the air after the filter was assessed by a panel of subjects. The results indicate that turning off the AHU or reducing the airflow outside working hours would significantly increase the sensory pollution emitted by a used bag filter immediately after the AHU is turned on, in comparison with continuous airflow through the AHU (P)

The Use of Spreadsheets to Calculate Water Vapour Diffusion According to the Glaser Method

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics
Authors: Rode, C. (Intern)
Number of pages: 11
Publication date: 2003

Publication information
Original language: English
Main Research Area: Technical/natural sciences

Electronic versions:
Spreadsheets_281003.pdf
Source: PublicationPreSubmission
Source-ID: 127863545
Publication: Communication › Report – Annual report year: 2003

Vplyv filtrov vetracích a klimatizačných zariadení na kvalitu vnútorného vzduchu: Počiatočné štúdie oxidačných procesov prebiehajúcich na povrchu kapsových filtrov vzduchu a ich dopad na vnímanú kvalitu vzduchu

General information
State: Published
Organisations: Section for Indoor Environment, Department of Civil Engineering, Department of Mechanical Engineering, Slovak University of Technology
Authors: Bekö, G. (Intern), Haláš, O. (Ekstern), Clausen, G. (Intern), Weschler, C. J. (Intern)
Pages: 31-33
Publication date: 2003
Main Research Area: Technical/natural sciences
Integrating CFD and building simulation

To provide practitioners with the means to tackle problems related to poor indoor environments, building simulation and computational fluid dynamics can usefully be integrated within a single computational framework. This paper describes the outcomes from a research project sponsored by the European Commission, which furthered the CFD modelling aspects of the ESP-r system. The paper summarises the form of the CFD model, describes the method used to integrate the thermal and flow domains and reports the outcome from an empirical validation exercise. © 2002 Published by Elsevier Science Ltd.
Omfang af og risiko for fugt og skimmel i konstruktioner og materialer: beregningsmetoder

General information
State: Published
Organisations: Department of Civil Engineering, Section for Indoor Climate and Building Physics
Authors: Rode, C. (Intern)
Number of pages: 29
Publication date: 2001

Publication information
Media of output: Powerpoint
Original language: English
Main Research Area: Technical/natural sciences
Electronic versions:
DANVAK_Carsten_Rode.pdf
Publication: Research - peer-review › Journal article – Annual report year: 2002

An investigation of flow characteristics at propeller open water tests and in behind conditions using thermoanemometric probe

General information
State: Published
Organisations: Department of Civil Engineering, Department of Mechanical Engineering, Solid Mechanics, Section for Indoor Environment
Authors: Lazarov, B. S. (Intern), Stephanov, S. (Ekstern), Kussow, K. (Ekstern), Melikov, A. K. (Intern)
Pages: 124.1-124.9
Publication date: 1984

Host publication information
Title of host publication: Proceedings of SMSSH'84, 13-th Scientific and Methodological Seminar on Ship Hydrodynamics
The aim is to ensure energy-reducing, cost-effective, resource efficient, and reliable renovation solutions, and to transform sustainable building renovation into a productive business with export potential. The partnership is widely supported in the building industry, cf. advisory board, inclusion of authorities and stakeholders.

The work is aimed at social housing buildings and will be demonstrated in full scale. Based on development within this “lead-user” segment of the renovation market, the partnership’s targets are to reduce energy consumption in the existing building stock by minimum 50%, achieve reduction in resource usage by 30%, and increase productivity 20% by industrialising building renovations, and at the same time ensure a good and healthy life inside the buildings.

Department of Civil Engineering
Section for Indoor Climate and Building Physics
Period: 01/05/2017 → 01/01/2020
Number of participants: 1
Acronym: REBUS
Project participant:
Elarga, Hagar (Intern)
Project

Annex68-Indoor air quality design and control in low energy residential buildings
To achieve nearly net zero energy use, all buildings in future will need to be more efficient and optimized. As new buildings are already well insulated in certain industrialised countries, the focus is shifting to limiting space heating energy consumption by reducing ventilation demand. Low energy buildings need to be airtight and energy demand for ventilation is often reduced by lowering the ventilation rate to the minimum necessary. Each of these can have adverse impacts on indoor air quality (IAQ). This project is therefore investigating how to ensure that future low energy buildings are able both to improve their energy performance and to provide comfortable and healthy indoor environments.

Reducing the amount of fresh air supplied to a building would save energy, but however may increase the risk of poor indoor air quality. Therefore, it is very important to find the ideal balance between energy efficiency and the need for ventilation. The aim of this project is to use existing data and tools, which in combination give an integrated picture of the air flow, hygrothermal and air quality conditions in whole buildings with a focus on optimisation of their use and operation. This should achieve energy efficiency alongside providing healthy and comfortable indoor environments.

Department of Civil Engineering
Section for Indoor Climate and Building Physics
Period: 15/03/2017 → 10/12/2019
Number of participants: 1
Project participant:
Elarga, Hagar (Intern)
Project

Warm or Cold, Lights influence on thermal comfort
Various indicators point out that a connection exists between the ambient temperature and the correlated color temperature that users prefer for the lit environment. In warm climate the use of cooler lighting is much more common than in a colder climate where people use much warmer light sources. Presumably the use of different colored light sources is due to the experience of cooler climate at cooler light sources and the impression of warmth follows a warmer looking light source. With new LED technology the correlated color temperature (warm white to cool white) is easily controllable.
The goal of the project is to demonstrate how controllable LED lighting can be used to expand the temperature interval that users find comfortable. The project is founded on previous research on colored light. It will lead to a decrease in the energy consumption of buildings.

Department of Photonics Engineering
Diode Lasers and LED Systems

Department of Civil Engineering
Section for Indoor Climate and Building Physics
Period: 01/03/2016 → 31/12/2018
Number of participants: 5
Project ID: 70963
Project participant:
Markvart, Jakob (Ekstern)
Thorseth, Anders (Intern)
Dam-Hansen, Carsten (Intern)
Toftum, Jørn (Intern)

Project Manager, organisational:
Logadóttir, Ásta (Ekstern)

Financing sources
Source: Public research council
Name of research programme: ELFORSK
Web address: http://www.elforsk.dk/
Year of approval: 2015

Relations
Related projects:
Combined daylight and Intelligent LED lighting : Getting the daylight into the buildings
Energibesparende LED farveblandings belysningssystem med høj lyskvalitet
Activities:
Danish national CIE committee (External organisation)
DALI Designer 5 programming
LED possibilities and challenges
Press / Media items:
Koldt LED-lys truer nordisk hygge

Models for flexible operation of buildings in district energy system Nordhavn
Department of Civil Engineering
Section for Indoor Climate and Building Physics

Section for Building Energy
Period: 15/09/2015 → …
Number of participants: 3
Phd Student:
Foteinaki, Kyriaki (Intern)
Supervisor:
Heller, Alfred (Intern)
Main Supervisor:
Rode, Carsten (Intern)

Relations
Parent project:
EnergyLab Nordhavn - New Urban Energy Infrastructures

Project
EnergyLab Nordhavn - New Urban Energy Infrastructures

Department of Electrical Engineering
Center for Electric Power and Energy
Energy resources, services and control
Energy Analytics and Markets
Energy system operation and management

Department of Applied Mathematics and Computer Science

Department of Civil Engineering
Section for Building Energy
Section for Indoor Climate and Building Physics

Department of Mechanical Engineering
Thermal Energy

HOFOR A/S

Balslev Consulting Engineers A/S
METRO THERM A/S
ABB Group

Københavns Kommune

By og Havn

Radius Elnet

CleanCharge Solutions
Period: 01/04/2015 → 31/03/2019
Number of participants: 20
Acronym: ELN
Number of related Ph.D. students: 9
Project participant:
Hashemi Toghroljerdi, Seyedmostafa (Intern)
Østergaard, Jacob (Intern)
Træholt, Chresten (Intern)
Pinson, Pierre (Intern)
Mitridati, Lesia Marie-Jeanne Mariane (Intern)
Klyapovskiy, Sergey (Intern)
Le Ray, Guillaume (Intern)
Gjelaj, Marjan (Intern)
You, Shi (Intern)
Harrestrup, Maria (Intern)
Rode, Carsten (Intern)
Elmegaard, Brian (Intern)
Ommen, Torben Schmidt (Intern)
Foteinaki, Kyriaki (Intern)
Luc, Katarzyna Marta (Intern)
Pieper, Henrik (Intern)
Meesenburg, Wiebke (Intern)
Mitridati, Lesia Marie-Jeanne Mariane (Intern)
Le Ray, Guillaume (Intern)

Project Manager, organisational:
Greisen, Christoffer (Intern)

Relations
Activities:
Performance analysis of heat pumps utilizing different low temperature heat sources to supply district heating

Publications:
Efficient Control of Active Transformers for Increasing the PV Hosting Capacity of LV Grids
Cost-Benefit Analysis of a Novel DC Fast-Charging Station with a Local Battery Storage for EVs
Optimal Design of DC Fast-Charging Stations for EVs in Low Voltage Grids
Active and reactive power support of MV distribution systems using battery energy storage
Efficient Control of Energy Storage for Increasing the PV Hosting Capacity of LV Grids
Optimal usage of low temperature heat sources to supply district heating by heat pumps
DC Fast-Charging Stations for EVs Controlled by a Local Battery Storage in Low Voltage Grids
Methods and Strategies for Overvoltage Prevention in Low Voltage Distribution Systems with PV

EnergyLab Nordhavn
The objective of this project is to develop new methods and solutions for design and dimensioning of the future cost-effective multi-carrier energy system (electricity, thermal, transport) based on Nordhavn as a globally visible real-life laboratory.

Department of Civil Engineering
Section for Indoor Climate and Building Physics
Period: 01/01/2015 → 31/12/2019
Number of participants: 1
energy flexible buildings, flexible users, living lab, urban energy infrastructure, Renewable energy

Project participant:
Li, Rongling (Intern)

RIBuild
RIBuild will strengthen the knowledge on how and under what conditions internal thermal insulation is to be implemented in historic buildings, without compromising their architectural and cultural values, with an acceptable safety level against deterioration and collapse of heavy external wall structures. The general objective of RIBuild is to develop effective, comprehensive decision guidelines to optimise the design and implementation of internal thermal insulation in historic buildings across the EU. RIBuild focuses on heavy external walls made of stone, brick and timber framing, as most historic buildings are made of these materials. The general objective is achieved through three main activities
• To obtain a thorough knowledge level to characterise the eligibility of the building for a deep internal thermal insulation renovation. This knowledge is obtained through screening of historic buildings, investigation of material properties and threshold values for failure
• To determine the conditions under which different internal insulation measures are reliable and affordable measures based on probabilistic modelling of the hygrothermal performance, the environmental impact and the cost/benefit
• To develop a set of comprehensive decision guidelines, which are demonstrated in a number of buildings. RIBuild addresses the most difficult retrofitting measure of historic buildings: internal thermal insulation. The adaption of knowledge developed by RIBuild contributes to sustainable historic buildings with improved energy efficiency implying an easier conversion of energy supply from inefficient fossil fuels to efficient renewable energy sources. RIBuild also assesses the hygrothermal performance of the building construction, thus no collateral damage occurs; in case of failure an easy roll back of the measures is possible. The guidelines developed in RIBuild strongly support the deep and holistic retrofitting approach which historic buildings face in the coming years

Work packages
The RIBuild research programme is divided into eight inter-correlated work packages (WPs). For a short description of each work package, please see the following.

WP1: Pre-renovation assessment
Examines common structural elements of historic buildings, determines their physical properties and classifies them according to type. The objective is to observe and describe the main symptoms of a deteriorating building envelope and study their possible causes.

WP leader: RTU
Participants: AAU, TUD, KUL, UNIVPM, DTU, SP, HES-SO

WP2: Material characterisation
Provides data for material properties and threshold values for historic building materials and existing insulation materials as a background for material characterisation models and guidelines for safe retrofitting measures.
WP leader: AAU
Participants: RTU, TUD, KUL, UNIVPM, DTU, SP, HES-SO, INTROFLEX

WP3: Case studies and laboratory measurements
Supports the research with high quality measurement data from both laboratory experiments on components and on-site monitoring of test buildings.

WP leader: TUD
Participants: AAU, RTU, KUL, UNIVPM, DTU, SP, INTROFLEX

WP4: Probabilistic assessment of internal insulation solutions
Develops an efficient strategy for the probabilistic hygrothermal assessment of internal solutions.

WP leader: KUL
Participants: AAU, TUD, HES-SO

WP5: Development of cost/benefit analysis and environmental impact assessment methodologies
Develops a probabilistic assessment methodology for assessing the environmental impact and cost/benefit of internal insulation solutions. The methodologies are based on Life Cycle Impact Assessment (LCA), Life Cycle Cost (LCC) and Cost-Optimal (CO) analysis.

WP Leader: UNIVPM
Participants: AAU, RTU, DTU, HES-SO

WP6: Application and evaluation of guidelines
Develops and assesses the methodology for internal insulation of historic buildings, based on the methodologies developed in WP4 and WP5.

WP Leader: DTU
Participants: AAU, RTU, TUD, KUL, UNIVPM, SP, HES-SO, INTROFLEX, EMA

WP7: Communication and dissemination
Coordinates the overall communication and network partners of RIBuild.

WP Leader: AAU
Participants: RTU, TUD, KUL, UNIVPM, DTU, SP, HES-SO, INTROFLEX, EMA

WP8: Project management
WP 8 is in charge of the overall management of RIBuild.

WP leader: AAU

Department of Civil Engineering
Section for Building Design
Section for Indoor Climate and Building Physics

Campus Service
Period: 01/01/2015 → 31/12/2019
Number of participants: 5

Internal insulation
Project ID: RIBuild
Project participant:
Hansen, Tessa Kvist (Intern)
Rode, Carsten (Intern)
Perkov, Thomas Holmer (Intern)
Nielsen, Ole Christian Kongsgaard (Intern)
Project Manager, academic:
Bjarlev, Søren Peter (Intern)

Related projects:
Hygrothermal performance of internal insulation in historic buildings
Interior insulation of buildings from 1850 to 1930 with massive external masonry walls and embedded wooden beam floor structure
Buildings for Smart Energy Cities

Centre for IT-Intelligent Energy Systems in Cities
Department of Civil Engineering
Section for Indoor Climate and Building Physics
Department of Management Engineering
Systems Analysis
DTU Climate Centre
Energy Systems Analysis
Section for Building Energy
Period: 15/09/2014 → 15/09/2017
Number of participants: 4
Phd Student:
Gianniou, Panagiota (Intern)
Supervisor:
Nielsen, Per Sieverts (Intern)
Heller, Alfred (Intern)
Main Supervisor:
Rode, Carsten (Intern)

Novel ventilation for hospital beds to reduce airborne cross-contamination with bacteria and other microorganisms in old and new hospitals

Department of Civil Engineering
Section for Indoor Environment
Period: 01/04/2014 → 30/12/2014
Number of participants: 2

invention, hospital ventilation
Project ID: 26938
Project participant:
Melikov, Arsen Krikor (Intern)
Bolashikov, Zhecho Dimitrov (Intern)

Renew school - Sustainable school building renovation promoting timber prefabrication, indoor environment quality and active use of renewables

Department of Civil Engineering
Section for Building Physics and Services
Section for Indoor Environment
Period: 01/03/2014 → 28/02/2017
Number of participants: 2
Acronym: RENEW school
Project participant:
Hviid, Christian Anker (Intern)
**Wargocki, Pawel (Intern)**

**Project CITIES**

Department of Civil Engineering

Section for Indoor Climate and Building Physics

Period: 01/01/2014 → 31/12/2019

Number of participants: 1

smart cities, smart buildings, intelligent energy systems, demand flexibility

Project participant:

Li, Rongling (Intern)

**Ventilationsforhold i kolde tagrum som skunkrum og hanebåndslofter i konstruktioner med diffusionsåbne undertage – Etape 2.**

Department of Civil Engineering

Section for Building Design

Section for Building Physics and Services

Section for Indoor Environment

Period: 01/11/2013 → 31/12/2015

Number of participants: 4

Project ID: Projekt nr. 26390

Project participant:

Bjarlev, Søren Peter (Intern)

Johnston, Christopher Just (Intern)

Peuhkuri, Ruut Hannele (Intern)

Hjorslev Hansen, Morten (Intern)

**Relations**

Related projects:

Ventilationsforhold i skunke og hanebåndslofter i konstruktioner med diffusionsåbne undertage.

Documents:

Ansøgning om midler til forskningsprojekt om ventilation af uisolerede tagrum - etape 2

**Cooling ceiling combined with personalized ventilation – occupant response and energy consumption**

Department of Civil Engineering

Section for Indoor Environment

Silesian University of Technology

Period: 01/11/2013 → 31/12/2015

Number of participants: 2

innovation, individually controlled micro-environment, energy reduction

Project ID: 26324

Number of related Ph.D. students: 1

Project participant:

Lipczynska, Aleksandra (Ekstern)

Project Manager, academic:

Melikov, Arsen Krikor (Intern)

**Human response to non-uniform environment generated by "nested" chilled beams**

Department of Civil Engineering
Energy performance of combined radiant and convective systems for energy efficient indoor environment

In Denmark, EU and other countries directives for energy savings are outlined. Substantial part of the energy used in public buildings is for ventilation and air conditioning. Indoor environment becomes important for occupants’ health, comfort and performance. It is a result of ventilation and air conditioning of occupied spaces. At present ventilation systems have poor performance (draught discomfort, poor air quality, etc. are often reported in buildings). Furthermore they are energy inefficient. The reduction of energy consumption in buildings requires development and use of new, energy efficient ventilation and air conditioning systems that create high quality indoor environment.

The proposed research will focus on the energy performance of two new systems for generating high quality indoor environment: 1) chilled beam with radiant panels and 2) chilled ceiling (i.e. radiant cooling) combined with ceiling supply ventilation to distribute air over the chilled ceiling and cool before it flows into the occupied zone. The new systems perform on combined radiant and convective cooling unlike the present available systems based only on the use of convective heat and mass exchange in spaces. It is expected that the use of water based radiant cooling in addition to
convective cooling to remove part of the heat generated in spaces will reduce the needed ventilation flow rate and thus to potential energy saving. The author of this application is involved in an ongoing research at DTU BYG on human response to the non-uniform thermal environment generated by the two systems as a result of the combined radiant and convective cooling. Investigation of the new systems with regard to energy use is also important and is needed to access the system performance. However this research is not included in the limited budget of the human subject study in progress. This proposal focuses on the missing and needed research related to the energy performance of the two systems. In this research the performance of the chilled beam with radiant panels (CBR) and chilled ceiling combined with mixing ventilation (CCMV) with regard to their energy consumption and resulting indoor climate will be studied and compared with the performance of the chilled beam (CB) without radiant panels which is widely used today. The research will include physical measurements and energy analysis. Test room equipped with the systems and with realistic simulator of solar heat load from windows will be used. The same test room is used in the mentioned above ongoing study to collect human response. Indoor parameters affecting the thermal and air quality performance of the two systems (CBR and CCMV) will be measured and compared to that achieved with conventional ventilation and conditioning systems. The indoor environment generated by the systems will be identified in comprehensive parametric measurements in the occupied zone of the room. Heated dummies, lighting and other heat load will be simulated. Thermal manikins will be used to assess the thermal environment. Energy performance of the systems will be simulated. The results of the measurements will be used for the simulations. The obtained experimental and simulation results will be analyzed in cluster with the human subject response collected in the ongoing project in order to draw conclusions and recommendations. Important practical implications of this study is that it will define a way for possible savings following the EU directive on energy efficiency through decreased energy consumption in the building sector, help improve the overall indoor environment and last but not least provide the ventilation engineers and consultants with necessary design recommendations.

Department of Civil Engineering
Section for Indoor Environment
Period: 01/01/2013 → 28/02/2015
Number of participants: 1
Project ID: 26269
Project participant:
Bolashikov, Zhecho Dimitrov (Intern)
Documents:
Total Project and Appendixes Bjarne Saxhof 2012 for Carsten
Project

**Human Exposure to Aerosol Contaminants in Modern Microenvironments**

Department of Civil Engineering
Section for Indoor Environment
Period: 01/01/2013 → 31/12/2016
Number of participants: 3
advanced air distribution, indoor aerosols, energy efficiency
Project ID: 26198
Number of related Ph.D. students: 1
Project participant:
Bolashikov, Zhecho Dimitrov (Intern)
Bivolarova, Mariya Petrova (Intern)
Project Manager, academic:
Melikov, Arsen Krikor (Intern)
Project

**Human convective boundary layer and its impact on human exposure**

Project: PhD (PhD Theses)
Dusan Licina, Human convective boundary layer and its impact on human exposure, 2012 – 2015, PhD theses, Technical University of Denmark, Department of Civil Engineering, Supervisor: Arsen Melikov

Department of Civil Engineering
Section for Indoor Environment
Period: 01/02/2012 → 31/01/2015
Number of participants: 1
Project participant:
Melikov, Arsen Krikor (Intern)
Energy-efficient bedroom ventilation that may improve sleep and next-day well-being
The objective of the project was to investigate the effect of ventilation on sleep quality and next-day well-being. The uniqueness of the study was that the subjects slept in their own beds. The results show positive effects of a higher ventilation rate on the subjectively assessed freshness of the air, on the subjects' mental state and their feeling of being rested. There was also a positive effect on performance and on sleep efficiency measured by actigraphs. It is the first time that it has been proved that higher air quality has a positive effect on sleep and next-day performance.

Department of Civil Engineering
Section for Indoor Environment
Period: 15/08/2011 → 31/07/2014
Number of participants: 1
Acronym: EESE
Project participant:
Strøm-Tejsen, Peter (Intern)

Financing sources
Source: Public research council
Name of research programme: The Danish Council for Independent Research | Technology and Production
Web address: http://ufm.dk/forskning-og-innovation/tillskud-til-forskningsprojekter/hvem-har-modtaget-
Amount: 2,054,880.00 Danish Kroner
Year of approval: 2010

Relations
Activities:
Clima 2013
13th SCANVAC International Conference on Air Distribution in Rooms
13th International Conference on Indoor Air Quality and Climate

Publications:
The effect of air quality on sleep

Human response to exposed chilled beams with incorporated radiant panel
Department of Civil Engineering
Section for Indoor Environment
Halton OY
Period: 01/06/2011 → 31/07/2015
Number of participants: 2
HVAC system, indoor environment, human response, energy use
Project ID: 26215
Project participant:
Bolashikov, Zhecho Dimitrov (Intern)
Project Manager, academic:
Melikov, Arsen Krikor (Intern)

Room velocities and person perception for room conditions with chilled beam systems
Department of Civil Engineering
Section for Indoor Environment
Halton OY
Uponor Corporation
Rettig
Period: 01/06/2011 → 31/12/2015
Number of participants: 2
Ductless personalized ventilation* – a novel method of air distribution in spaces (human response and energy performance)

Department of Civil Engineering

Section for Indoor Environment

Period: 01/08/2010 → 31/07/2014

Number of participants: 2

personalized ventilation , human response

Project ID: 26098

Number of related Ph.D. students: 1

Project participant:

Dalewski, Mariusz (Intern)

Project Manager, academic:

Melikov, Arsen Krikor (Intern)

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Performance Indicators for Health, Comfort and Safety of the Indoor Environment

Department of Civil Engineering

Section for Indoor Environment

Period: 01/04/2009 → 31/03/2011

Number of participants: 1

indoor environment, prediction, modeling

Acronym: PERFECTION

Project participant:

Melikov, Arsen Krikor (Intern)

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Convective plumes generated by occupants

Project: PhD (PhD Theses)

Daria Zukowska, Convective plumes generated by occupants, 2007 – 2011, PhD theses, Technical University of Denmark, Department of Mechanical Engineering, Supervisor: Arsen Melikov

Department of Civil Engineering

Section for Indoor Environment

Period: 01/06/2007 → 31/05/2011

Number of participants: 1

Project participant:

Melikov, Arsen Krikor (Intern)

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Efficient air distribution methods

Department of Civil Engineering

Section for Indoor Environment

Section for Building Physics and Services

Period: 01/04/2007 → 31/03/2012

Number of participants: 3

advanced air distribution, invention, office environment, hospital environment

Number of related Ph.D. students: 2

Phd Student:
Evaluation of performance characteristics of newly developed ceiling mounted personalized and mixing ventilation system
Project: PhD (PhD Theses)
Yang BinEvaluation of performance characteristics of newly developed ceiling mounted personalized and mixing ventilation system, 2006-2009, PhD theses, Technical University of Denmark, Department of Civil Engineering, Supervisor: Arsen Melikov

Department of Civil Engineering
Section for Indoor Environment
Period: 01/11/2006 → 31/10/2009
Number of participants: 1
Project participant:
Melikov, Arsen Krikor (Intern)

Evaluation of Performance of newly developed enhanced displacement ventilation in office environment in the tropics
Project: PhD
Sun WeimengEvaluation of Performance of newly developed enhanced displacement ventilation in office environment in the tropics, 2006-2010, PhD theses, Technical University of Denmark, Department of Civil Engineering, Supervisor: Arsen Melikov

Department of Civil Engineering
Section for Indoor Environment
Period: 01/10/2006 → 30/09/2010
Number of participants: 1
Project participant:
Melikov, Arsen Krikor (Intern)

Evaluation of Performance of newly developed enhanced displacement ventilation in office environment in the tropics
Project: PhD
Sun WeimengEvaluation of Performance of newly developed enhanced displacement ventilation in office environment in the tropics, 2006-2010, PhD theses, Technical University of Denmark, Department of Civil Engineering, Supervisor: Arsen Melikov

Department of Civil Engineering
Section for Indoor Environment
Period: 01/10/2006 → 30/09/2010
Number of participants: 2
Phd Student:
Sun, Weimeng (Ekstern)
Main Supervisor:
Melikov, Arsen Krikor (Intern)

Personalised ventilation – demonstration projec
Department of Civil Engineering
Section for Indoor Environment
Exhausto A/S
COWI A/S
Period: 01/09/2006 → 01/09/2008
Number of participants: 1
Project Manager, organisational:
Melikov, Arsen Krikor (Intern)
Evaluation of performance characteristics of newly developed ceiling mounted personalized and mixing ventilation system
PhD project

Department of Civil Engineering
Section for Indoor Environment
Period: 01/04/2006 → 31/03/2009
Number of participants: 2
personalized ventilation, human response, Design method
Phd Student:
Bin, Yang (Intern)
Main Supervisor:
Melikov, Arsen Krikor (Intern)

Chilled beams – control of air distribution and its impact on human response

Department of Civil Engineering
Section for Indoor Environment
Period: 01/01/2006 → 31/12/2011
Number of participants: 1
active chilled beam, human response, physical environment
Number of related Ph.D. students: 1
Project Manager, academic:
Melikov, Arsen Krikor (Intern)

Innovationsnetværk vedrørende integrerede lavenergiløsninger på bygningsområdet

Section for Building Physics and Services
Department of Civil Engineering
Section for Indoor Environment
Department of Mechanical Engineering
Statens Byggeforskningsinstitut
Aalborg University
Period: 01/01/2006 → 30/06/2010
Number of participants: 5
Acronym: LavEByg
Project ID: 25723
Project participant:
Tommerup, Henrik M. (Intern)
Project Manager, organisational:
Svendsen, Svend (Intern)
Aggerholm, Søren (Ekstern)
Olesen, Bjarne W. (Intern)
Heiselberg, Per (Ekstern)

Financing sources
Source: Program. Andre statslige danske - Andre prog.midler
Name of research programme: Program. Andre statslige danske - Andre prog.midler
Amount: 4,000,000.00 Danish Kroner

Development of Highly Efficient Personalized Ventilation for Crowded Spaces

Department of Energy Engineering
Department of Civil Engineering
Section for Indoor Environment

STVF
Period: 01/09/2005 → 30/11/2005
Number of participants: 1
Project Manager, organisational:
Melikov, Arsen Krikor (Intern)

Project

ALLHOME – A study on the Relation between Allergy/Asthma and Indoor Air Quality in Homes in Bulgaria
Department of Mechanical Engineering
Department of Civil Engineering
Section for Indoor Environment
Number of participants: 1
Project Manager, organisational:
Melikov, Arsen Krikor (Intern)

Project

Ventilation measurement in homes based on metabolic CO2 produced by people
Department of Civil Engineering
Section for Indoor Environment
STVF
Period: 01/09/2004 → 31/10/2006
Number of participants: 1
Project participant:
Melikov, Arsen Krikor (Intern)

Project

Assessment of Thermal Environment in Aircraft Cabin
Department of Mechanical Engineering
Department of Civil Engineering
Section for Indoor Environment
Boeing Commercial Airplanes
Period: 01/03/2004 → 30/11/2004
Number of participants: 1
Project Manager, organisational:
Melikov, Arsen Krikor (Intern)

Project

Evaluation of energy efficient personalized air units for enhanced ventilation in the tropics
Evaluation of energy efficient personalized air units for enhanced ventilation in the tropics, National University of Singapore, Singapore, 2003-2005, Co-PI.
Research project in collaboration with National University of Singapore.
Department of Civil Engineering
Section for Indoor Environment
National University of Singapore
Period: 01/11/2003 → 31/10/2005
Number of participants: 1
Project participant:
Melikov, Arsen Krikor (Intern)
**Optimal Seat Control Algorithm**
Department of Mechanical Engineering
Department of Civil Engineering
Section for Indoor Environment
Johnoson Control
Period: 01/05/2003 → 30/11/2005
Number of participants: 1
Project participant:
Melikov, Arsen Krikor (Intern)

**Human response to Personalized Ventilation**
Department of Mechanical Engineering
Department of Civil Engineering
Section for Indoor Environment
STVF
Period: 01/09/2002 → 30/11/2005
Number of participants: 1
Project Manager, organisational:
Melikov, Arsen Krikor (Intern)

**Development of Air terminal Device with High Efficiency**
Department of Energy Engineering
Department of Civil Engineering
Section for Indoor Environment
Period: 01/09/2002 → 31/12/2004
Number of participants: 1
Project Manager, organisational:
Melikov, Arsen Krikor (Intern)

**Integrated Design Optimisation of Building Energy Performance and Indoor Environment**
Research project
Department of Civil Engineering
Section for Indoor Environment
Technical University of Sofia
University of Strathclyde
Czech Technical University
Silesian University of Technology
Evgueni Iordanov & Co.
Period: 01/11/1998 → 31/10/2001
Number of participants: 1
Number of related Ph.D. students: 3
Project Manager, organisational:
Melikov, Arsen Krikor (Intern)
Project

**ACCURACY OF DRAUGHT MEASUREMENT**

Department of Civil Engineering

Section for Indoor Environment

Period: 01/02/1998 → 31/01/2000

Number of participants: 1

low velocity measurements, improved instruments, draft prediction, requirements, standards

Number of related Ph.D. students: 1

Project Manager, organisational:

Melikov, Arsen Krikor (Intern)

Accuracy of Draught Measurement


Department of Civil Engineering

Section for Indoor Environment

Gebruder TROX GmbH

Dantec Measurement Technology A/S

SWEMA

Innova Air Tech Instruments

CETIAT

ADAI

Silesian University of Technology

Period: 01/02/1998 → 31/01/2000

Number of participants: 1

Number of related Ph.D. students: 4

Project Manager, organisational:

Melikov, Arsen Krikor (Intern)

Humidity in Buildings

Contribution to the International Centre for Indoor Environment and Energy: Modelling and experimental investigation of humidity transfer and energy consumption in buildings. The research aims at establishing complete modelling capabilities of the hygrothermal conditions in buildings with their spaces, building materials, furnishing, activity of occupants, and influence from exterior conditions.

Department of Buildings and Energy

Section for Indoor Environment

Department of Civil Engineering

Period: 01/01/1998 → 31/12/2002

Number of participants: 2

Project participant:

Fanger, P.O. (Ekstern)

Project Manager, organisational:

Rode, Carsten (Intern)

Financing sources

Source: Unknown

Name of research programme: Ukendt

Amount: 0.00 Danish Kroner

Project
Human perception of air movement: Impact of airflow frequency and direction on the sensation of draught
Department of Civil Engineering
Section for Indoor Environment
Period: 01/04/1996 → 31/03/1999
Number of participants: 2
velocity fluctuations, human response, measurements
Phd Student:
Zhou, Genhong (Intern)
Supervisor:
Melikov, Arsen Krikor (Intern)
Project

Dynamic Response of SWEMAAIR 300 Thermal Anemometer with SWA-01 Velocity Transducer
Dynamic Response of SWEMAAIR 300 Thermal Anemometer with SWA-01 Velocity Transducer, SWEM, Sweden, 1996
Department of Energy Engineering
Department of Civil Engineering
Section for Indoor Environment
SWEMA
Silesian University of Technology
Period: 01/02/1996 → 30/11/2006
Number of participants: 1
Project Manager, organisational:
Melikov, Arsen Krikor (Intern)
Project

Human response to cooling with air jets
Human response to cooling with air jets, ASHRAE, USA, ASHRAE RP-518, 1991-1993
Department of Civil Engineering
Section for Indoor Environment
ASHRAE
Period: 01/01/1991 → 31/12/1993
Number of participants: 1
Project Manager, organisational:
Melikov, Arsen Krikor (Intern)
Project

Activities:

OB-17: Symposium on Occupant Behaviour and Adaptive Thermal Comfort
Period: 17 May 2017
Rune Korsholm Andersen (Organizer)
Department of Civil Engineering
Section for Indoor Climate and Building Physics
Degree of recognition: International

Related event

OB-17: Symposium on Occupant Behaviour and Adaptive Thermal Comfort: Joint IEA EBC Annex 68 and 69 Symposium 17/05/2017 → 17/05/2017
Kgs. Lyngby, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.
Journal of Exposure Science and Environmental Epidemiology (Journal)
Period: 2016 → …
Gabriel Bekö (Reviewer)
Department of Civil Engineering
Section for Indoor Climate and Building Physics

Related journal
Journal of Exposure Science and Environmental Epidemiology
1559-0631
BFI (2018): BFI-level 2, Scopus rating (2016): CiteScore 2.8 SJR 1.174 SNIP 1.08, ISI indexed (2013): ISI indexed yes,
Web of Science (2018): Indexed yes
Central database
Activity: Research › Peer review of manuscripts

UPTAKE OF CHEMICALS FROM INDOOR AIR: PATHWAYS AND HEALTH EFFECTS
Period: 31 Oct 2016
Gabriel Bekö (Invited speaker)
Department of Civil Engineering
Section for Indoor Climate and Building Physics

Related event
ICHES 2016
29/10/2016 → 02/11/2016
Nagoya, Japan
Activity: Talks and presentations › Conference presentations

9th International Conference on Indoor Air Quality Ventilation & Energy Conservation In Buildings
Kyriaki Foteinaki (Participant)
Department of Civil Engineering
Section for Indoor Climate and Building Physics

Related event
9th International Conference on Indoor Air Quality Ventilation & Energy Conservation In Buildings
23/10/2016 → 26/10/2016
Songdo, Korea, Republic of
Activity: Attending an event › Participating in or organising a conference

Flow Measurement
Period: 13 Oct 2016
Mariya Petrova Bivolarova (Invited speaker)
Department of Civil Engineering
Section for Indoor Climate and Building Physics

Description
Introducing different used in practice methods for airflow measurement in building ventilation systems

Related external organisation
Unknown external organisation
Activity: Talks and presentations › Conference presentations
CPH Climate Solutions
Period: 3 Oct 2016
Kyriaki Foteinaki (Speaker)
Department of Civil Engineering
Section for Indoor Climate and Building Physics

Related event

CPH Climate Solutions
03/10/2016 → 04/10/2016
Copenhagen, Denmark
Activity: Talks and presentations › Conference presentations

OB-16 International Symposium on Building Energy Performance and Occupant Behavior
Period: 3 Aug 2016
Rune Korsholm Andersen (Speaker)
Department of Civil Engineering
Section for Indoor Climate and Building Physics

Description
VERIFICATION OF OCCUPANTS' BEHAVIOUR MODELS IN RESIDENTIAL BUILDINGS
Documents:
Abstract for OB 16 symposium aug 2016 version 2

Related event

OB-16 International Symposium on Building Energy Performance and Occupant Behavior
03/08/2016 → 03/08/2016
Ottawa, Canada
Activity: Talks and presentations › Conference presentations

Skinful of Secrets: Dermal Exposure and Effects
Period: 7 Jul 2016
Gabriel Bekö (Speaker)
Department of Civil Engineering
Section for Indoor Climate and Building Physics
Degree of recognition: International

Related event

14th international conference on Indoor Air Quality and Climate
03/07/2016 → 08/07/2016
Ghent, Belgium
Activity: Talks and presentations › Conference presentations

Occupant behaviour (IEA Annex 66)
Period: 25 May 2016
Rune Korsholm Andersen (Invited speaker)
Department of Civil Engineering
Section for Indoor Climate and Building Physics

Description
Organiser and speaker in workshop about Occupant behaviour (IEA Annex 66) during the Clima2016 conference in Aalborg
Documents:
CLIMA 2016_Workshop_IEA_Annex66_Abstract_RAndersen
WS29
Related event

WS29 in Clima2016: Occupant behaviour
25/05/2016 → …
Aalborg, Denmark
Activity: Talks and presentations › Conference presentations

12th REHVA World Congress CLIMA 2016
Period: 22 May 2016 → 25 May 2016
Kyriaki Foteinaki (Participant)
Department of Civil Engineering
Section for Indoor Climate and Building Physics

Related event

12th REHVA World Congress CLIMA 2016
22/05/2016 → 25/05/2016
Aalborg, Denmark
Activity: Attending an event › Participating in or organising a conference

IEA EBC Annex 67
Period: 16 Mar 2016
Panagiota Gianniou (Speaker)
Department of Civil Engineering
Section for Indoor Climate and Building Physics

Description
Findings of common exercise: Flexibility of detached single zone building

Related event

IEA EBC Annex 67: 2nd Working meeting
16/03/2016 → …
Trondheim, Norway
Activity: Talks and presentations › Conference presentations

Assessment of Active Double Skin Façade Integrated With PV Cell.
Period: 2015
Hagar Elarga (Speaker)
Michele De Carli (Other)
Department of Civil Engineering
Section for Indoor Climate and Building Physics
Degree of recognition: International

Related event

ASHRAE
24/01/2015 → 28/01/2015
Chicago, United States
Activity: Talks and presentations › Conference presentations

CFD Analysis of active facades integrated with PV cells in different climates.
Period: 2015
Hagar Elarga (Speaker)
Angelo Zarrella (Guest lecturer)
Michele De Carli (Other)
Department of Civil Engineering
Related event

ASME-ATI, Thermal Energy Systems: Production, Storage, Utilization and the Environment
17/05/2015 → …
Naples, Italy
Activity: Talks and presentations › Conference presentations

Environment International (Journal)
Period: 2015 → …
Gabriel Bekö (Reviewer)
Department of Civil Engineering
Section for Indoor Climate and Building Physics

Related journal

Environment International
0160-4120
Web of Science (2018): Indexed yes
Central database
Activity: Research › Peer review of manuscripts

IEA EBC Annex 67 (External organisation)
Period: 2015 → 2019
Rongling Li (Participant)
Department of Civil Engineering
Section for Indoor Climate and Building Physics

Description
An international expert group working on the research topic of energy flexible buildings
Degree of recognition: International
Links:

Related external organisation

IEA EBC Annex 67
Activity: Membership › Membership of research networks or expert groups

PhD committee, Kaunas University of Technology, Lithuania (External organisation)
Period: 2015 → …
Gabriel Bekö (Participant)
Department of Civil Engineering
Section for Indoor Climate and Building Physics

Related external organisation

PhD committee, Kaunas University of Technology, Lithuania
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

DTU Sustain Conference 2015
Period: 17 Dec 2015
Kyriaki Foteinaki (Participant)
Department of Civil Engineering
Section for Indoor Climate and Building Physics

Related event

**DTU Sustain Conference 2015**
17/12/2015 → 17/12/2015
Lyngby, Denmark
Activity: Attending an event › Participating in or organising a conference

**Building energy demand for smart energy cities**
Period: 25 Nov 2015
Panagiota Gianniou (Speaker)
Department of Civil Engineering
Section for Indoor Climate and Building Physics

Related event

**CITIES WP1/WP2 meeting in Energinet headquarters**
25/11/2015 → …
Fredericia, Denmark
Activity: Talks and presentations › Conference presentations

**Miljøstrategisk Årsmødet 2015**
Period: 24 Nov 2015
Jens-Phillip Petersen (Organizer)
Department of Civil Engineering
Section for Indoor Climate and Building Physics

Description
Organisation/conduction of panel discussion and workshop "'Lokale implementering af energistrategier - hvordan kan energistrategier få større merværdi for lokale byområder?' at the Miljøstrategisk Årsmøde 2015

Links:

Related event

**Miljøstrategisk Årsmødet 2015**
23/11/2015 → 24/11/2015
Activity: Attending an event › Participating in or organising a conference

**Dermal uptake of phthalates directly from air**
Period: 7 Oct 2015
Gabriel Bekö (Invited speaker)
Department of Civil Engineering
Section for Indoor Climate and Building Physics

Description
Center for Endocrine Disruptors, Annual Information Day

Related external organisation

**Unknown external organisation**
Activity: Talks and presentations › Conference presentations

**WP3 CITIES Workshop on 'Flexibility and Buildings'**
Period: 7 Sep 2015
Panagiota Gianniou (Organizer)
Department of Civil Engineering
Section for Indoor Climate and Building Physics

**Description**
WP3 CITIES Workshop on ‘Flexibility and Buildings’

**Related event**
WP3 CITIES Workshop on ‘Flexibility and Buildings’
07/09/2015 → 07/09/2015
Lyngby, Denmark
Activity: Attending an event › Participating in or organising a conference

**Aggregation of building energy demands – Sønderborg case**
Period: 26 May 2015
Panagiota Gianniou (Speaker)
Department of Civil Engineering
Section for Indoor Climate and Building Physics

**Related event**
CITIES Second General Consortium Meeting
26/05/2015 → 27/05/2015
Kgs. Lyngby, Denmark
Activity: Talks and presentations › Conference presentations

**Buildings for Smart Energy Cities**
Period: 20 May 2015
Panagiota Gianniou (Speaker)
Department of Civil Engineering
Section for Indoor Climate and Building Physics

**Related event**
EuroTech PhD Workshop
20/05/2015 → 21/05/2015
Eindhoven, Netherlands
Activity: Talks and presentations › Conference presentations

**Phthalate intake of Danish children: Exposure pathways and potential health effects**
Period: 13 Feb 2015
Gabriel Bekö (Invited speaker)
Department of Civil Engineering
Section for Indoor Climate and Building Physics

**Description**
Metalund seminar series, Lund University

**Related external organisation**
Unknown external organisation
Activity: Talks and presentations › Conference presentations

**Building Research and Information (Journal)**
Period: 2014 → …
Arsen Krikor Melikov (Reviewer)
Department of Civil Engineering
Section for Indoor Environment

Description
Building Research & Information

Related journal

Building Research and Information
0961-3218
Central database
Activity: Research › Peer review of manuscripts

Editorial Board Member - Indoor Air Journal (External organisation)
Period: 2014 → …
Gabriel Bekö (Participant)
Department of Civil Engineering
Section for Indoor Climate and Building Physics

Related external organisation

Editorial Board Member - Indoor Air Journal
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

Environmental Research (Journal)
Period: 2014 → …
Gabriel Bekö (Reviewer)
Department of Civil Engineering
Section for Indoor Climate and Building Physics

Related journal

Environmental Research
0013-9351
Central database
Activity: Research › Peer review of manuscripts

Journal of Building Performance Simulation (Journal)
Period: 2014
Arsen Krikor Melikov (Reviewer)
Department of Civil Engineering
Section for Indoor Environment

Description
Journal of Building Performance Simulation

Related journal

Journal of Building Performance Simulation
1940-1493
Central database
Activity: Research › Peer review of manuscripts
**P L o S One (Journal)**
Period: 2014 → …
Gabriel Bekö (Reviewer)
Department of Civil Engineering
Section for Indoor Climate and Building Physics

**Related journal**

**P L o S One**
1932-6203
Indexed in DOAJ
Central database
Activity: Research › Peer review of manuscripts

**13th SCANVAC International Conference on Air Distribution in Rooms**
Peter Strøm-Tejsen (Speaker)
Department of Civil Engineering
Section for Indoor Environment

**Related event**

**13th SCANVAC International Conference on Air Distribution in Rooms: New ventilation strategies based in active and passive technology in buildings and for comfort in airplanes**
19/10/2014 → 22/10/2014
São Paulo, Brazil
Activity: Talks and presentations › Conference presentations

**Effect of individual and collective heat cost allocation on indoor environment in Danish apartments**
Period: 4 Aug 2014
Rune Korsholm Andersen (Invited speaker)
Department of Civil Engineering
Section for Indoor Environment
Documents:
Abstract for OB-14 - Effect of heat cost allocation on indoor environment

**Related event**

**Symposium on Occupant Behaviour**
04/08/2014 → 06/08/2014
Nottingham, United Kingdom
Activity: Talks and presentations › Conference presentations

**13th International Conference on Indoor Air Quality and Climate**
Period: 7 Jul 2014 → 12 Jul 2014
Peter Strøm-Tejsen (Speaker)
Department of Civil Engineering
Section for Indoor Environment

**Related event**

**13th International Conference on Indoor Air Quality and Climate**
07/07/2014 → 12/07/2014
Hong Kong, Hong Kong
**ASHRAE Annual Conference**

**Period:** 1 Jul 2014

Angela Simone (Speaker)

Department of Civil Engineering

Section for Indoor Environment

**Description**

2. Experimental Study including Subjective Evaluations of Mixing and Displacement Ventilation combined with Radiant Floor Heating/ Cooling System

SEMINAR 26 (INTERMEDIATE) Indoor Air Quality and Comfort: Ventilation and Air-Conditioning This session offers a select group of recently published papers from the ASHRAE HVAC&R Research Journal regarding new developments in ventilation and air-conditioning technology to include research of displacement ventilation with a radiant floor heating/cooling system and human response to convective and radiant cooling.

**Related event**

**ASHRAE Annual Conference**

28/06/2014 → 02/07/2014

Seattle, United States

Activity: Talks and presentations › Conference presentations

**ASHRAE Standard Committee (External organisation)**

**Period:** 1 Jul 2014 → 30 Jun 2018

Arsen Krikor Melikov (Participant)

Department of Civil Engineering

Section for Indoor Environment

**Description**

This Committee improves the standards developed and published by the American Society of Heating, Refrigerating and Air Conditioning Engineers

**Related external organisation**

**ASHRAE Standard Committee**

Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

**ASHRAE Annual Conference**

**Period:** 29 Jun 2014

Angela Simone (Speaker)

Department of Civil Engineering

Section for Indoor Environment

**Description**

2. Evaluation of Different Concepts for Ventilative Night Cooling by Building Simulations (Angela Simone, Ph.D., Member)

SEMINAR 4 (ADVANCED)

Cooling Potential with Increased Night Ventilation in Low Energy Buildings

In post-occupancy studies of low energy buildings, elevated temperature levels is a commonly reported problem. Ventilative cooling can be an attractive and energy efficient solution to reduce peak load and energy use in new and existing residential buildings. Equipment required for ventilative cooling in residential buildings is available and has been shown to be cost-effective in many climates. The seminar presents the concept of ventilative cooling together with studies of the potential impact on energy consumption and indoor environment in different climatic regions.
Related event

ASHRAE Annual Conference
28/06/2014 → 02/07/2014
Seattle, United States
Activity: Talks and presentations › Conference presentations

Masseeksperimentat 2014
Period: 1 Mar 2014 → 1 Nov 2014
Birgitte Andersen (Organizer)
Department of Systems Biology
Fungal Physiology and Biotechnology
Department of Civil Engineering
Section for Indoor Environment
Links:
http://masseeksperimentet.danishsciencefactory.dk/

Related event

Masseeksperimentat 2014
15/09/2014 → 03/10/2014
Denmark
Activity: Attending an event › Participating in or organising a conference

Environmental Science & Technology (Washington) (Journal)
Period: 2013 → …
Gabriel Bekö (Reviewer)
Department of Civil Engineering
Section for Indoor Climate and Building Physics

Related journal

Environmental Science & Technology (Washington)
0013-936X
Central database
Activity: Research › Peer review of manuscripts

Risk Analysis (Journal)
Period: 2013
Arsen Krikor Melikov (Reviewer)
Department of Civil Engineering
Section for Indoor Environment

Description
Risk analyses journal

Related journal

Risk Analysis
0272-4332
Central database
Activity: Research › Peer review of manuscripts
Indexed in DOAJ
Central database
Activity: Research › Peer review of manuscripts

**Textile Research Journal (Journal)**
Period: 2012 → …
Arsen Krikor Melikov (Reviewer)
Department of Civil Engineering
Section for Indoor Environment

**Description**
Textile Research Journal

**Related journal**

**Textile Research Journal**
0040-5175
BFI (2018): BFI-level 1, Scopus rating (2016): CiteScore 1.42 SJR 0.552 SNIP 1.06, Web of Science (2018): Indexed yes
Central database
Activity: Research › Peer review of manuscripts

**7th Windsor Conference 2012**
Period: 14 Aug 2012
Rune Korsholm Andersen (Organizer)
Department of Civil Engineering
Section for Indoor Environment

**Description**
Invited Chair of Workshop on Personal Control and Occupant behaviour in office buildings

**Related event**

**7th Windsor Conference 2012: The changing context of comfort in an unpredictable world**
12/04/2012 → 15/04/2012
London, United Kingdom
Activity: Attending an event › Participating in or organising a conference

**Building(s) for occupants?**
Period: 16 Apr 2012 → 17 Apr 2012
Rune Korsholm Andersen (Organizer)
Department of Civil Engineering
Section for Indoor Environment

**Description**
International workshop aimed at young researchers in the field of occupant behaviour, thermal comfort and indoor air quality and their relation to energy usage.

Organization of international workshop
Documents:
Flyer
Links:
http://prezi.com/zclfvt9pddpa/buildings-for-occupants-contents/?auth_key=a4cf2c9f61272fd366272c29e8c5b2a61651fd (Link)

**Related event**

**Building(s) for occupants?: Discussing methodologies to investigate and model the occupant's needs and actions**
16/04/2012 → 17/04/2012
Karlsruhe, Germany
Activity: Attending an event › Participating in or organising a conference

What happened to ventilation and our environment?
Period: 4 Apr 2012
Gabriel Bekö (Lecturer)
Department of Civil Engineering
Section for Indoor Environment

Description
Guest lecture at the Slovak University of Technology

Related external organisation

Unknown external organisation
Activity: Talks and presentations › Conference presentations

Building Services, Indoor Climate and Us
Period: 3 Apr 2012
Gabriel Bekö (Lecturer)
Department of Civil Engineering
Section for Indoor Environment

Description
Guest lecture at the Slovak University of Technology

Related external organisation

Unknown external organisation
Activity: Talks and presentations › Conference presentations

Applied Thermal Engineering (Journal)
Period: 2011
Arsen Krikor Melikov (Reviewer)
Department of Civil Engineering
Section for Indoor Environment

Description
Applied Thermal Engineering

Related journal

Applied Thermal Engineering
1359-4311
Central database
Activity: Research › Peer review of manuscripts

Building and Environment (Journal)
Period: 2011 → …
Arsen Krikor Melikov (Reviewer)
Department of Civil Engineering
Section for Indoor Environment

Related journal

Building and Environment
Building Simulation (Journal)

Period: 2011 → …
Arsen Krikor Melikov (Reviewer)
Department of Civil Engineering
Section for Indoor Environment

Description
Building Simulation – An International Journal

Related journal

International Journal of Industrial Ergonomics (Journal)

Period: 2011
Arsen Krikor Melikov (Reviewer)
Department of Civil Engineering
Section for Indoor Environment

Description
International Journal of Industrial Ergonomics

Related journal

Journal of Aerospace Engineering (Journal)

Period: 2011
Arsen Krikor Melikov (Reviewer)
Department of Civil Engineering
Section for Indoor Environment

Description
Journal of aerospace engineering

Related journal
Journal of Healthcare Engineering (Journal)
Period: 2011
Arsen Krikor Melikov (Reviewer)
Department of Civil Engineering
Section for Indoor Environment

Related journal
Journal of Healthcare Engineering
2040-2295
Scopus rating (2016): CiteScore 1.12 SJR 0.276 SNIP 0.492, Web of Science (2018): Indexed yes
Indexed in DOAJ
Local database
Activity: Research › Peer review of manuscripts

Journal of Renewable and Sustainable Energy (Journal)
Period: 2011
Arsen Krikor Melikov (Reviewer)
Department of Civil Engineering
Section for Indoor Environment

Description
Journal of Renewable and Sustainable Energy

Related journal
Journal of Renewable and Sustainable Energy
1941-7012
BFI (2018): BFI-level 1, Scopus rating (2016): CiteScore 1.2 SJR 0.418 SNIP 0.523, ISI indexed (2013): ISI indexed yes,
Web of Science (2018): Indexed yes
Central database
Activity: Research › Peer review of manuscripts

Journal of the Air and Waist Management Association (Journal)
Period: 2011
Arsen Krikor Melikov (Reviewer)
Department of Civil Engineering
Section for Indoor Environment

Description
Journal of the Air and Waist Management Association

Related journal
Journal of the Air and Waist Management Association
1096-2247
Scopus rating (2016): CiteScore 1.73 SJR 0.669 SNIP 0.826, Web of Science (2018): Indexed yes
Local database
Activity: Research › Peer review of manuscripts

Member of scientific committee of Healthy Buildings 2012 conference (External organisation)
Period: 1 Oct 2011 → 12 Jul 2012
Gabriel Bekö (Member)
Department of Civil Engineering
Section for Indoor Environment
Degree of recognition: International

Related external organisation

Member of scientific committee of Healthy Buildings 2012 conference
Activity: Membership › Membership in review committee

Member of Scientific Committee of Building Simulation Conference, Sydney, 2011 (External organisation)
Period: Feb 2011 → 16 Nov 2011
Rune Korsholm Andersen (Participant)

Department of Civil Engineering
Section for Indoor Environment
Degree of recognition: International

Related external organisation

Member of Scientific Committee of Building Simulation Conference, Sydney, 2011
Activity: Membership › Membership in review committee

A S H R A E Journal (Journal)
Period: 2010
Arsen Krikor Melikov (Reviewer)

Department of Civil Engineering
Section for Indoor Environment

Related journal

A S H R A E Journal
0001-2491
BFI (2018): BFI-level 1, Scopus rating (2016): CiteScore 0.16 SJR 0.277 SNIP 0.772, ISI indexed (2013): ISI indexed yes,
Web of Science (2018): Indexed yes
Central database
Activity: Research › Peer review of manuscripts

Journal of Hazardous Materials (Journal)
Period: 2010
Arsen Krikor Melikov (Reviewer)

Department of Civil Engineering
Section for Indoor Environment

Description
Journal of Hazardous Materials

Related journal

Journal of Hazardous Materials
0304-3894
Web of Science (2018): Indexed yes
Central database
Activity: Research › Peer review of manuscripts

Review of scientific articles for the journal Atmospheric Environment (Journal)
Period: 20 Dec 2010
Gabriel Bekö (Reviewer)

Department of Civil Engineering
Section for Indoor Environment
**Related journal**

**Review of scientific articles for the journal Atmospheric Environment**

Local database

Activity: Research › Peer review of manuscripts

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**Indeklima Forum 2010**

Period: 11 Nov 2010

Gabriel Bekö (Speaker)

Department of Civil Engineering

Section for Indoor Environment

**Description**

Place: Lyngby, Denmark

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**Related external organisation**

**Unknown external organisation**

Activity: Talks and presentations › Conference presentations

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**Sustainable Buildings II**

Period: 7 Oct 2010 → 8 Oct 2010

Gabriel Bekö (Speaker)

Department of Civil Engineering

Section for Indoor Environment

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**Related event**

**Sustainable Buildings II**

07/10/2010 → 08/10/2010

Eindhoven, Netherlands

Activity: Talks and presentations › Conference presentations

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**Member of scientific committee of Indoor Air 2011 conference (External organisation)**

Period: 1 Oct 2010 → 10 Jun 2011

Gabriel Bekö (Participant)

Department of Civil Engineering

Section for Indoor Environment

**Related external organisation**

**Member of scientific committee of Indoor Air 2011 conference**

Activity: Membership › Membership in review committee

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**10th Rehva World Congress "Sustainable Energy Use in Buildings"**

Period: 9 May 2010 → 12 May 2010

Pawel Wargocki (Chairman)

Department of Civil Engineering

Section for Indoor Environment

**Related event**

**10th Rehva World Congress "Sustainable Energy Use in Buildings"**

09/05/2010 → 12/05/2010

Antalya, Turkey

Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.
10th Rehva World Congress "Sustainable Energy Use in Buildings"
Period: 9 May 2010 → 12 May 2010
Pawel Wargocki (Speaker)
Department of Civil Engineering
Section for Indoor Environment

Related event
10th Rehva World Congress "Sustainable Energy Use in Buildings"
09/05/2010 → 12/05/2010
Antalya, Turkey
Activity: Talks and presentations › Conference presentations

Architectural Engineering
Period: 2 May 2010
Pawel Wargocki (Speaker)
Department of Civil Engineering
Section for Indoor Environment

Description
Miljømedicinske forlæsninger

Related external organisation
Aarhus University
Inge Lehmanns Gade 10, 8000, Aarhus C, Denmark
Activity: Talks and presentations › Guest lectures, external teaching and course activities at other universities

Review of scientific articles for the journal Indoor Air (Journal)
Period: 20 Apr 2010
Gabriel Bekö (Reviewer)
Department of Civil Engineering
Section for Indoor Environment

Related journal
Review of scientific articles for the journal Indoor Air
Local database
Activity: Research › Peer review of manuscripts

Aerosol Science and Technology (Journal)
Period: 2009 → ...
Arsen Krikor Melikov (Reviewer)
Department of Civil Engineering
Section for Indoor Environment

Description
Aerosol Science and Technology

Related journal
Aerosol Science and Technology
0278-6826
Central database


**Indeklima Forum 2009**  
Period: 12 Nov 2009  
Gabriel Bekö (Speaker)  
Department of Civil Engineering  
Section for Indoor Environment  

**Description**  
Place: Ballerup, Denmark  

**Related external organisation**  
Unknown external organisation  

**Activity:** Talks and presentations › Conference presentations

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**National Air Filtration Association annual convention 2009**  
Period: 16 Sep 2009 → 18 Sep 2009  
Gabriel Bekö (Speaker)  
Department of Civil Engineering  
Section for Indoor Environment  

**Description**  
Place: Toronto, Canada  

**Related external organisation**  
Unknown external organisation  

**Activity:** Talks and presentations › Conference presentations

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**9th International Healthy Building Conference and Exhibition 2009**  
Period: 13 Sep 2009 → 17 Sep 2009  
Peter Strøm-Tejsen (Speaker)  
Department of Civil Engineering  
Section for Indoor Environment  

**Related event**  

**9th International Healthy Building Conference and Exhibition 2009**  
Syracuse, NY, United States  
Activity: Talks and presentations › Conference presentations

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**Review of scientific articles for the journal Building and Environment (Journal)**  
Period: 1 Jan 2009 → …  
Gabriel Bekö (Reviewer)  
Department of Civil Engineering  
Section for Indoor Environment  

**Related journal**  

**Review of scientific articles for the journal Building and Environment**  
Local database  
Activity: Research › Peer review of manuscripts
Energy and Buildings (Journal)
Period: 2008 → …
Arsen Krikor Melikov (Reviewer)
Department of Civil Engineering
Section for Indoor Environment

Description
Energy and Buildings

Related journal
Energy and Buildings
0378-7788
Central database
Activity: Research › Peer review of manuscripts

Indoor Air (Journal)
Period: 2008 → …
Gabriel Bekö (Reviewer)
Department of Civil Engineering
Section for Indoor Climate and Building Physics

Related journal
Indoor Air
0905-6947
Central database
Activity: Research › Peer review of manuscripts

Indeklima Forum 2008
Period: 12 Nov 2008
Gabriel Bekö (speaker)
Department of Civil Engineering
Section for Indoor Environment

Description
Place: Indeklima Forum - NFA, Copenhagen

Related external organisation
Unknown external organisation
Activity: Talks and presentations › Conference presentations

7th International Thermal Manikin and Modelling Meeting
Period: 3 Sep 2008 → 5 Sep 2009
Peter Strøm-Tejsen (Participant)
Department of Civil Engineering
Section for Indoor Environment

Related event
7th International Thermal Manikin and Modelling Meeting
03/09/2008 → 05/09/2008
Coimbra, Portugal
11th International Conference on Indoor Air Quality and Climate
Peter Strøm-Tejsen (Organizer)
Department of Civil Engineering
Section for Indoor Environment

Related event
11th International Conference on Indoor Air Quality and Climate
17/08/2008 → 22/08/2008
Copenhagen, Denmark
Activity: Attending an event › Participating in or organising a conference

DANVAK dagen 2008
Period: 1 Jan 2008 → …
Rune Korsholm Andersen (Speaker)
Department of Civil Engineering
Section for Indoor Environment

Description
Place: Bella Center

Related external organisation
Unknown external organisation
Activity: Talks and presentations › Conference presentations

Occupant behaviour and control of the indoor environment
Period: 1 Jan 2008 → …
Rune Korsholm Andersen (Speaker)
Department of Civil Engineering
Section for Indoor Environment

Description
Place: DTU

Related external organisation
Unknown external organisation
Activity: Talks and presentations › Conference presentations

ASHRAE Technical Committee 2.1 "Physiology and Human Environment" (External organisation)
Period: 2007 → 2016
Arsen Krikor Melikov (Participant)
Department of Civil Engineering
Section for Indoor Environment

Description
Voting Member
Degree of recognition: International

Related external organisation
ASHRAE Technical Committee 2.1 "Physiology and Human Environment"
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar
ASHRAE Technical Committee 5.3 "Room Air Distribution" (External organisation)
Period: 2007 → 2011
Arsen Krikor Melikov (Participant)
Department of Civil Engineering
Section for Indoor Environment

Description
Voting Member
Degree of recognition: International

Related external organisation
ASHRAE Technical Committee 5.3 "Room Air Distribution"
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

HVAC & R Research (Journal)
Period: 2007 → …
Arsen Krikor Melikov (Reviewer)
Department of Civil Engineering
Section for Indoor Environment

Description
International Journal of HVAC&R Research Technical

Related journal
HVAC & R Research
2374-4731
Central database
Activity: Research › Peer review of manuscripts

10th International Conference on Air Distribution in Rooms
Peter Strøm-Tejsen (Speaker)
Department of Civil Engineering
Section for Indoor Environment

Related event
Roomvent - 10th International Conference on Air Distribution in Rooms
13/06/2007 → 15/06/2007
Helsinki, Finland
Activity: Talks and presentations › Conference presentations

Clima 2007 WellBeing Indoor Congress
Period: 10 Jun 2007 → 14 Jun 2007
Peter Strøm-Tejsen (Participant)
Department of Civil Engineering
Section for Indoor Environment

Related event
Clima 2007 WellBeing Indoor Congress
10/06/2007 → 14/06/2007
Helsinki, Finland
Activity: Attending an event › Participating in or organising a conference

**Journal of the Royal Society. Interface (Journal)**
Period: 2006
Arsen Krikor Melikov (Reviewer)
Department of Civil Engineering
Section for Indoor Environment

**Description**
Journal of the Royal Society Interface

**Related journal**
Journal of the Royal Society. Interface
1742-5689
Central database
Activity: Research › Peer review of manuscripts

**Journal of Ventilation (Journal)**
Period: 2006
Arsen Krikor Melikov (Reviewer)
Department of Civil Engineering
Section for Indoor Environment

**Related journal**
Journal of Ventilation
Local database
Activity: Research › Peer review of manuscripts

**Healthy Buildings 2006**
Period: 4 Jun 2006 → 8 Jun 2006
Peter Strøm-Tejsen (Speaker)
Department of Civil Engineering
Section for Indoor Environment

**Related event**
Healthy Buildings 2006
04/06/2006 → 08/06/2006
Lisbon, Portugal
Activity: Talks and presentations › Conference presentations

**Building Services Engineering Research & Technology (Journal)**
Period: 2005
Arsen Krikor Melikov (Reviewer)
Department of Civil Engineering
Section for Indoor Environment

**Description**
Building Services Engineering Research and Technology (CIBSE)

**Related journal**
10th International Conference on Indoor Air Quality and Climate
Period: 4 Sep 2005 → 9 Sep 2005
Peter Strøm-Tejsen (Speaker)
Department of Civil Engineering
Section for Indoor Environment

Related event

9th International Conference on Indoor Air Quality and Climate
04/09/2005 → 09/09/2005
Beijing, China
Activity: Talks and presentations › Conference presentations

9th International Conference on Air Distribution in Rooms
Period: 5 Sep 2004 → 8 Sep 2004
Peter Strøm-Tejsen (Participant)
Department of Civil Engineering
Section for Indoor Environment

Related event

9th International Conference on Air Distribution in Rooms
05/09/2004 → 08/09/2004
Coimbra, Portugal
Activity: Attending an event › Participating in or organising a conference

7th International Conference on Healthy Buildings 2003
Period: 7 Dec 2003 → 11 Dec 2003
Peter Strøm-Tejsen (Speaker)
Department of Civil Engineering
Section for Indoor Environment

Related event

7th International Conference on Healthy Buildings 2003
07/12/2003 → 11/12/2003
Singapore, Singapore
Activity: Talks and presentations › Conference presentations

9th International Conference on Indoor Air Quality and Climate
Period: Jul 2002
Peter Strøm-Tejsen (Participant)
Department of Civil Engineering
Section for Indoor Environment

Related event

9th International Conference on Indoor Air Quality and Climate
30/06/2002 → 05/07/2002
Monterey, CA, United States
Activity: Attending an event › Participating in or organising a conference
ASHRAE Technical Committee 5.3 "Room Air Distribution" (External organisation)
Period: 2000 → 2004
Arsen Krikor Melikov (Participant)
Department of Civil Engineering
Section for Indoor Environment

Description
Voting Member
Degree of recognition: International

Related external organisation
ASHRAE Technical Committee 5.3 "Room Air Distribution"
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

International Journal on Architectural Science (Journal)
Period: 2000 → …
Arsen Krikor Melikov (Reviewer)
Department of Civil Engineering
Section for Indoor Environment

Related journal
International Journal on Architectural Science
Local database
Activity: Research › Journal editor

Building and Environment (Journal)
Period: 1998 → …
Arsen Krikor Melikov (Reviewer)
Department of Civil Engineering
Section for Indoor Environment

Description
Building and Environment

Related journal
Building and Environment
0360-1323
Central database
Activity: Research › Peer review of manuscripts

Indoor Air Online (Journal)
Period: 1995 → …
Arsen Krikor Melikov (Reviewer)
Department of Civil Engineering
Section for Indoor Environment

Description
Indoor Air Journal

Related journal
Prizes:

REHVA Young Scientist Award
Gabriel Bekö (Recipient)
Department of Civil Engineering, Section for Indoor Environment

Details
Awarded date: 8 May 2010
Granting Organisations: Antalia, Turkey
Prize: Prizes, scholarships, distinctions

Yagiou Award
Gabriel Bekö (Recipient)
Department of Civil Engineering, Section for Indoor Climate and Building Physics

Details
Awarded date: Jul 2014
Degree of recognition: International
Granting Organisations: International Society of Indoor Air Quality and Climate – ISIAQ
Prize: Prizes, scholarships, distinctions

Press clippings:

Novel ventilation reduces infections in hospitals
Arsen Krikor Melikov
12/11/2014
Department of Civil Engineering, Section for Indoor Environment

Media contribution (1)

Novel ventilation reduces infections in hospitals
12/11/2014
TV2 Nyhederne, Television
Friederike Naja Vageler Felbo (Journalist)
3 min
https://www.dropbox.com/s/nk1dl8ivdf9yb3/TV2_22-nyhederne_141112.mp4?dl=0
Arsen Krikor Melikov
Department of Civil Engineering, Section for Indoor Environment
Press / Media

Luften i flyet er bedre end sit rygte
Arsen Krikor Melikov
11/11/2014
Department of Civil Engineering, Section for Indoor Environment

Media contribution (1)

Luften i flyet er bedre end sit rygte
11/11/2014
Jyllands-Posten, Print
Oliver Batchelor
http://jyllands-posten.dk/rejser/ECE7185995/Luften-i-flyet-er-bedre-end-sit-rygte/
Arsen Krikor Melikov
Department of Civil Engineering, Section for Indoor Environment
Press / Media
Ny DTU-opfindelse stopper smittespredning på hospitaler: Succesfulde forsøg har fået DTU-forskere til at søge patent på et nyt ventilationssystem til hospitalssenge, hvor to bokse med UV-lys indfanger vira og gør den uskadelig. Flere firmaer har vist interesse for systemet.

Zhecho Dimitrov Bolashikov
04/10/2010
Department of Civil Engineering, Section for Indoor Environment

Media contribution (1)

Luftrenser på senge stopper smitte
Arsen Krikor Melikov
04/10/2010
Department of Civil Engineering, Section for Indoor Environment

Media contribution (1)

Ny DTU-opfindelse stopper smittespredning på hospitaler
Arsen Krikor Melikov
04/10/2010
Department of Civil Engineering, Section for Indoor Environment

Media contribution (1)
Luftrenser på senge stopper smitte: Forskere har fundet på et nyt ventilationssystem til hospitalssenge - det skal forhindre smitte i at brede sig fra den ene patient til den anden.

Zhecho Dimitrov Bolashikov
10/04/2010
Department of Civil Engineering, Section for Indoor Environment

Media contribution (1)

Luftrenser på senge stopper smitte: Forskere har fundet på et nyt ventilationssystem til hospitalssenge - det skal forhindre smitte i at brede sig fra den ene patient til den anden.
10/04/2010
DR, Radio
Maria Av Skardi Bundgaard
http://www.dr.dk/Nyheder/Indland/2010/10/04/073056
Zhecho Dimitrov Bolashikov
Department of Civil Engineering, Section for Indoor Environment
Press / Media