Experimental assessment of the robustness in fire of lightweight ship bulkheads

Full-scale tests of A-60 steel and FRD-60 aluminium and FRP bulkheads exposed to fire were carried out in order to compare their respective behaviours in terms of their ultimate load-carrying capacity beyond the prescribed 60 min threshold under thermomechanical loadings. These three materials were chosen as implementation within the SOLAS framework requires documenting a level of robustness equivalent to that of steel. This is a complex process since robustness is not clearly defined and no procedure exists to quantify it. It was found that robustness can be quantified as a time-to-mechanical-failure and is highly dependent on the fire scenario (load, fire exposure, and boundary conditions). Regulatory codes and design practices were found to disregard specific properties of alternative materials, and only consider one default scenario, which is not representative of a real-life situation. It was concluded that specific properties of alternative materials should be used and equivalence in terms of safety should be documented through performance-based design, for instance risk analyses, instead of forcing requirements originally developed for steel structures on their lightweight counterparts.
Scaling analysis of ice melting during burning of oil in ice-infested waters

To promote the knowledge of constraints on use of in situ burning (ISB) in presence of ice, an order of magnitude scaling analysis was conducted to develop a theoretical model for estimating the melting intrusion length of burning oil in ice. Scaling of the heat, momentum, and mass conservation equations of a liquid fuel adjacent to an ice wall and exposed to flame from above was carried out to obtain an expression that describes the evolution of the melt intrusion length. The available experimental data on melting length were then correlated to the results of the scaling analysis using a least
square regression method, which showed a good agreement. The melting intrusion length is an important parameter
determining the efficiency of ISB in the Arctic. Burning of the oil in ice-infested waters results in melting of the ice and a
unique geometry change in the ice, which is referred to as lateral cavity formation. Melting will in turn influence the
removal efficiency of the ISB method by changing heat and mass transfer processes in a manner that affects the burning
behavior of the oil slick adjacent to the ice. Thus, any assessment of ISB outcomes in icy conditions is dependent upon an
adequate quantification of the extent of the melting length. The findings of this study clarify the heat and mass transfer
process controlling burning of an oil-slick in ice-infested waters and provide practical guidance for oil spill responders and
decision makers to simply evaluate the extent of oil intrusion in the ice and to predict the outcome of ISB.

General information
State: Published
Organisations: Department of Civil Engineering, University of Maryland, Worcester Polytechnic Institute
Contributors: Farmahini Farahani, H., Torero, J. L., Jomaas, G., Rangwala, A. S.
Pages: 386-392
Publication date: 2019
Peer-reviewed: Yes

Publication information
Volume: 130
ISSN (Print): 0017-9310
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 4.23 SJR 1.498 SNIP 2.048
Web of Science (2017): Impact factor 3.891
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.75 SJR 1.605 SNIP 2.013
Web of Science (2016): Impact factor 3.458
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 3.09 SJR 1.733 SNIP 1.905
Web of Science (2015): Impact factor 2.857
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 2.97 SJR 1.584 SNIP 1.973
Web of Science (2014): Impact factor 2.383
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 3.38 SJR 0.88 SNIP 2.134
Web of Science (2013): Impact factor 2.522
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 2.79 SJR 1.626 SNIP 2.121
Web of Science (2012): Impact factor 2.315
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 3.04 SJR 1.066 SNIP 1.951
Web of Science (2011): Impact factor 2.407
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.592 SNIP 2.103
A fire risk assessment model for residential high-rises with a single stairwell

As few or none prescriptive guidelines for fire risk assessment of residential high-rise buildings exist, it has been unclear which fire safety design features constitute an acceptable (adequate) safety level. In order to fill this gap a simplified risk-based decision-support tool, the Fire Risk Model (FRM), was developed. The FRM evaluates both the risk level to the occupants and the property risk level as a function of the building characteristics, height and fire safety features for single stairwell residential high-rise buildings. The acceptability of a high-rise design is then defined through comparison with the risk level associated with a 22 m high prescriptive design. The FRM and its applicability are introduced by summarily revisiting the concept of equivalency and adequate safety. The underlying assumptions and the pitfalls of equivalency assessments are discussed, and the associated performance of the FRM evaluated. It was found that compartmentation and the door configurations in the egress path play an important role, along with sprinklers, in order for the design to successfully keep the stairwell free from smoke. Specifically, modern curtain wall facades were found to result in a reduced safety level compared to traditional facades with a spandrel. When opting for a modern curtain wall, additional safety features were found to be required in order to obtain an equivalent safety level.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Ghent University, Technical University of Denmark, NIRAS A/S
Contributors: Hansen, N. D., Steffensen, F., Valkvist, M., Jomaas, G., Van Coile, R.
Pages: 160-169
Publication date: 2018
Peer-reviewed: Yes

Publication information
Journal: Fire Safety Journal
Volume: 95
ISSN (Print): 0379-7112
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
A simple correlation for monitoring the ignition propensity of wet nordic spruce wood

A combination of cone heater experiments and asymptotic analysis was used to determine the moisture content of Nordic spruce with varying degree of drying. The fuel moisture content was measured by weighing the specimens before and after a drying procedure in an oven. A high-flux asymptotic solution from an integral model established that the ignition temperature from the experiments (directly linked to the intercept heat flux) was constant for both the dry and the moist wood. As a result, one simple equation was developed that can be used to determine the time to ignition for a piece of wet spruce from the time to ignition of dry wood. This simple correlation, combined with models giving the fuel moisture content of wood from humidity and temperature of air surrounding, can be used as an engineering equation for monitoring the ignition propensity of timber.

General information
State: Accepted/In press
Organisations: Department of Civil Engineering, Research Institutes of Sweden
Contributors: Mindykowski, P., Jørgensen, M., Svensson, S., Jomaas, G.
Number of pages: 7
Publication date: 2018
Peer-reviewed: Yes

Publication information
Journal: Fire Safety Journal
ISSN (Print): 0379-7112
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.17 SJR 0.789 SNIP 1.776
Web of Science (2017): Impact factor 1.888
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.03 SJR 0.927 SNIP 1.597
Web of Science (2016): Impact factor 1.165
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.69 SJR 0.803 SNIP 1.487
Web of Science (2015): Impact factor 0.936
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.49 SJR 0.891 SNIP 1.884
Web of Science (2014): Impact factor 0.957
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 2.05 SJR 0.833 SNIP 2.821
Web of Science (2013): Impact factor 1.063
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 2.21 SJR 0.967 SNIP 2.718
Web of Science (2012): Impact factor 1.222
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 2.47 SJR 1.189 SNIP 2.65
Web of Science (2011): Impact factor 1.656
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.92 SNIP 1.57
Web of Science (2010): Impact factor 1.017
Can a spreading flame over electric wire insulation in concurrent flow achieve steady propagation in microgravity?

Concurrent flame spread over electric wire insulation was studied experimentally in microgravity conditions during parabolic flights. Polyethylene insulated Nickel-Chrome wires and Copper wires were examined for external flow velocities ranging from 50 mm/s to 200 mm/s. The experimental results showed that steady state flame spread over wire insulation in microgravity could be achieved, even for concurrent flow. A theoretical analysis on the balance of heat supply from the flame to the unburned region, radiation heat loss from the surface to the ambient and required energy to sustain the flame propagation was carried out to explain the presence of steady spread over insulated wire under concurrent flow. Based on the theory, the change in heat input (defined by the balance between heat supply from flame and radiation heat loss) was drawn as a function of the flame spread rate. The curve intersected the linear line of the required energy to sustain the flame. This balance point evidences the existence of steady propagation in concurrent flow. Moreover, the estimated steady spread rate (1.2 mm/s) was consistent with the experimental result by considering the ratio of the actual flame length to the theoretical to be 0.5. Further experimental results showed that the concurrent flame spread rate increased with the external flow velocity. In addition, the steady spread rate was found to be faster for Copper wires than for Nickel-Chrome wires. The experimental results for upward spreading (concurrent spreading) in normal gravity were compared with the microgravity results. In normal gravity, the flame did not reach a steady state within the investigated parameter range. This is due to the fact that the fairly large flame spread rate prevented the aforementioned heat balance to be reached, which meant that such a spread rate could not be attained within the length of the tested sample.

General information
State: Accepted/In press
Organisations: Department of Civil Engineering, Section for Building Design, Hokkaido University, CNRS
Number of pages: 8
Publication date: 2018
Peer-reviewed: Yes

Publication information
Journal: Proceedings of the Combustion Institute
ISSN (Print): 1540-7489
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Original language: English

Keywords: Flame spread rate, Concurrent flow, Microgravity, Electrical wire, Fire safety in space

DOIs: 10.1016/j.proci.2018.05.007

Source: FindIt
Source-ID: 2435210377
Convection-driven cavity formation in ice adjacent to externally heated flammable and non-flammable liquids

A parametric experimental study on melting of ice adjacent to liquids exposed to various heat fluxes from above was conducted in order to understand the role of liquid properties in formation of cavities in ice. In previous experiments related to in situ burning (ISB) of crude oil contained in ice, the convective motion in the fuel layer was identified as a key parameter determining the amount of the ice melting. An experimental setup was designed to measure the melting rate of the ice and penetration speed of the liquid similar to the lateral cavity formation problem observed in ISB experiments. Lateral cavity formation is identified as a key factor reducing the removal efficiency of ISB. The experiments were conducted in a transparent glass tray (70mm×70mm×45mm) with a 20mm thick ice wall (70mm×50mm×20mm) placed on one side of the tray. Liquids in the tray (water, n-pentane, dodecane, n-octane, m-xylene, and 1-butanol) that were adjacent to the ice wall were exposed to varying heat fluxes mimicking flame heat feedback from a pool fire. The results of ice melting rate among different liquids were found to vary significantly. The exposure of the liquids to the radiative heat flux led to temperature difference between the liquid and the ice, thereby creating a heat transfer pathway towards the ice that provided the required energy for the melting. It is suggested that Marangoni-driven convection caused by the temperature gradient near the ice and below the free surface of the liquid is influential in the ice melting. A scaling analysis of the surface flow was undertaken to elucidate the influence of surface tension effect (Marangoni convection). It was found that the surface flow velocity obtained from the surface tension effect at the liquid free surface correlates well to the melting front velocity.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Worcester Polytechnic Institute, Tsinghua University
Contributors: Farmahini Farahani, H., Fu, Y., Jomaas, G., Rangwala, A. S.
Number of pages: 9
Pages: 54-62
Publication date: 2018
Peer-reviewed: Yes

Publication information
Journal: Cold Regions Science and Technology
Volume: 154
ISSN (Print): 0165-232X
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.11 SJR 0.806 SNIP 1.271
Web of Science (2017): Impact factor 1.925
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.18 SJR 0.905 SNIP 1.681
Web of Science (2016): Impact factor 1.909
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 2.06 SJR 0.84 SNIP 1.525
Web of Science (2015): Impact factor 1.693
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.82 SJR 0.72 SNIP 1.515
Web of Science (2014): Impact factor 1.367
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 1.89 SJR 0.712 SNIP 1.776
Web of Science (2013): Impact factor 1.444
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 1.51 SJR 0.672 SNIP 1.463
Experimental Study of the Fire Behaviour on Flat Roof Constructions with Multiple Photovoltaic (PV) Panels

Fire experiments were conducted on four mock-up roof constructions with an array of six photovoltaic (PV) panels to study the fire dynamics and flame spread behaviour, so as to better characterise the fire risks of such a system. As it is customary to retrofit PV panels to existing warehouse roofs, where expanded polystyrene (EPS) and polyvinylchloride-based roofing membrane B-ROOF(t2) is a typical roofing, the experiments were carried out on such installations, but with a mitigation solution on top; 30mm mineral wool or 40mm polyisocyanurate (PIR). All mock-ups were 6.0m long, whereas the width was 2.4m (Experiments 1 and 2) and 4.8m (Experiments 3 and 4), respectively. A wood crib was placed under the PV panels and it ignited the roofing membrane after 7min to 8min, which in all four experiments resulted in fire spread under all the six PV panels covering an area of 5.1mx2.0m. However, no self-sustained fire was observed beyond the area below the PV array. Within the first hour, the maximum temperatures were measured to respectively 175 degrees C and 243 degrees C underneath the two mitigation solutions of PIR insulation and mineral wool, which is more than 100 degrees C below the piloted ignition temperature for the EPS insulation. However, the EPS was ignited in both experiments with the PIR insulation due to thermal degradation of the protective material after approximately 1h. These experiments confirm that a small initial fire underneath a PV installation can transform into a hazardous scenario due to the changed fire dynamics associated with adding the PV panels to the existing roof.

General information
State: Published
Organisations: Section for Building Design, Department of Civil Engineering, University of Edinburgh
Contributors: Kristensen, J. S., Jomaas, G.
Pages: 1807-1828
Publication date: 2018
Peer-reviewed: Yes

Publication information
Journal: Fire Technology
Experimental study of the performance of intumescent coatings exposed to standard and non-standard fire conditions

Three different experimental setups corresponding to three different fire scenarios were used to investigate how different heating conditions and heating rates affect the behaviour of two different thin intumescent coatings (a solvent-based and a water-based paint). Coated steel samples were exposed to different standard and non-standard fire conditions in an electric oven, in a gas furnace and in a cone heater. A common trend was observed in the thermal resistance development of the tested coatings and three phases (inert phase, transient phase and steady phase) were identified according to four critical points: activation, end of reaction, binder exhaustion and steel austenitization point. The results also showed that the water-based paint performed better at low heating rates, while the tested solvent-based paint performed better at high heating rates and did not activate or provide proper insulation at very low heating rates. In summary, the study confirms that the current procedure for the design of intumescent coatings has shortcomings, as different paints have different performances according to the heating conditions and, in particular, according to the fire heating rate.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Technical University of Denmark
Contributors: Lucherini, A., Giuliani, L., Jomaas, G.
Pages: 42-50
Publication date: 2018
Peer-reviewed: Yes

Publication information
Journal: Fire Safety Journal
Volume: 95
ISSN (Print): 0379-7112
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.17 SJR 0.789 SNIP 1.776
Web of Science (2017): Impact factor 1.888
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.03 SJR 0.927 SNIP 1.597
Web of Science (2016): Impact factor 1.165
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.69 SJR 0.803 SNIP 1.487
Web of Science (2015): Impact factor 0.936
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.49 SJR 0.891 SNIP 1.884
Web of Science (2014): Impact factor 0.957
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 2.05 SJR 0.833 SNIP 2.821
Web of Science (2013): Impact factor 1.063
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Fire-induced reradiation underneath photovoltaic arrays on flat roofs

The impact of the reflection of fire-induced heat from a gas burner was studied experimentally to gain knowledge on the interaction between photovoltaic (PV) panels and a fire on flat roofs. The heat flux was measured in a total of eight points at the same level as the top of the gas burner. The gas burner was placed underneath the center of a PV panel, installed in a geometry similar to a commercial east-west orientated mounting system, and the eight points were symmetrical pairs of two at four different distances from the burner. Measurements were compared with tests with no PV panel, and thereby without the reflection from the PV panel. A significant increase of the received heat flux was recorded, with ascending percentage-wise difference for increased heat release rates. This indicates that PV panels can have a significant contribution in roof fires, primarily because they stimulate fire spread over the roof on which they have been mounted. The received heat flux is higher underneath the most elevated part of the PV panel, due to two important, flame-related reasons: 1) the flame deflection toward the most elevated part of the panel and 2) a nonhomogeneous temperature distribution on the PV panel surface, due to the deflected flame, and thereby a nonhomogeneous emission from the heated PV panel. Finally, the results were very similar for a brand new PV panel and a PV panel tested for the fourth time, except during the period when the thin combustible film underneath the new PV panel is burning, supporting that it is the fire dynamics and not the fire load associated with the PV panels that is promoting fire spread associated with PV panels on flat roofs. With this in mind, the current results are relevant not only for PV panels but also for any inclined roof covering panel with limited combustibility.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Technical University of Denmark, University of Edinburgh
Contributors: Kristensen, J. S., Merci, B., Jomaas, G.
Fire Performance of Sandwich Panels in a Modified ISO 13784-1 Small Room Test: The Influence of Increased Fire Load for Different Insulation Materials

Four sandwich panel rooms were constructed as prescribed in the ISO 13784-1 test. However, the construction followed normal industry practice, and the panels were also subjected to the kinds of damage typically found in commercial premises, although such damage may not typically be concentrated in such a small room. The fire load was increased to simulate fires actually occurring in commercial premises by stepping up the propane burner output from the usual maximum of 300-600 kW, and by placing a substantial wooden crib in two of the rooms. The results showed significant differences in fire growth rate and burning behaviour between those panels filled with polyisocyanurate (PIR) and those filled with stone wool in both the experiments without and with the wooden crib. Most significantly, the PIR pyrolysis products caused earlier ignition (by radiation from above) of the wooden crib 11 min into the experiment (1 min after the burner was stepped up to 300 kW), whereas the crib ignited 22 min into the test (2 min after the burner had been stepped up to 600 kW, which is beyond the test standard both in time and heat input) for the stone wool panels. This interaction between building and contents is most often ignored in fire safety assessments. After a few minutes, the PIR pyrolysis products that escaped outside the room, from between the panels, ignited. The extra thermal exposure from the PIR-fuelled flames distorted the panels, which in turn exposed more PIR, resulting in large flames on both the inside and outside of the enclosure. From a fire safety perspective this is most important as it shows that with the large fire loads that are commonly found in commercial premises, steel-faced PIR filled panels are not capable of acting as fire barriers, and may support flame spread through compartment walls and ceilings. In addition, the PIR panelled rooms produced very large quantities of dense smoke and toxic effluents, whereas the stone wool panelled rooms produced small amounts of light smoke of lower toxicity. Furthermore, the experiments showed that modifications to the standard test can lead to extremely different outcomes for some of the products. As the modifications simulated real-life situations, it seems important to discuss whether the standard is robust enough for property safety scenarios encountered in industrial premises.
Pumice stones as potential in-situ burning enhancer
Small-scale and mid-scale experiments were conducted in order to evaluate pumice stones as a potential enhancement for in-situ burning (ISB). Four oil types, several emulsification degrees of one crude oil were studied. In general, it was observed that the pumice stones did not improve the burning efficiency (BE). In fact, for large pumice coverage ratios, the BE was affected negatively, especially for the emulsified crude oil, which is the most likely condition of the oil that may be subjected to ISB. Furthermore, it was observed that a relatively large amount of the pumice stones were sinking during and after the burn, thus bringing the oil into the water column. Finally, the species production of CO and CO$_2$ was not reduced. Based on the presented results, pumice stones have a negative impact on the efficiency of ISB, and they are
ruled out as an ISB enhancer and should not be used in relation to ISB.

**General information**

State: Published
Organisations: Department of Civil Engineering, Section for Building Design
Contributors: Rojas Alva, U., Andersen, B. S., Jomaas, G.
Pages: 167-174
Publication date: 2018
Peer-reviewed: Yes

**Publication information**

Journal: Cold Regions Science and Technology
Volume: 146
ISSN (Print): 0165-232X
Ratings:
- BFI (2019): BFI-level 1
- Web of Science (2019): Indexed yes
- BFI (2018): BFI-level 1
- Web of Science (2018): Indexed yes
- BFI (2017): BFI-level 1
- Scopus rating (2017): CiteScore 2.11 SJR 0.806 SNIP 1.271
- Web of Science (2017): Impact factor 1.925
- Web of Science (2017): Indexed yes
- BFI (2016): BFI-level 1
- Scopus rating (2016): CiteScore 2.18 SJR 0.905 SNIP 1.681
- Web of Science (2016): Impact factor 1.909
- BFI (2015): BFI-level 1
- Scopus rating (2015): CiteScore 2.06 SJR 0.84 SNIP 1.525
- Web of Science (2015): Impact factor 1.693
- Web of Science (2015): Indexed yes
- BFI (2014): BFI-level 1
- Scopus rating (2014): CiteScore 1.82 SJR 0.72 SNIP 1.515
- Web of Science (2014): Impact factor 1.367
- BFI (2013): BFI-level 1
- Scopus rating (2013): CiteScore 1.89 SJR 0.712 SNIP 1.776
- Web of Science (2013): Impact factor 1.444
- ISI indexed (2013): ISI indexed yes
- BFI (2012): BFI-level 1
- Scopus rating (2012): CiteScore 1.51 SJR 0.672 SNIP 1.463
- Web of Science (2012): Impact factor 1.293
- ISI indexed (2012): ISI indexed yes
- Web of Science (2012): Indexed yes
- BFI (2011): BFI-level 1
- Scopus rating (2011): CiteScore 1.77 SJR 0.904 SNIP 1.54
- Web of Science (2011): Impact factor 1.429
- ISI indexed (2011): ISI indexed yes
- BFI (2010): BFI-level 1
- Scopus rating (2010): SJR 1.269 SNIP 1.419
- Web of Science (2010): Impact factor 1.488
- BFI (2009): BFI-level 1
- Scopus rating (2009): SJR 0.808 SNIP 1.318
- BFI (2008): BFI-level 1
- Scopus rating (2008): SJR 0.875 SNIP 1.488
- Web of Science (2008): Indexed yes
- Scopus rating (2007): SJR 0.775 SNIP 1.087
- Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.581 SNIP 1.365
Scopus rating (2005): SJR 0.401 SNIP 1.282
Scopus rating (2004): SJR 0.963 SNIP 1.271
Scopus rating (2003): SJR 0.393 SNIP 1.253
Scopus rating (2002): SJR 0.389 SNIP 0.839
Scopus rating (2001): SJR 0.723 SNIP 1.274
Scopus rating (2000): SJR 0.305 SNIP 0.622
Scopus rating (1999): SJR 0.319 SNIP 0.614

Original language: English
Keywords: In-situ burning, Pumice stones, Burning efficiency, Burning enhancement, Combustion products

DOIs:
10.1016/j.coldregions.2017.12.004

Source: FindIt
Source-ID: 2394036628
Research output: Research - peer-review › Journal article – Annual report year: 2018

Research Investigations into Herder Fate, Effects and Windows of Opportunity

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, S.L. Ross Environmental Research Ltd., Aarhus University, U.S. Army Cold Regions Research and Engineering Laboratory
Number of pages: 223
Publication date: 2018

Publication information
Publisher: International Association of Oil & Gas Producers
Original language: English
Electronic versions:
research_investigations_into_herder_fate_effects_and_windows_of_opportunity_final_february_1_2017.pdf

Research output: Research › Report – Annual report year: 2018

A study on burning behavior and convective flows in Methanol pool fires bound by ice
An experimental study on methanol pool fires bound by ice was carried to research the burning behavior and flow field (within the liquid-phase) of methanol. The experiments were conducted in two parts: 1- in a cylindrical ice cavity/pan (10.2 cm diameter and 6 cm depth) at three different conditions to analyze burning parameters of methanol, 2- in a square glass tray with outside dimensions of 10 × 10 cm and a depth of 5 cm to obtain flow field of methanol pool with a two-dimensional PIV (Particle Image Velocimetry) system. The results of the experiments of the first part show the cold boundaries of the ice cavity/pan act as a heat sink causing considerable heat losses. Thus, burning rates and burning efficiencies are found to be lower with cold boundaries. However, the burning rate values in ice cavity are found to be the highest because of the melting of the ice and expansion of the cavity. The analysis of the results obtained by the PIV system showed the velocity magnitudes and flow patterns in the liquid-phase of icy methanol fire significantly change over the course of burning. In the instants after ignition a horizontal flow induced by Marangoni near the surface was observed. Later on, mixing of melt-water with methanol and sinking of this mixture caused a cycle in the tray that resulted in a vortex appearing in the middle of the pool. Magnitudes of velocity were also observed to increase after ignition. The increase in the velocity magnitudes is expected to significantly impact the melting and size of the lateral cavity.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Worcester Polytechnic Institute
Contributors: Farahani, H. F., Jomaas, G., Rangwala, A. S.
Number of pages: 16
Pages: 1983-1998
Publication date: 2017

Host publication information
Title of host publication: 2017 International Oil Spill Conference Proceedings
Volume: 2017
Convection-driven melting in an n-octane pool fire bounded by an ice wall

An experimental study on an n-octane pool fire bound on one side by an ice wall was carried out to investigate the effects on ice melting by convection within the liquid part of the fuel. Experiments were conducted in a square glass tray (9.6 cm × 9.6 cm × 5 cm) with a 3 cm thick ice wall (9.6 cm × 6.5 cm × 3 cm) placed on one side of the tray. The melting front velocity, as an indicator of the melting rate of the ice, increased from 0.04 cm/min to 1 cm/min. The measurement of the burning rates and flame heights showed two distinctive behaviors; an induction period from the initial self-sustained flame to the peak mass loss rate followed by a steady phase from the peak of mass loss rate until the manual extinguishment. Similarly, the flow field measurements by a 2-dimensional PIV system indicated the existence of two different flow regimes. In the moments before ignition of the fuel, coupling of surface tension and buoyancy forces led to a combined one roll structure in the fuel. After ignition the flow field began transitioning toward an unstable flow regime (separated) with an increase in number of vortices around the ice wall. The separated regime started with presence of a multi-roll structure separating from a primary horizontal flow on the top driven by Marangoni convection. As the burning rate/flame height increased the velocity and evolving flow patterns enhanced the melting rate of the ice wall. Experimentally determined temperature contours, using an array of finely spaced thermocouples in the liquid fuel, were used to further investigate the two layer temperature structure; an upper layer (~8 mm thick) with steep temperature gradient in the vertical direction and a layer of low temperature in deeper regions. A hot zone with thickness of ~3 mm was present below the free surface corresponding to the multi-roll location. The multi-roll structure could be the main reason for the transport of the heat received from the flame toward the ice wall which causes the melting.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Worcester Polytechnic Institute
Number of pages: 9
Pages: 219-227
Publication date: 2017
Peer-reviewed: Yes

Publication information
Journal: Combustion and Flame
Volume: 179
ISSN (Print): 0010-2180
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 5.27 SJR 2.427 SNIP 2.176
Web of Science (2017): Impact factor 4.494
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 4.41 SJR 1.117 SNIP 2.184
Web of Science (2016): Impact factor 3.663
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.12 SJR 2.807 SNIP 2.379
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 3.78 SJR 1.335 SNIP 2.34
Web of Science (2014): Impact factor 3.082
BFI (2013): BFI-level 2
Convection-driven melting in an n-octane pool fire bounded by an ice wall

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Worcester Polytechnic Institute, University of Edinburgh
Publication date: 2017
Media of output: PowerPoint
Effectiveness of a chemical herder in association with in-situ burning of oil spills in ice-infested water

The average herded slick thickness, surface distribution and burning efficiency of a light crude oil were studied in ice-infested water to determine the effectiveness of a chemical herder in facilitating the in-situ burning of oil. Experiments were performed in a small scale (1.0m²) and an intermediate scale (19m²) setup with open water and 3/10, 5/10 and 7/10 brash ice coverages. The herded slick thicknesses (3-8mm) were ignitable in each experiment. The presence of ice caused fracturing of the oil during the herding process, which reduced the size of the herded slicks and, as a consequence, their ignitability, which in turn decreased the burning efficiency. Burning efficiencies relative to the ignited fraction of the oil were in the expected range (42-86%). This shows that the herder will be an effective tool for in-situ burning of oil when the ignitability issues due to fracturing of the oil are resolved.
Effect of Flow Direction on the Extinction Limit for Flame Spread over Wire Insulation in Microgravity

Experiments to determine the Limiting Oxygen Concentration (LOC) of a flame spread over electric wire insulation were carried out in microgravity provided by parabolic flights. The difference between the LOC in opposed and concurrent flows was evidenced. Polyethylene insulated Copper (Cu) wires and polyethylene insulated Nickel-Chrome (NiCr) wires with inner core diameter of 0.50 mm and insulation thickness of 0.30 mm were examined with external flow velocities ranging from 50 mm/s to 200 mm/s. The results for the Copper wires show that with increasing external flow velocity, the LOC monotonically decreased for the concurrent flow conditions and the LOC first decreased and then increased ("U" trend) for the opposed flow conditions. Similar trends were found in the experiments with NiCr wires. Also, in terms of the minimum LOC value, the minimum LOC was comparable for both wire types in both flow conditions. However, for the concurrent flow, the minimum LOC was about 1-2% lower (in oxygen concentration) than for opposed flow for both wire types. A heat balance model for the electric wire with flame propagation was established to estimate the LOC under opposed and concurrent flow conditions in microgravity. In this model, it was suggested that the LOC can be estimated using the normalized radiative heat loss from the sample surface. Result of the calculation qualitatively matched the LOC profile extracted from the experiments.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Hokkaido University, Universite Pierre et Marie Curie
Number of pages: 5
Publication date: 2017
Peer-reviewed: Yes
Effect of the Ignition Method on the Extinction Limit for a Flame Spreading over Electric Wire Insulation

Flame spread experiments with wire insulation were conducted in microgravity (parabolic flights) and in normal gravity to understand the effect of the ignition condition on the Limiting Oxygen Concentration (LOC) for an opposed air flow condition of 100 mm/s (typical flow velocity on ISS). Both the ignition power (50-110 W) and the igniter heating time (5-15 s) were varied. Polyethylene-coated Nickel-Chrome or copper wires with inner core diameter of 0.50 mm and insulation thickness of 0.30 mm were used as sample wires, and a 0.50 mm diameter coiled Kanthal wire was used as the igniter.

The experimental results show that the LOC of NiCr core wires assume an almost constant value under normal gravity conditions once ignition occurred, whereas under microgravity conditions, the LOC gradually decreases as the ignition power or heating time increases and eventually it reaches an almost constant value. Thus, the effect of ignition condition on LOC is more evident in microgravity than in normal gravity. The variation in LOC value is about 2% within the tested range of ignition conditions. Finally, the results suggest that there exists a minimum ignition power and heating time to obtain the correct LOC values for electric wire combustion, especially in microgravity. In Cu core wire cases, the LOC monotonically decreases as the heating time increases because of preheating by the igniter. This preheating helps to sustain spreading during microgravity period. Future study is required to find the proper ignition condition for a high-conductivity wire. The results have the potential to improve safety aspects associated with the development of a fire safety standard for spacecraft.

Experimental study on the influence of different thermal insulation materials on the fire dynamics in a reduced-scale enclosure

Four scaled (1:5) fire experiments with two identically classified types of commercially available sandwich panels incorporating either stone wool (SW) or poly-isocyanurate (PIR) foam as cores were conducted using a modified version of the ISO 13784-1 (Reaction to fire tests for sandwich panel building systems — Part 1: Small room test) standard. This was to assess the suitability of scaled experiments for assessing sandwich panel fire behavior. In the modified version of the test standard (scaled and full experiments), the fire severity was increased to simulate fires that could occur in commercial premises. This was achieved by prolonging and doubling the heat release rate output of the gas burner at the end of the experiments. Furthermore, non-structural damages such as screw-hole damages were applied to the enclosures to reflect real life observations.

The results showed differences in the fire behavior, depending on whether the enclosures were constructed of panels filled with SW or PIR insulation material. The mass losses of the insulation materials showed significant contribution from the PIR cores, regardless of fire load and the non-structural damage.

The qualitative behavior with respect to the “flashover” failure criterion, as stated in the ISO 13784-1, was successfully obtained in all of the scaled experiments. As such, the scaled experiments mimicked the behavior of the full scale SW experiments to a satisfactory degree. However, the PIR compartments failed considerably earlier in the full scale tests than in the scaled experiments. Therefore, it can be concluded that when the energy contribution from the core material remained negligible compared to the gas burner, the measured parameters matched quite well. Therefore, if the insulating core material does not dominate the fire dynamics of the compartment and the energy from the gas burner dictates the fire scenario then the scaled set-up will predict the temperature in the full scale compartment. Based on this and with further development with respect to, especially, time, this kind of scaled experiments could be a valuable testing method for assessment of the behavior of sandwich panel, and therefore merit further studies and eventually increased use.
Firefighter Nozzle Reaction

Nozzle reaction and hose tension are analyzed using conservation of fluid momentum and assuming steady, inviscid flow and a flexible hose in frictionless contact with the ground. An expression that is independent of the bend angle is derived for the hose tension. If this tension is exceeded owing to anchor forces, the hose becomes straight. The nozzle reaction is found to equal the jet momentum flow rate, and it does not change when an elbow connects the hose to the nozzle. A forward force must be exerted by a firefighter or another anchor that matches the forward force that the jet would exert on a perpendicular wall. Three reaction expressions are derived, allowing it to be determined in terms of hose diameter, jet diameter, flow rate, and static pressure upstream of the nozzle. The nozzle reaction predictions used by the fire service are 56% to 90% of those obtained here for typical firefighting hand lines. Sharing these findings with the fire protection community can improve the safety of firefighters.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, University of Maryland
Contributors: Chin, S. K., Sunderland, P. B., Jomaas, G.
Number of pages: 11
Pages: 1907-1917
Publication date: 2017
Peer-reviewed: Yes

Publication information
Journal: Fire Technology
Volume: 53
Issue number: 5
ISSN (Print): 0015-2684
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.51 SJR 0.658 SNIP 1.546
Web of Science (2017): Impact factor 1.483
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.3 SJR 0.66 SNIP 1.396
Web of Science (2016): Impact factor 1.471
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 0.77 SJR 0.455 SNIP 0.825
Web of Science (2015): Impact factor 1.016
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.06 SJR 0.533 SNIP 1.433
Web of Science (2014): Impact factor 1.297
BFI (2013): BFI-level 1
The impact of the reflection of fire-induced heat from a gas burner was studied experimentally to gain knowledge on the interaction between photovoltaic (PV) panels and a fire. The heat flux was measured in a total of eight points at the same level as the top of the gas burner. The gas burner was placed underneath the centre of a PV panel and the eight points were measured in symmetrical pairs of two at four different distances from the burner. The heat release rate from the gas burner was increased stepwise every four minutes. The measurements were made underneath a PV panel installed in a geometry similar to a commercial East-West orientated mounting system and was compared to a baseline test without the re-reflection from the PV panel. A significant increase of the received heat flux was noticed and the trend indicated an ascending percentage-wise difference as a function of an increased heat release rate. Contrary to the basic view factor theory, the received heat flux was higher underneath the most elevated part of the PV panel, and this occurred due to two important flame related reasons: 1) the deflection of the flame towards the most elevated part of the panel, resulting in an increased amount of radiation from the flame towards the surface; 2) A non-homogeneous distribution of the temperature on the PV panel surface, due to the deflected flame, and thereby a non-homogeneous emission from the heated PV panel. Finally, it was seen that two similar tests conducted with respectively a brand new PV panel and a PV panel tested for the fourth time, showed very comparable results, except during the period when the thin combustible film underneath the new PV panel was burning. This resulted in a higher heat flux during that period and implies that the results presented herein
are conservative in that they are lower than what can be expected in case of a real fire hazard, where the PV panel is by definition involved in the fire for the first time. It can be concluded that PV panels can have a significant contribution in roof fires, as they stimulate fire spread over the roof on which they have been mounted. These findings emphasise that the risk related to the installation of PV panels is not only associated with the increased fire load and possibility of ignition, but largely also with the changed fire dynamic surroundings of the roof construction.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Technical University of Denmark, Ghent University
Contributors: Steemann Kristensen, J., Merci, B., Jomaas, G.
Number of pages: 13
Pages: 34-43
Publication date: 2017

Host publication information
Title of host publication: Proceedings of the Fire and Materials 2017 Conference
Place of publication: San Francisco, USA
Publisher: Interscience Communications
Electronic versions:
FAM_Kristensen_Merci_Jomaas_accepted_by_FAM.pdf
Research output: Research - peer-review › Article in proceedings – Annual report year: 2017

Ice & Fire: the Burning Question
With the Arctic opening up to new shipping routes and increased oil exploration and production due to climate change, the risk of an Arctic oil spill is increasing. Of the classic oil spill response methods (mechanical recovery, dispersants and in-situ burning), in-situ burning is considered to be particularly a suitable response method in the Arctic. In-situ burning aims to remove the oil from the marine environment by burning it from the water surface. A recent Ph.D. thesis from the Technical University of Denmark has provided some new insights with respect to the fire science behind this response method.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design
Contributors: van Gelderen, L., Jomaas, G.
Pages: 26-27
Publication date: 2017
Peer-reviewed: Unknown

Publication information
Journal: Frontier Energy
Issue number: Spring 2017
ISSN (Print): 2047-3702
Original language: English
URLs:
https://issuu.com/frontierenergy/docs/fe_17spring_17_lr
Source: PublicationPreSubmission
Source-ID: 132516285
Research output: Communication › Journal article – Annual report year: 2017

Ongoing Research on Herding Agents for In Situ Burning in Arctic Waters: Studies on Fate and Effects
Research on the fate and effects of herding agents used to contain and thicken oil slicks for in situ burning in Arctic waters continues under the auspices of the International Association of Oil and Gas Producers Arctic Oil Spill Response Technology – Joint Industry Program (JIP). In 2014/2015 laboratory studies were conducted on the fate and effects of herders. The purpose of the studies was to improve the knowledge base used to evaluate the environmental risk of using herders in connection with in situ burning for oil spill response in Arctic seas. Two herding agents were studied (OP 40 and ThickSlick 6535).
Laboratory-scale herding and burning experiments were carried out for investigating the physical fate of the two herders during combustion of Alaska North Slope and Grane crude oils (fresh and emulsified). The results showed that after burning, the herder was mainly found on the water surface, and only small concentrations of herders were found in the water column (0.2-22.8 mg/L).
The inherent properties of herders in relation to toxicity and bioaccumulation on the high Arctic copepods (Calanus hyperboreus), as well as the biodegradability of herders were studied under arctic conditions. The results indicated that a distinct mortality was seen at the highest test concentrations of the herders. However, the concentration of herders required to produce acute toxicity in the laboratory was approximately three orders of magnitude higher than the
concentrations measured in the water column when herders were used to conduct an in situ burn in the laboratory. OP-40 might bio-accumulate whereas TS6535 might not. TS6535 was mostly degraded within 7 days, whereas the degradation of OP-40 was insignificant over 28 days.

Since herders are mainly considered as a surface active chemical compound, the potential impacts of herders on Arctic seabird feathers (from legally hunted Thick-Billed Murre and Common Eider) were investigated. Different dosages of herders were tested; high dosages that might be present just after the application of the herder and low dosages (approximately monolayers) likely to occur for a significant time and distance from the operations. Low dosages corresponding to approximately monolayers of OP-40 and TS6535 did not cause feathers to sink; however they did absorb more water than the controls. The high dosages caused measured damages to the feather microstructure.

Finally, laboratory burning experiments were carried out to determine if there was a difference in the composition of smoke plumes from mechanically contained burns versus herded oil burns. Herder was not measured in the smoke plumes, and there were no other noticeable differences in combustion between the two methods of containment (herder vs. metal ring).
Reducing the computational requirements for simulating tunnel fires by combining multiscale modelling and multiple processor calculation

Multiscale modelling of tunnel fires that uses a coupled 3D (fire area) and 1D (the rest of the tunnel) model is seen as the solution to the numerical problem of the large domains associated with long tunnels. The present study demonstrates the feasibility of the implementation of this method in FDS version 6.0, a widely used fire-specific, open source CFD software. Furthermore, it compares the reduction in simulation time given by multiscale modelling with the one given by the use of multiple processor calculation. This was done using a 1200m long tunnel with a rectangular cross-section as a demonstration case. The multiscale implementation consisted of placing a 30MW fire in the centre of a 400m long 3D domain, along with two 400m long 1D ducts on each side of it, that were again bounded by two nodes each. A fixed volume flow was defined in the upstream duct and the two models were coupled directly. The feasibility analysis showed a difference of only 2% in temperature results from the published reference work that was performed with Ansys Fluent (Colella et al., 2010). The reduction in simulation time was significantly larger when using multiscale modelling than when performing multiple processor calculation (97% faster when using a single mesh and multiscale modelling; only 46% faster when using the full tunnel and multiple meshes). In summary, it was found that multiscale modelling with FDS v.6.0 is feasible, and the combination of multiple meshes and multiscale modelling was established as the most efficient method for reduction of the calculation times while still maintaining accurate results. Still, some unphysical flow oscillations were predicted by FDS v.6.0 and such results must be treated carefully.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Technical University of Denmark, Imperial College London, Exponent, Inc., Greater Copenhagen Fire Department
Contributors: Vermesi, I., Rein, G., Colella, F., Valkvist, M., Jomaas, G.
Pages: 146-153
Publication date: 2017
Peer-reviewed: Yes

Publication information
Journal: Tunnelling and Underground Space Technology
Volume: 64
ISSN (Print): 0886-7798
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 3.11 SJR 1.696 SNIP 2.061
Web of Science (2017): Impact factor 2.418
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.9 SJR 1.758 SNIP 2.408
Spread and burning behavior of continuous spill fires

Spill fire experiments with continuous discharge on a fireproof glass sheet were conducted to improve the understanding of spill fire spread and burning. Ethanol was used as the fuel and the discharge rate was varied from 2.8 mL/s to 7.6 mL/s. Three ignition conditions were used in the experiments: no ignition, instantaneous ignition and delayed ignition. The spread rate, regression rate, penetrated thermal radiation and the temperature of the bottom glass were analyzed. The experiments clearly show the entire spread process for spill fires. Further, the regression rate of spill fires at the quasi-steady burning was lower than that of pool fires and the ratio of the spill fires’ regression rate to the pool fires’ regression rate was found to be approximately 0.89. With respect to the radiative penetration and the heat conduction between the fuel layer and the glass, a regression rate expression for spill fires was developed based on some modifications on existing expressions for pool fires. In addition, a complete phenomenological model for spill fires was developed by combining the characteristics of spread and burning. The model was verified by the experimental data and found to predict the spread process for spill fires with reasonable accuracy.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Tsinghua University, China University of Petroleum
The influence of vehicular obstacles on longitudinal ventilation control in tunnel fires

The effect of the vehicular blockage in a tunnel under longitudinal ventilation smoke control was systematically studied using a small-scale tunnel (1:30 of a standard tunnel section) with a helium-air mixture as the buoyant plume. The experimental results showed excellent agreement with full-scale data and reference correlations from former studies. When there are vehicular obstacles in the tunnel, the critical velocity decreased as a function of the blockage ratio. Notwithstanding, it was found that the relative size of the vehicular obstacle and the relative location of the fire source can have a reversed effect, inasmuch as the presence vehicular obstacle exerted an influence on the critical and confinement velocities. Moreover, the backlayering distance was evidently affected by the vehicular blockage. A parallel analysis was carried out for the backlayering distance for lower and upper regimes of the dimensionless heat release rate, where the current data was compared against data from other studies. The method and experimental set-up proved their ability to reproduce several phenomena and thus also their capability to supply relevant and valuable information on the effect of the vehicular blockage on tunnel fire dynamics.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design
Contributors: Alva, W. U. R., Jomaas, G., Dederichs, A.
Number of pages: 12
Pages: 25-36
Publication date: 2017
Peer-reviewed: Yes

Publication information
Journal: Fire Safety Journal
Volume: 87
ISSN (Print): 0379-7112
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.17 SJR 0.789 SNIP 1.776
Web of Science (2017): Impact factor 1.888
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.03 SJR 0.927 SNIP 1.597
Web of Science (2016): Impact factor 1.165
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.69 SJR 0.803 SNIP 1.487
Web of Science (2015): Impact factor 0.936
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.49 SJR 0.891 SNIP 1.884
Theoretical Analysis on Marangoni-driven Cavity Formation in Ice during In-situ Burning of Oil Spills in Ice-infested Waters - Paper Number IN43D-0096

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Worcester Polytechnic Institute
Contributors: Farahani, H. F., Jomaas, G., Rangwala, A. S.
Publication date: 2017
Peer-reviewed: Yes
Event: Poster session presented at 2017 AGU Fall Meeting, New Orleans, United States.
Electronic versions:
The Parameters Controlling the Burning Efficiency of In-Situ Burning of Crude Oil on Water
Parameters that control the burning efficiency of in-situ burning of crude oil on water were identified by studying the influence of the initial slick thickness, vaporization order, oil slick diameter, weathering state of the oil, heat losses to the water layer and heat flux to the fuel surface on the burning efficiency for light and heavy crude oils. These parameters were studied in several small scale and intermediate scale experimental setups. The results showed that the heat losses to the water layer increase with increasing burning time because the components in a crude oil evaporate from volatile to non-volatile. Due to the relatively low heat feedback (reradiation and convection, in kW/m²) to the fuel surface of small scale pool fires, as compared to large scale pool fires, these heat losses were shown to limit the burning efficiency in small scale experiments. By subjecting small scale crude oil pool fires to an incident heat flux, the burning efficiency of a light crude oil could be increased from 48% to 90%. Similarly, increasing the diameter from 0.1 to 1.1 m, which thus increased the heat feedback to the fuel surface, increased the burning efficiency from 41% to 84% for a light crude oil. It can be concluded that the pool fire diameter is the key parameter that determines the burning efficiency of crude oil fires on water, which was partially attributed to the increasing heat flux (in kW/m²) to the fuel surface with increasing diameter. Increasing the heat flux to the fuel surface through external radiation resulted in an increase of the burning efficiency in small scales experiments. The burning efficiencies were, however, still lower than the ≥ 90% burning efficiencies observed in large scale fires of crude oil on water. It is therefore probable that other factors also increase the burning efficiency as the burning diameter increases.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design
Contributors: van Gelderen, L., Jomaas, G.
Pages: 817-832
Publication date: 2017

Thermal properties and burning efficiency of crude oils and refined fuel oil
The thermal properties and burning efficiencies of fresh and weathered crude oils and a refined fuel oil were studied in order to improve the available input data for field ignition systems for the in-situ burning of crude oil on water. The time to ignition, surface temperature upon ignition, heat release rate, burning rate and burning efficiency of two fresh crude oils (DUC, a light crude and Grane, a heavy crude), one fresh refined fuel oil (IFO 180) and weathered DUC (30-40 wt% evaporated and 40 wt% evaporated with 40 vol% water) were tested. Experiments were conducted in a newly designed water-cooled holder for a cone calorimeter under incident heat fluxes of 0, 5, 10, 20, 30, 40 and 50 kW/m². The results clearly showed that the weathered oils were the hardest to ignite, with increased ignition times and critical heat flux of 5-10 kW/m². Evaporation and emulsification were shown to be the determining factors increasing the critical heat flux compared to the physical properties of the oils. Boilover was observed for both emulsified DUC and fresh Grane and dominated the energy released by these oils. These results provided further evidence that the boilover phenomenon is correlated to the superheating of relatively volatile components such as water (DUC emulsion) or light hydrocarbons (Grane). Boilovers can thus occur due to inherent properties of the burning oil and should therefore be taken into account in the safety planning of in-situ burning operations. Maximum burning efficiencies of 85-90% were obtained for heat fluxes of 40-50 kW/m² for the crude oils and 80% at 30 kW/m² for IFO 180. The heat feedback in large scale fires, however, was estimated to be about 17 kW/m², for which the burning efficiencies were < 80%. These results indicate that the increased heat feedback to the fuel surface is not the only factor that increases the burning efficiency for large scale fires compared to laboratory experiments. Additional factors such as feeding of surrounding oil into the fire by buoyancy induced wind flows into the hot smoke plume are probably also contributing to these increased burning efficiencies.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design
Publication date: 2017
Vaporization order and burning efficiency of crude oils during in-situ burning on water

In order to improve the understanding of the burning efficiency and its observed size dependency of in-situ burning of crude oil on water, the vaporization order of the components in crude oils was studied. The vaporization order of such multicomponent fuels was assessed by studying the surface temperature, flame height, burning rate and burn residues of three alkanes (n-octane, dodecane and hexadecane), a mixture of these alkanes (1:1:1 volumetric ratio) and two crude oils (light and medium-light crudes). The experimental results were compared to four models for the vaporization order of multicomponent fuels. The alkanes were tested as benchmark fuels with a uniform vaporization order, for which all components evaporate simultaneously. As expected, these pure fuels showed a steady state burning with a near-constant surface temperature, flame height and burning rate. The alkane mixture showed similar steady state results but became dominated by the heaviest component towards the end of the burning. These results indicate that the lightest components had been depleted from the mixture. A near-uniform vaporization order in which the lighter components evaporate preferably best matched these results. The crude oils did not show any steady state behavior, but instead had an increasing surface temperature and decreasing burning rate and flame height, indicating a volatility controlled vaporization order. An increasing concentration gradient from the medium to heavy fraction in the burn residues furthermore showed that the vaporization was diffusion-limited. Analysis of the heat transfer balance for the crude oils indicated that the energy available for evaporation decreased over time due to increasing heat losses, which were caused by the volatility controlled vaporization order. Presumably, larger scale fires can overcome these heat losses, as they typically have higher burning rates, which increase the heat feedback to the fuel surface and therefore can result in the higher burning efficiencies.
A Helium-Technique Experimental Study of Longitudinal Ventilation Control in Sloped, Small-Scale Tunnels

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design
Contributors: Alva, W. U. R., Jomaas, G., Dederichs, A.
An experimental study of the fire development of various sandwich panels with mineral and plastic core materials exposed to a 1:5 scaled ISO 13784-1 fire test.

A novel model for interpreting experimental results from sandwich composites exposed to fire conditions

Chemical herder effectiveness as oil spill response tool in ice-infested water
Effectiveness of a chemical herder as a tool for in-situ burning of oil spills in ice-infested water

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Aarhus University
Contributors: van Gelderen, L., Fritte-Rasmussen, J., Jomaas, G.
Number of pages: 2
Pages: 68-69
Publication date: 2016

Host publication information
Title of host publication: ARTEK Event 2016 – International Conference Sanitation in Cold Climate Regions
Publisher: Arctic Technology Centre, DTU Technical University of Denmark
ISBN (Print): 9788778774316
Electronic versions:
Book_of_Abstracts_Artek_Event_2016.pdf

Bibliographical note
Byg Report R-340
Research output: Research - peer-review › Conference abstract in proceedings – Annual report year: 2016

Effects of oil and oil burn residues on seabird feathers
It is well known, that in case of oil spill, seabirds are among the groups of animals most vulnerable. Even small amounts of oil can have lethal effects by destroying the waterproofing of their plumage, leading to loss of insulation and buoyancy. In the Arctic these impacts are intensified. To protect seabirds, a rapid removal of oil is crucial and in situ burning could be an efficient method. In the present work exposure effects of oil and burn residue in different doses was studied on seabird feathers from legally hunted Common eider (Somateria mollissima) by examining changes in total weight of the feather and damages on the microstructure (Amalgamation Index) of the feathers before and after exposure. The results of the experiments indicate that burn residues from in situ burning of an oil spill have similar or larger fouling and damaging effects on seabird feathers, as compared to fresh oil.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Aarhus University
Pages: 446-452
Publication date: 2016
Peer-reviewed: Yes

Publication information
Journal: Marine Pollution Bulletin
Volume: 109
Issue number: 1
ISSN (Print): 0025-326X
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.4 SJR 1.147 SNIP 1.228
Web of Science (2017): Impact factor 3.241
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Experimental Study of the Behavior of Steel Structures Protected by Different Intumescent Coatings and Exposed to Various Fire Scenarios

Three different experimental setups corresponding to three different fire scenarios were used to investigate how different heating conditions and heating rates affect the behavior of two different thin intumescent coatings (solvent-based and water-based paints, respectively). The results confirm that the current procedure for the design of intumescent coatings has shortcomings, as different paints have different performances according to the heating conditions and, in particular, according to the fire’s heating rate. The tested water-based paint had better performance for low heating rates, while the tested solvent-based paint had better performance for high heating rates. However, for really low heating rates the solvent-based paint did not activate or provide proper insulation.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Technical University of Denmark
Contributors: Lucherini, A., Costa, R., Giuliani, L., Jomaas, G.
Number of pages: 8
Pages: 1065-1072
Publication date: 2016

Host publication information
Title of host publication: Structures in Fire 2016. Proceedings of the 9th international conference on structures in fire
Publisher: DEStech Publications, Inc.
Electronic versions:
Lucherini_2016_Experimental_Study_of_the_behaviour_of_steel_structures_protected_by_different_intumescent_coatings_1.pdf
Source: PublicationPreSubmission
Source-ID: 125650895
Research output: Research - peer-review › Article in proceedings – Annual report year: 2016

Fire safety in space – Investigating flame spread interaction over wires

A new rig for microgravity experiments was used for the study flame spread of parallel polyethylene-coated wires in concurrent and opposed airflow. The parabolic flight experiments were conducted at small length- and time scales, i.e. typically over 10 cm long samples for up to 20 s. For the first time, the influence of neighboring spread on the mass burning rate was assessed in microgravity. The observations are contrasted with the influence characterized in normal gravity. The experimental results are expected to deliver meaningful guidelines for future, planned experiments at a larger scale.

Arisign from the current results, the issue of the potential interaction among spreading flames also needs to be carefully investigated as this interaction plays a major role in realistic fire scenarios, and therefore on the design of the strategies that would allow the control of such a fire. Once buoyancy has been removed, the characteristic length and time scales of the different modes of heat and mass transfer are modified. For this reason, interaction among spreading flames may be revealed in microgravity, while it would not at normal gravity, or vice versa. Furthermore, the interaction may lead to an enhanced spread rate when mutual preheating dominates or, conversely, a reduced spread rate when oxidizer flow vitiation is predominant.

In more general terms, the current study supports both the SAFFIRE and the FLARE projects, which are large projects with international scientific teams. First, material samples will be tested in a series of flight experiments (SAFFIRE 1-3) conducted in Cygnus vehicles after they have undocked from the ISS. These experiments will allow the study of ignition and possible flame spread in real spacecraft conditions, i.e. over real length scale samples within real time scales. Second, concomitant research conducted within the FLARE project is dedicated to the assessment of new standard tests for materials that a spacecraft can be composed of. Finally, these tests aim to define the ambient conditions that will mitigate and potentially prohibit the flame spread in microgravity over the material studied.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Sorbonne Universités, Hokkaido University, JAXA, Belisama R&D, University of Queensland
Pages: 500-509
Publication date: 2016
Peer-reviewed: Yes

Publication information
Fundamentals of Premixed Flames

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design
Contributors: Jomaas, G.
Pages: 373-395
Publication date: 2016

Host publication information
Title of host publication: SFPE Handbook of Fire Protection Engineering
Publisher: Springer
ISBN (Print): 978-1-4939-2564-3
ISBN (Electronic): 978-1-4939-2565-0
DOIs:
10.1007/978-1-4939-2565-0_12
Research output: Research - peer-review » Book chapter – Annual report year: 2016

Performance of chemical herders for in situ burning of crude oil in ice infested waters

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Technical University of Denmark
Contributors: Adamopoulou, E., van Gelderen, L., Jomaas, G.
Number of pages: 1
Publication date: 2016
Peer-reviewed: Yes
Event: Abstract from The 7th International Student Petroleum Congress & Career Expo "East meets West", Krakow, Poland.

Electronic versions:
Performance_of_chemical_herders_for_ISB_Poland_conference_.pdf
Source: PublicationPreSubmission
Source-ID: 123602696
Research output: Research - peer-review » Conference abstract for conference – Annual report year: 2016

The effectiveness of chemical herders as oil spill response tool in ice-infested water

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Aarhus University
Contributors: van Gelderen, L., Fritt-Rasmussen, J., Jomaas, G.
Number of pages: 1
Publication date: 2016
Peer-reviewed: Yes

Electronic versions:
AMOP2016_abstract_van_Gelderen_et_al..pdf
Source: PublicationPreSubmission
Source-ID: 125020334
Research output: Research - peer-review » Conference abstract for conference – Annual report year: 2016
Topology optimization for simplified structural fire safety

Topology optimization is applied in an idealized structural fire safety model, where the minimum compliance problem is constrained by temperature-controlled structural degradation. The constraint ensures a certain structural stiffness after a prescribed time. As this time period is extended, resulting optimized topologies tend to become thicker or introduce redundant members that can take over when structural parts near the origin of the fire lose their load carrying capability. Hence, the structural degradation model acts as an erosion operator on the topology and indirectly enforces a minimum length scale on the final designs.

General information

State: Published
Organisations: Department of Mechanical Engineering, Department of Civil Engineering, Section for Building Design, Solid Mechanics, Technical University of Denmark
Contributors: Madsen, S., Lange, N. P., Giuliani, L., Jomaas, G., Lazarov, B. S., Sigmund, O.
Number of pages: 11
Pages: 333-343
Publication date: 2016
Peer-reviewed: Yes

Publication information
Journal: Engineering Structures
Volume: 124
ISSN (Print): 0141-0296
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.32 SJR 1.69 SNIP 2.165
Web of Science (2017): Impact factor 2.755
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.93 SJR 1.547 SNIP 2.037
Web of Science (2016): Impact factor 2.258
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 2.59 SJR 1.631 SNIP 2.15
Web of Science (2015): Impact factor 1.893
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 2.4 SJR 1.701 SNIP 2.488
Web of Science (2014): Impact factor 1.838
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 2.69 SJR 1.967 SNIP 2.799
Web of Science (2013): Impact factor 1.767
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 2.23 SJR 1.786 SNIP 2.608
Web of Science (2012): Impact factor 1.713
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 2.26 SJR 1.644 SNIP 2.747
Web of Science (2011): Impact factor 1.351
**Vaporization order of crude oil during in-situ burning on water**

**General information**

State: Published
Organisations: Department of Civil Engineering, Section for Building Design, University of Copenhagen
Contributors: van Gelderen, L., Malmquist, L. M., Christensen, J. H., Jomaas, G.
Number of pages: 1
Publication date: 2016
Peer-reviewed: Yes

**Electronic versions:**

Source: PublicationPreSubmission
Source-ID: 125390194
Research output: Research - peer-review › Poster – Annual report year: 2016

**Chemical herding and in-situ burning of crude oil in a water basin in Sisimiut, Greenland**

**General information**

State: Published
Organisations: Department of Civil Engineering, Section for Building Design, ARTEK, Section for Arctic Engineering and Sustainable Solutions, Technical University of Denmark
Number of pages: 1
Publication date: 2015
Peer-reviewed: No
Crude oil burning mechanisms: A conceptual model review

In order to improve predictions for the burning efficiency and the residue composition of in-situ burning of crude oil, the burning mechanism of crude oil was studied in relation to the composition of its hydrocarbon mixture, before, during and after the burning. The surface temperature, flame height, mass loss rate and residues of three hydrocarbon liquids (n-octane, dodecane and hexadecane), two crude oils (DUC and REBCO) and one hydrocarbon liquid mixture of the aforementioned hydrocarbon liquids were studied using the Crude Oil Flammability Apparatus. The experimental results were compared to the predictions of four conceptual models that describe the burning mechanism of multicomponent fuels. Based on the comparisons, hydrocarbon liquids were found to be best described by the Equilibrium Flash Vaporization model, showing a constant gas composition and gasification rate. The multicomponent fuels followed the diffusion-limited gasification model, showing a change in the hydrocarbon composition of the fuel and its evaporating gases, as well as a decreasing gasification rate, as the burning progressed. This burning mechanism implies that the residue composition and burning efficiency mainly depend on the highest achievable oil slick temperature. Based on this mechanism, predictions can then be made depending on the hydrocarbon composition of the fuel and the measured surface temperature.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, University of Copenhagen
Contributors: van Gelderen, L., Malmquist, L., Jomaas, G.
Number of pages: 16
Publication date: 2015

Host publication information
Title of host publication: Proceedings of the 38th AMOP Technical Seminar on Environmental Contamination and Response
Electronic versions:
Crude_oil_burning_mechanisms_A_conceptual_model_review_L._van_Gelderen_L._Malmquist_G._Jomaas_2015_AMOP.pdf
Source: PublicationPreSubmission
Source-ID: 116831560
Research output: Research - peer-review › Article in proceedings – Annual report year: 2015

Determination of the moisture content of Nordic spruce wood through cone heater experiments and an integral model

The combination of cone heater experiments and an integral model was used to determine the moisture content of Nordic spruce with varying degree of drying. Nine specimens of Nordic spruce were pre-heated to 105°C in a convective oven for durations ranging from 0 days (no drying) and up to 63 days in increments of 7 days. The fuel moisture content was measured by weighting the specimens before and after the pre-heating. A mass loss cone was used to determine the time for piloted ignition of each specimen. A high-flux asymptotic solution from an integral model permitted to determine that the ignition temperature (directly linked to the intercept heat flux) was constant for dry and wet wood pieces. Furthermore, from this result and the high-flux asymptotic solution, the fuel moisture content of the wet specimen was calculated and found to be very close to the measured value. As a result, one equation is developed that can be used to determine the time to ignition of a piece of wet spruce, and it is suggested that this method can be used for establishing similar equations for other types of moist wood.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, University of Borås, Technical University of Denmark
Contributors: Mindykowski, P. A., Jørgensen, M., Svensson, S., Jomaas, G.
Number of pages: 1
Publication date: 2015

Host publication information
Title of host publication: Proceedings of the 2nd European Symposium of Fire Safety Science
Electronic versions:
2ndesfss_ABSTRACT.pdf
Source: PublicationPreSubmission
Source-ID: 112838238
Research output: Research - peer-review › Article in proceedings – Annual report year: 2015
Effects of convective motion in n-octane pool fires in an ice cavity

The effects of convective flows in n-octane pool fires in an ice cavity were investigated and it was found that a new set of parameters to the classical problem of bounded pool fires arises under these unique conditions. To systematically understand these parameters, two sets of experiments were performed by burning n-octane in cylindrically shaped ice cavities of 5.7 cm diameter. The first set of experiments was intended to provide a clear understanding of the geometry change of the cavity and displacement of the fuel layer. The results of these experiments showed that the rate of melting of the ice walls were higher in areas where the fuel layer was in contact with ice than in places where the flame was present. Due to the melting of the ice walls, a ring-shaped void was formed around the perimeter of the cavity. In the second set of experiments, the change in the temperature of the fuel layer was measured by use of multiple thermocouples at different locations inside the ice cavity. The results of the temperature analysis showed that the lateral temperature gradient of the fuel layer was an increasing function of time, whereas the vertical temperature gradient was a decreasing function of time. Using these experimental results, two dimensionless numbers (Marangoni and Rayleigh) were calculated. The Marangoni number represents the surface tension driven flows in the fuel layer and the Rayleigh number represents the buoyancy driven flows in the fuel layer. The results of this study showed two major convective phases; in the first half of the burning time, the buoyancy driven flows (Rayleigh) were dominant, while Marangoni convection was dominant in the second half of the burning time. The role of these mechanisms in affecting the flow and melting the ice is discussed. (C) 2015 The Combustion Institute. Published by Elsevier Inc. All rights reserved.
Experimental assessment of the suitability of monitors and tv-screens for placement in evacuation routes

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Technical University of Denmark
Contributors: Leisted, R. R., Ellerbæk Hinge, R., Mindykowski, P. A., Jomaas, G.
Number of pages: 1
Publication date: 2015
Peer-reviewed: Yes
Electronic versions:
Leisted_Mindykowski_Hinge_Jomaas_Abstract_FSD_2015.pdf
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 CO$_2$ 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.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Section for Indoor Environment, Technical University of Denmark
Contributors: Dogbeh, A., Jomaas, G., Bjarløv, S. P., Toftum, J.
Pages: 20-26
Publication date: 2015
Peer-reviewed: Yes
Early online date: 2014

Publication information
Journal: Building and Environment
Volume: 88
ISSN (Print): 0360-1323
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 5.22 SJR 2.169 SNIP 2.534
Web of Science (2017): Impact factor 4.539
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.51 SJR 1.998 SNIP 2.215
Web of Science (2016): Impact factor 4.053
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 4.37 SJR 2.067 SNIP 2.463
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 4.14 SJR 1.887 SNIP 2.742
Web of Science (2014): Impact factor 3.341
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 3.57 SJR 1.547 SNIP 2.551
Web of Science (2013): Impact factor 2.7
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 3.06 SJR 1.293 SNIP 2.857
Web of Science (2012): Impact factor 2.43
ISI indexed (2012): ISI indexed yes
Fire safety in space: Beyond flammability testing of small samples

An international research team has been assembled to reduce the uncertainty and risk in the design of spacecraft fire safety systems by testing material samples in a series of flight experiments (Saffire 1, 2, and 3) to be conducted in an Orbital Science Corporation Cygnus vehicle after it has undocked from the International Space Station (ISS). The tests will be fully automated with the data downlinked at the conclusion of the test before the Cygnus vehicle re-enters the atmosphere.

The unmanned, pressurized environment in the Saffire experiments allows for the largest sample sizes ever to be tested for material flammability in microgravity, which will be based on the characteristics of flame spread over the surface of the combustible material. Furthermore, the experiments will have a duration that is unmatched in scale compared to earth based microgravity research facilities such as drop towers (about 5 s) and parabolic flights (about 20 s). In contrast to sounding rockets, the experiments offer a much larger volume, and the reduction in the oxygen concentration during the Saffire experiments will be minimal.

The selection of the experimental settings for the first three Saffire experiments has been based on existing knowledge of scenarios that are relevant, yet challenging, for a spacecraft environment. Given that there is always airflow in the space station, all the experiments are conducted with flame spread in either concurrent or opposed flow, though with the flow being stopped in some tests, to simulate the alarm mode environment in the ISS and thereby also to study extinguishment. The materials have been selected based on their known performance in NASA STD-6001Test-1, and with different materials being classified as charring, thermally thin, and thermally thick. Furthermore, materials with non-uniform surfaces will be investigated.
Importance of the slick thickness for effective in-situ burning of crude oil

In order to improve the potential of in-situ burning (ISB), the importance of the oil slick thickness on two pure oils (n-octane and dodecane) and two fresh crude oils (Grane and REBCO) was studied in relation to the regression rate, boilover tendency, mass loss rate, burning efficiency and flame height. The experiments were performed in a new experimental apparatus, the Crude Oil Flammability Apparatus (COFA), which has been developed to study ISB of oil on water in a controlled laboratory environment with large water-to-oil ratios. The regression rate, average mass loss rate and burning efficiency reached a constant maximum value for all oils at slick thicknesses exceeding 10–20 mm. For thinner initial slick thicknesses, these values were greatly reduced, most likely due to heat losses to the water. A further increase in the initial slick thickness could not improve the burning efficiency above 75% for the crude oils, showing that it only has a limited effect on the burning efficiency as higher burning efficiencies have been reported for larger scales. Furthermore, the results showed that the burning mechanisms differ for pure and crude oil, indicating that the hydrocarbon mixture in crude oils changes as the burning progresses. This observation merits further research.

General information

State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Technical University of Denmark, Aarhus University, Worcester Polytechnic Institute
Pages: 1-9
Publication date: 2015
Peer-reviewed: Yes

Publication information

Journal: Fire Safety Journal
Volume: 78
ISSN (Print): 0379-7112
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.17 SJR 0.789 SNIP 1.776
Web of Science (2017): Impact factor 1.888
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Modification of poly(styrene-block-butadiene-block-styrene) [SBS] with phosphorus containing fire retardants

An elaborate survey of the chemical modification methods for endowing highly flammable SBS with increased fire resistant properties by means of chemical modification of the polymer backbone with phosphorus containing fire retardant species is presented. Optimal conditions for free radical addition of the Psingle bondH containing fire retardants to a double bond...
of poly(butadiene) block of SBS were found, affording varied degree of the modification (0.2–21 mol%). Alternatively, a two-step procedure based on an epoxidation step followed by hydrolysis of the epoxides with phosphoric acid was developed resulting in 20 mol% of poly(butadiene) block modification. Based on TGA results, organophosphorus-modified SBS was found to be amenable to charring – a property which correlated directly with the reduced flammability of the modified polymer observed in Cone Calorimetry tests. Furthermore, conceptually novel application of the H3PO4 modified SBS as a fire retardant additive for bitumen material, in combination with synergetic melamine species, offered 25% better self-extinguishing properties of such formulation already at a low loading level of the fire retardant components (3.5 wt.%).

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Amphiphilic Polymers in Biological Sensing, Department of Civil Engineering, Section for Building Design, Danish Technological Institute
Pages: 136-146
Publication date: 2015
Peer-reviewed: Yes

Publication information
Journal: European Polymer Journal
Volume: 70
ISSN (Print): 0014-3057
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 3.7 SJR 0.996 SNIP 1.193
Web of Science (2017): Impact factor 3.741
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.75 SJR 1.059 SNIP 1.292
Web of Science (2016): Impact factor 3.531
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 3.58 SJR 1.022 SNIP 1.342
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 3.35 SJR 1.117 SNIP 1.47
Web of Science (2014): Impact factor 3.005
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 3.43 SJR 1.087 SNIP 1.665
Web of Science (2013): Impact factor 3.242
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 2.99 SJR 1.074 SNIP 1.715
Web of Science (2012): Impact factor 2.562
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 3.03 SJR 1.109 SNIP 1.822
Web of Science (2011): Impact factor 2.739
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.297 SNIP 1.548
On the use of Bio-based Building Products in Denmark - Fire safety regulations, research and future challenges

General information
State: Published
Organisations: Department of Management Engineering, Production and Service Management, Risk Research Group, Implementation and Performance Management, Department of Civil Engineering, Section for Building Design, DBI - The Danish Institute of Fire and Security Technology, Danish Technological Institute
Contributors: Jomaas, G., Dragsted, A., Fynholm, P., Markert, F.
Number of pages: 2
Publication date: 2015
Peer-reviewed: No
Event: Abstract from COST Action FP1404 Fire safe use of bio-based building products kick-off, Barcelona, Spain.

Residual Structural Capacity of Timber Components after Exposure to High Temperatures

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Technical University of Denmark
Contributors: Mindykowski, P. A., Jørgensen, M., Svensson, S., Jomaas, G.
Number of pages: 1
Publication date: 2015
Peer-reviewed: Yes
**Scaled experiments using the helium technique to study the vehicular blockage effect on longitudinal ventilation control in tunnels**

A model tunnel (1:30 compared to a standard tunnel section) with a helium-air smoke mixture was used to study the vehicular blockage effect on longitudinal ventilation smoke control. The experimental results showed excellent agreement with full-scale data and confirmed that the critical velocity decreases in proportion with the blockage ratio. Nevertheless, it was found that the relative position of the fire source and the relative size of the vehicular blockage can have an opposite effect, as the vehicular blockage influenced the critical and confinement velocity. The method demonstrated the ability to provide valuable information on the effect of vehicular blockage on tunnel fire dynamics.

**General information**

State: Published
Organisations: Department of Civil Engineering, Section for Building Design
Contributors: Alva, W. U. R., Jomaas, G., Dederichs, A.
Number of pages: 16
Pages: 49-64
Publication date: 2015

**Host publication information**

Title of host publication: Proceedings of the 16th International Symposium on Aerodynamics, Ventilation & Fire in Tunnels
Electronic versions: 91_Rojas_Alva_et_al.pdf
Source: PublicationPreSubmission
Source-ID: 116619808
Research output: Research - peer-review › Article in proceedings – Annual report year: 2015

**Scaling of the burning efficiency for multicomponent fuel pool fires**

In order to improve the validity of small scale crude oil burning experiments, which seem to underestimate the burning efficiency obtained in larger scales, the gasification mechanism of crude oil was studied. Gasification models obtained from literature were used to make a set of predictions for relevant burning related parameters which were then compared to experimental results. These parameters, the surface temperature, mass loss rate, flame height and residue composition, were studied for three hydrocarbon liquids (n-octane, dodecane and hexadecane) and two crude oils (DUC and REBCO). Based on the models-experiments comparison, it was suggested that crude oil burns according to a distillation-like mechanism, with the light components burning off first, followed by increasingly heavier components as the burning progresses. Thus, in order for the crude oil to burn near 100%, the surface temperature must continuously increase to evaporate the heaviest components. Small scale experiments were deemed to lack a sufficient flame volume and resulting heat feedback to the fuel surface to reach such temperatures, thus explaining the lower burning efficiencies. Small scale experiments featuring an external heat source to simulate the larger fire size are currently in process.

**General information**

State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Worcester Polytechnic Institute
Number of pages: 1
Publication date: 2015
Peer-reviewed: Yes
Keywords: In-situ burning, Burning efficiency, Scaling
Source: PublicationPreSubmission
Source-ID: 110842925
Research output: Research - peer-review › Conference abstract for conference – Annual report year: 2015

**An Assessment of the Fire Safety Hazard Associated with External Fire Spread in Tall Buildings with Combustible Façade Material**

External fire spread poses a severe threat to the fire safety of tall buildings with the ensuing risk of multiple simultaneous compartment fires and in the worst case, a complete structural failure. However, it is important to understand every aspect of the causes that lead to external fire spread in order to obtain a conclusive assessment of the fire safety hazards associated with combustible facades.

Prescriptive fire safety codes are typically not allowing any type of combustible façade in buildings that are taller than 2-3 stories. However, a performance based approach does not contain height limitations in many countries. The study within
external fire spread has shown that the transition from prescriptive to performance based approach can be cryptic and it is important to keep in mind that a performance based design requires that all aspects are taken into account. Therefore, a method was developed to study the likelihood of fire spread from inside a compartment to the façade in a tall timber building, in order to contribute to the overall understanding of fire safety in tall timber buildings. The method is based on the principles of the analytical Law model, thus the parameters of opening factor, compartment temperature and heat flux were considered.

An accompanying case study was based on one of the most well-known medium-rise timber buildings (Limnologen), which was primarily chosen because it has combustible façades that were only allowed due to the implementation of residential sprinklers. The technical trade-off carried two main concerns, which serve as the base for this discussion. First, the sprinklers are only installed inside the building, thus fire spread that originates from the outer perimeter was neglected. Second, the sprinkler’s effect was not analyzed, thus it was ambiguous whether they were actually needed or not. The study has its main focus around the second concern and the results show that the residential sprinklers in many cases were found to not improve the external fire spread risk.

**General information**

State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Technical University of Denmark, University of Queensland
Contributors: Lavard Brogaard, N., Torero, J. L., Jomaas, G.
Number of pages: 1
Pages: 29
Publication date: 2014

**Host publication information**

Title of host publication: Book of Abstracts : Fire Safety Day 2014
Source: PublicationPreSubmission
Source-ID: 97260298
Research output: Research - peer-review » Conference abstract in proceedings – Annual report year: 2014

**A new Experimental Rig for Oil Burning on Water: Results for Crude and Pure Oils**

A new experimental apparatus, the Crude Oil Flammability Apparatus (COFA), has been developed to study in-situ burning of crude and pure oils spilled on water in a controlled laboratory environment with large water-to-oil ratios. The parameters and phenomena studied for an asphaltic crude oil (Grane) and two pure oils (n-Octane and dodecane) with different initial oil layer thicknesses include burning efficiency, burning rate, regression rate, flame height and boilover. Pyrex glass cylinders (157 and 260 mm ID) placed on top of a steel foot in a water basin (1m x 1m x 0.5m) enabled free circulation of the water, which, along with the large water-to-oil ratios (up to 10,000) ensured that the oil burning barely increased the temperature of the surrounding water environment, which created more realistic offshore conditions than seen in many other laboratory studies. The burning efficiency was found to be nearly 100% for n-Octane and of dodecane, whereas the crude oil burning efficiency ranged between 35% and 65%. The main reason for this variation proved to be the onset of an extremely violent boilover, which occurs for oils with relatively high boiling temperatures when the water sub layer is superheated. When the initial crude oil layer thickness exceeded 20 mm the oil became solid and no boilover occurred. The heat-loss to the water sub-layer also had an effect on the burning efficiency and the regression rate was found to reach a constant value after increasing continuously as the oil was heated. Similar results were found regarding the flame height which reached a steady flame height. The pure fuels, n-Octane and dodecane, produced a much higher steady flame height than the crude oil, however they did not reach boilover, though dodecane showed boilover tendencies. Theoretical predictions with existing correlations and input data specific for the current oils generally compared well with the experimental data for both the time to boilover and the regression rates. As such, the COFA is envisioned to produce high-fidelity results in the future and thereby contribute to the further development of in-situ burning as an alternative response technique for oil spills on water.

**General information**

State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Technical University of Denmark, Aarhus University, Worcester Polytechnic Institute
Number of pages: 14
Publication date: 2014

**Host publication information**

Title of host publication: Proceedings of the 11th International Symposium on Fire Safety Science
Publisher: International Association for Fire Safety Science
Keywords: In-Situ Burning, Burning efficiency, Burning rates, Boilover, Crude oil
URLs: http://www.iafss.org/publications
Source: dtu
Source-ID: u::10970
Assessment of the Fire Risk Levels in an Office Building and a Nightclub with Prescriptive Designs

A comparison of the risk level of an office building and a nightclub with code compliant prescriptive designs was conducted in order to evaluate whether an uniform safety level of the two occupancy types can be established. A risk assessment method using Monte Carlo simulations and 1- and 2-zone fire models and hand calculations for the egress was used for the comparison. An existing model formed the basis for the study, though with substantial new developments. For the available safe egress time (ASET) the main objective was to ensure continuity of the fire development, whereas the pre-movement time and the movement time were adjusted for the required safe egress time (RSET) of the nightclub. The number of simulations required in order to obtain reliable results was considered sufficient at 20,000. The comparison of the risk profiles of the nightclub and the office building showed significant difference in risk levels, with that of the nightclub being substantially higher. The higher risk level in the nightclub is caused by a relatively fast mean value of the fire growth rate and the high number of occupants. Hence, the requirements in the prescriptive code do not ensure a similar safety level for the two occupancy types when evaluated by the risk-based approach. In addition, a sensitivity analysis was conducted for the fire growth rate and for the fire area in the nightclub. In this analysis the increase in the standard deviation of the fire area, which was assigned a log-normal distribution, resulted in a higher risk level. In contrast, a reduction in the fire area did not have any significant affects on the risk level. Furthermore, the effect of the sprinkler system and the effects of the ventilation system were compared. The analysis showed that the sprinkler system with an RTI value of 50 m$^2$s$^{-1}$ had a much more sufficient contribution to the risk level compared to a natural ventilation system and a sprinkler system of an RTI value of 100 m$^2$s$^{-1}$.

The risk profiles for the two occupancy types were compared to tolerable safety levels suggested herein. One of them being an acceptance curve derived from fire statistics in the United Kingdom (UK). In this comparison the acceptance level of the office building was stricter due to the differences in the statistics of the two occupancy types. However, the office building nearly met the requirements of the acceptance curve, whereas the nightclub was far from meeting the requirements. Another suggested tolerable level herein was derived from the UK specifications by the Health and Safety Executive, which distinguish between tolerable safety level for members of the public and for workplaces. This comparison made it even more difficult for the nightclub to meet the required occupant safety level.

Effect of insulation material on the fire performance of composite panels

State: Published
Organisations: Department of Civil Engineering, Section for Building Design, University of Edinburgh, Technical University of Denmark, University of Central Lancashire, If P&C Insurance, University of Queensland
Number of pages: 1
Publication date: 2014

Host publication information
Title of host publication: Book of Abstracts : Fire Safety Day 2014
Keywords: Risk assessment, Occupancy types, Zone-models, Monte Carlo simulations
Source: PublicationPreSubmission
Source-ID: 97260258
Research output: Research - peer-review › Conference abstract in proceedings – Annual report year: 2014
FDS Modeling of the Sensitivity of the Smoke Potential Values used in Fire Safety Strategies

To investigate the sensitivity of Fire Dynamics Simulator (FDS) with respect to the input parameters that are used to define the optical properties of the smoke, a parametric study was performed for relevant fire scenarios in an open plan office building. The parametric study mainly focuses on the two key parameters in FDS that define the optical properties of the smoke, namely the smoke potential and the effective heat of combustion.

In Denmark, the open source computational fluid dynamics (CFD) program Fire Dynamics Simulator is commonly used to assess the production and transport of the combustion products in performance based fire safety design. The results are used to evaluate the safety level of buildings based on the time comparison between the available safe egress time (ASET) and the required safe egress time (RSET). For a majority of performance based analysis the optical properties of the smoke determine the available safe egress time, as defined based on the acceptance visibility criterion defined in the Danish performance-based fire safety design code. Because there is no uniform test method to measure the optical properties of the smoke and due to the absence of a best practice guide that is widely accepted by the fire engineering community, values from a vast variety of experiments are used in the engineering analysis to express the properties that determine the decrease of visibility from the presence of smoke. The selection of these values, which are used as input parameters in the simulation model, determines to a great extent the results obtained using the CFD simulation tools, and thereby also the fire safety design.

As the majority of combustible materials in buildings are characterized by smoke potential values lower than 2.0 ob∙m³/g, the underestimation of this input parameter may lead to the wrong assessment of the evacuation safety level of the building. In this context, in order to ensure a robust fire safety solution it is recommended that values around 1.0 - 2.0 ob∙m³/g are used to define the optical properties of the smoke in office building fires. Using these values to defining the design fires will reduce the sensitivity of the numerical fire simulation and further reduce the risk of overestimating the evacuation safety level (ESL) of the building.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Technical University of Denmark, COWI AS
Contributors: Corches, A., Ulriksen, L., Jomaas, G.
Number of pages: 12
Publication date: 2014

Host publication information
Title of host publication: Proceedings of the 10th International Conference on Performance-Based Codes and Fire Safety Design Methods
Keywords: Smoke potential, Performance-based fire safety design, Optical density, Visibility, FDS
Electronic versions: Corches_Ulriksen_Jomaas_FDS_Modeling_of_the_Sensitivity_of_the_Smoke_Potential_Values_used_in_Fire_Safety_Strategies.pdf
Source: PublicationPreSubmission
Source-ID: 97571280
Research output: Research - peer-review › Article in proceedings – Annual report year: 2014

FDS Modeling of the Sensitivity of the Smoke Potential Values Used in Fire Safety Strategies

Performance-based analysis is commonly used for fire safety strategies in Denmark. In order to evaluate the safety level of buildings, a time comparison between the available safe egress time (ASET) and the required safe egress time (RSET) is established. As the buildings are becoming more complex both from a geometrical and functional point of view, this type of comparison typically rely on numerical simulation methods, such as, computation fluid dynamics (CFD), to assess the amount of heat and smoke produced during fires and to estimate the transport of the combustion products.

After the numerical simulation methods were adopted to simulate fires in buildings in Denmark, it has been observed that, for a majority of fire strategy reports, the optical properties of the smoke determine the available safe egress time. These critical times are most often defined by the visibility criteria defined in the Danish performance-based fire design code [1]. As there is no uniform test method to measure the optical properties of the smoke, values from different experiments are used in engineering analysis to express the properties that determine the decrease of visibility through smoke [2-6]. Furthermore, it has been observed that the selection of the smoke potential value used as input in the numerical simulation models to a high extent determine the results obtained using the CFD simulation tools.

To investigate the sensitivity of the numerical methods in respect to the input data, a parametric study was performed for relevant fire scenarios in a typical office building. By analysing the optical properties of the smoke and the soot production phenomena it was determined that the mass concentration of soot particles in the gaseous phase determine the optical properties of the smoke. Moreover, by examining the combustion model in Fire Dynamics Simulator (FDS) [7] it was observed that the optical properties of the smoke are determined primarily by the yield of soot and the effective heat of combustion. Therefore, these parameters were selected for the parametric investigation.

A probabilistic method and a numerical model were used in order to determine the sensitivity of the FDS simulations. The probabilistic approach was used to determine the most representative values of the input parameters. This probabilistic approach was applied on a database of smoke potential values and effective heat of combustion for building materials and furniture elements. The numerical model was based on a simplified model of a four-story office building with a central atrium. This method was used to determine the sensitivity of the simulation results with respect to the time until untenable conditions and
the activation time of the smoke detectors for different smoke potential and effective heat of combustion values. It was shown that for approximately 70% of the building materials and furniture elements included in the extensive database developed during this study, the selection of the effective heat of combustion and smoke potential value determine the outcome, both for the visibility level and smoke detector response. On the other hand, for materials with a smoke potential value higher than 2.0 ob m⁻³/g (solid plastics, thermoplastic polymers and halogenated materials), it was observed that the fire simulation results are less dependent upon the values of the input parameters. The current approach is considered a valuable contribution, because it creates an overview of how important it is to use the correct values for the smoke potential and the effective heat of combustion in fire safety strategies and for fire safety design. In addition, it provides a database of values that can be used in fire safety strategies according to the design fire scenario.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, COWI AS
Contributors: Corches, A., Ulriksen, L., Jomaas, G.
Number of pages: 2
Pages: 34-35
Publication date: 2014

Host publication information
Title of host publication: Book of Abstracts : Fire Safety Day 2014
Source: PublicationPreSubmission
Source-ID: 97260426
Research output: Research - peer-review › Conference abstract in proceedings – Annual report year: 2014

Fire performance of sandwich panels in a modified ISO room test
Four sandwich panel rooms were constructed as prescribed in the ISO 13784-1 test. However, the construction followed normal industry practice, and the panels were then subjected to damage typically found in commercial premises. The fire load was increased to simulate fires actually occurring in commercial premises, by stepping-up the propane burner from 300 kW to 600 kW, and placing substantial wooden cribs in two of the rooms. The results showed significant differences in fire growth rate and burning behaviour between those panels filled with polyisocyanurate (PIR) and those filled with stone wool in both the experiments without and with the wood crib. Most significantly, the PIR pyrolysis products caused ignition (by radiation from above) of the wood crib 1 minute after the burner was stepped up to 300 kW (11 minutes into the test) rather than 2 minutes after the burner had been stepped up to 600 kW (22 minutes into the test) for the stone wool panels. This interaction between building and contents is frequently ignored in assessments of fire safety. After a few minutes, the PIR pyrolysis products that escaped outside the room, from between the panels, ignited. The extra thermal attack from PIR fuelled flames distorted the panels, exposing more PIR and resulting in large flames on both the inside and outside of the enclosure. From a fire safety perspective this is most important as it shows that with larger fire loads typical of those found in commercial premises, steel-faced PIR filled panels are not capable of acting as fire barriers, and support flame spread through compartment walls and ceilings. In addition, the PIR panelled rooms produced very large quantities of dense smoke and toxic effluents, where the stone wool panelled rooms produced small amounts of light smoke of lower toxicity.

General information
State: Published
Organisations: Technical University of Denmark, University of Edinburgh, University of Central Lancashire, University of Queensland
Pages: 58-61
Publication date: 2014
Peer-reviewed: Yes

Publication information
Journal: Materiały Budowlane
Volume: 2014
Issue number: 10
Original language: English
Source: PublicationPreSubmission
Source-ID: 118677764
Research output: Research - peer-review › Journal article – Annual report year: 2015

Fire Safety in Space: Beyond Flammability Testing of Small Samples

General information
**Functionality Inspection of Interconnected Fire Protection Systems**

After 2004, where the Danish buildings code changed from prescriptive to performance-based requirements for fire safety, the number of installed fire protections systems has increased with about 30 percent. Furthermore, fire safety strategies often call for combinations of active fire protection systems, such as a smoke detection system, sprinkler system, warning system and fire ventilation system. However, only smoke detections systems and sprinkler systems require inspection from an independent accredited company, whereas the other systems' functionality is entirely up to the professionals that install them and the owner's maintenance schedule, both of which do not require any supervision from the authorities.

Herein, 12 complex buildings, in which all fire protections systems were inspected by an independent accredited company, were studied to see whether or not the buildings adhere to the fire safety design in their operational phase. The results showed that the functionality of the interconnected fire protection systems was not as designed in the performance-based analysis. Furthermore, due to the lack of this functionality the fire safety level is not at high as the authorities’ demand, something which could have fatal consequences in the event of a fire.

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**General information**

State: Published  
Organisations: Department of Civil Engineering, Section for Building Design, Aalborg Fire Brigade  
Contributors: Kærup, R., Jomaas, G.  
Number of pages: 12  
Publication date: 2014

**Host publication information**

Title of host publication: Proceedings of the 10th International Conference on Performance-Based Codes and Fire Safety Design Methods  
Electronic versions:  
[Kærup_Jomaas_SFPE_2014_10th_International_Conference.pdf](Kærup_Jomaas_SFPE_2014_10th_International_Conference.pdf)  
Source: PublicationPreSubmission  
Source-ID: 97571275  
Research output: Research - peer-review › Article in proceedings – Annual report year: 2014

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**In-situ burning of crude oil in the Arctic: Understanding and predicting the environmental impact**

**General information**

State: Published  
Organisations: Department of Civil Engineering, Section for Building Design, Aarhus University, Technical University of Denmark, Worcester Polytechnic Institute  
Number of pages: 1  
Publication date: 2014  
Peer-reviewed: Yes  
Electronic versions:  
[Poster for 11th IAFSS - L. van Gelderen et al..pdf](Poster for 11th IAFSS - L. van Gelderen et al..pdf)  
Source: dtu  
Source-ID: u::10796  
Research output: Research - peer-review › Poster – Annual report year: 2014

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**Large-scale Spacecraft Fire Safety Tests**

**General information**

State: Published  
Organisations: Department of Civil Engineering, Section for Building Design, NASA Glenn Research Center, University of California at Berkeley, University of Queensland, University of Edinburgh, Belisama R&D, European Space Agency - ESA, Universite Pierre et Marie Curie, University of Bremen, Lomonosov Moscow State University, Hokkaido University, Case Western Reserve University
Slick Thickness Optimization for In-Situ burning of Crude Oil Using a New Experimental Rig

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Aarhus University, Worcester Polytechnic Institute, Technical University of Denmark
Number of pages: 1
Pages: 21
Publication date: 2014

Host publication information
Title of host publication: Book of Abstracts : Fire Safety Day 2014
Source: PublicationPreSubmission
Source-ID: 97260281
Research output: Research - peer-review › Conference abstract in proceedings – Annual report year: 2014

Spacecraft Fire Experiment (Saffire) Development Status
The status is presented of a spacecraft fire safety research project that is under development to reduce the uncertainty and risk in the design of spacecraft fire safety systems for exploration missions. The Spacecraft Fire Safety Demonstration Project is developing three Spacecraft Fire Experiments (Saffire-I, -II, and -III) to conduct a series of material flammability tests at a length scale that is realistic for a serious spacecraft fire in low-gravity. The objectives of these experiments are to (1) determine how rapidly a large scale fire grows in low-gravity and (2) investigate the low-g flammability limits compared to those obtained in NASA’s normal gravity material flammability screening test. The experiments will be conducted in Orbital Science Corporation’s Cygnus vehicle after it has deberthed from the International Space Station. Although the experiment will need to meet rigorous safety requirements to ensure the carrier vehicle does not sustain damage, the absence of a crew removes the need for strict containment of combustion products. The tests will be fully automated with the data downlinked at the conclusion of the test before the Cygnus vehicle reenters the atmosphere. A computer modeling effort will complement the experimental effort. An international topical team is collaborating with the NASA team in the definition of experiment requirements and performing supporting analysis, experimentation and technology development. The status of the overall experiment are summarized in this paper along with a brief look at future experiments that could further enhance NASA’s approach to spacecraft fire safety.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, NASA Glenn Research Center, University of California at Berkeley, University of Queensland, Universite Pierre et Marie Curie, University of Bremen, Lomonosov Moscow State University, Hokkaido University, University of Edinburgh, Belisama R&D, European Space Agency - ESA, Case Western Reserve University
Number of pages: 9
Publication date: 2014

Host publication information
Title of host publication: Proceedings of the 44th International Conference on Environmental Systems (ICES)
Publisher: Texas Tech University Libraries
Electronic versions:
2014_ICES_SFS_Demo_Paper_265_5_16_2014.pdf
The effect of emulsification on the in-situ burning of crude oil spills

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Technical University of Denmark
Contributors: Stefanakis, A., Bertram, F., van Gelderen, L., Jomaas, G.
Number of pages: 1
Publication date: 2014
Peer-reviewed: Yes
Event: Poster session presented at Oil and Gas Horizons 2014, Moscow, Russian Federation.
Electronic versions:
SPE_Poster_Stefanakis_Bertram_vanGelderen_Jomaas_1.pdf
Source: PublicationPreSubmission
Source-ID: 102673355
Research output: Research - peer-review › Poster – Annual report year: 2014

The Feasibility of Multiscale Modeling of Tunnel Fires Using FDS 6

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, Imperial College London, Exponent, Inc.
Contributors: Vermesi, I., Colella, F., Rein, G., Jomaas, G.
Number of pages: 1
Publication date: 2014
Peer-reviewed: Yes
Event: Poster session presented at 6th International Symposium on Tunnel Safety and Security, Marseille, France.
Electronic versions:
prod11396373269842.izabella_poster_istss_final.pdf
Source: dtu
Source-ID: u::10981
Research output: Research - peer-review › Poster – Annual report year: 2014

The Feasibility of Multiscale Modeling of Tunnel Fires Using FDS 6
The HVAC component of FDS 6 was used to divide a 1.2km tunnel into a 3D near fire area and a 1D area further away from the fire in order to investigate the feasibility of multiscale modeling of tunnel fires with this new feature in FDS. The two sub-models were coupled directly. The results were compared with reference works on multiscale modeling and the outcome is considered positive, with a deviation of less than 5% in magnitude of relevant parameters, yet with a significant reduction of the simulation runtime. As such, the multiscale method is deemed feasible for simulating tunnel fires in FDS6. However, the simplifications that are made in this work require further investigation in order to take full advantage of the potential of this computational method.

INTRODUCTION
Multiscale modeling for tunnel flows and fires has previously been studied using RANS general purpose CFD software and it has yielded satisfactory results in comparison to full scale CFD simulations [1-3]. It combines a 3D domain for the near fire zones, which are characterized by large temperature and pressure gradients, with a 1D network approach for the far field, where the flow is treated as a mono-dimensional quantity. The present study aimed to analyze whether or not the multiscale modeling approach for tunnel fires could be successfully applied in Fire Dynamics Simulator 6 (FDS6), an open source, fire-specific CFD software [4] that is easily accessible to modeling specialists.

METHOD
The implementation of multiscale modeling in FDS used a mono-directional road tunnel with a rectangular cross-section of 8m width and 6.5m height. Its total length of 1200m was split into 400m of 3D domain with two 1D ducts of 400m on either side. The 3D domain was divided into 17 meshes in order to reduce the runtime of the simulations. The tunnel walls were considered adiabatic and the model used ambient conditions at the portals. The 1D model was defined using the novel HVAC component of FDS6 as two ducts connected to the FDS domain and to the ambient by two nodes each. The ducts had a cross sectional area equal to the one of the tunnel in the 3D domain. A fixed flow was specified in the tunnel to induce the flow given by the jet fans. The ventilation system consisted of 5 jet fan pairs in each duct, but only the jet fans from one side were activated simultaneously. The main fire scenario involved a 30MW fire, as this exemplifies the peak release rate of a burning bus.

DISCUSSION
The results obtained using FDS showed good agreement with the ones obtained in the reference work by Colella et al [5]. While the multiple meshes introduced an error of approx. 10°C and velocity errors of less than 0.5m/s, the results showed deviation of less than 5% from the results obtained using a full CFD solution in the reference work. Figure 2 presents averaged temperature results in the 3D model from the simulation involving the main scenario. The durations of the simulations were significantly reduced using the multiscale model with a cell size of 0.4m, with one simulation requiring around 6h to complete on an 18-core computer using multiple meshes.

CONCLUSION
Using the results of the reference work as validation, it was concluded that it is feasible to use multiscale modeling of tunnel fires in FDS6. This method provides a significant reduction in run time and computational resources, while maintaining an accuracy similar to the one given by using a full CFD solution.

An experimental investigation on self-acceleration of cellular spherical flames
The cells that continuously develop over the flame surface of an expanding spherical flame increase its area and thereby the global propagation rate, resulting in the possibility of self-acceleration. The present study examines whether this self-acceleration could be self-similar, and, if so, whether it could also be self-turbulizing. Extensive experiments at elevated pressures and thereby reduced laminar flame thicknesses and enhanced propensity to exhibit Darrieus-Landau instability were conducted for hydrogen/air mixtures over an extensive range of equivalence ratios. The results demonstrate the strong possibility of self-similar flame acceleration, weak influence of the system pressure and diffusional-thermal instability, and a corresponding moderate spread in the power-law acceleration exponent.
Development of Large-Scale Spacecraft Fire Safety Experiments

The status is presented of a spacecraft fire safety research project that is being developed to reduce the uncertainty and risk in the design of spacecraft fire safety systems by testing at nearly full scale in low-gravity. Future crewed missions are expected to be longer in duration than previous exploration missions outside of low-earth orbit and accordingly, more complex in terms of operations, logistics, and safety. This will increase the challenge of ensuring a fire-safe environment for the crew throughout the mission. Based on our fundamental uncertainty of the behavior of fires in low-gravity, the need for realistic scale testing at reduced gravity has been demonstrated. To address this knowledge gap, the NASA Advanced...
Exploration Systems Program Office in the Human Exploration and Operations Mission Directorate has established a project with the goal of substantially advancing our understanding of the spacecraft fire safety risk. The activity of this project is supported by an international topical team of fire experts from other space agencies who conduct research that is integrated into the overall experiment design. The large-scale space flight experiment will be conducted in an Orbital Sciences Corporation Cygnus vehicle after it has debarthed from the ISS. Although the experiment will need to meet rigorous safety requirements to ensure the carrier vehicle does not sustain damage, the absence of a crew removes the need for strict containment of combustion products. The tests will be fully automated with the data downlinked at the conclusion of the test before the Cygnus vehicle reenters the atmosphere. Several computer modeling and ground-based experiment efforts will complement the flight experiment effort. The international topical team is collaborating with the NASA team in the definition of the experiment requirements and performing supporting analysis, experimentation and technology development. The status of the overall experiment and the associated international technology development efforts are summarized.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, NASA Glenn Research Center, University of California at Berkeley, Case Western Reserve University, University of Queensland, Universite Pierre et Marie Curie, University of Bremen, Lomonosov Moscow State University, Hokkaido University, University of Edinburgh, Belisama R&D, European Space Agency - ESA
Number of pages: 12
Publication date: 2013

Host publication information
Title of host publication: Proceedings of the 43rd International Conference on Environmental Systems
Electronic versions: ICES 2013 Ruff.pdf

Bibliographical note
AIAA 2013-3410
Source: dtu
Source-ID: u::8346
Research output: Research - peer-review › Article in proceedings – Annual report year: 2013

Element size and other restrictions in finite-element modeling of reinforced concrete at elevated temperatures
One of the accepted approaches for postpeak finite-element modeling of RC comprises combining plain concrete, reinforcement, and interaction behaviors. In these, the postpeak strain-softening behavior of plain concrete is incorporated by the use of fracture energy concepts. This study attempts to extend this approach for RC at elevated temperatures. Prior to the extension, the approach is investigated for associated modeling issues and a set of limits of application are formulated. The available models of the behavior of plain concrete at elevated temperatures were used to derive inherent fracture energy variation with temperature. It is found that the currently used tensile elevated temperature model assumes that the fracture energy decays with temperature. The existing models in compression also show significant decay of fracture energy at higher temperatures (>400°) and a considerable variation in values. Application of the evaluated fracture energy values shows that these impose severe element size and reinforcement ratio limits. The effect of the limits is illustrated for a RC specimen. © 2013 American Society of Civil Engineers.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, University of Edinburgh
Contributors: Carstensen, J. V., Jomaas, G., Pankaj, P.
Pages: 1325-1333
Publication date: 2013
Peer-reviewed: Yes

Publication information
Journal: Journal of Engineering Mechanics
Volume: 139
Issue number: 10
ISSN (Print): 0733-9399
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Keywords: Concrete beams and girders, Concretes, Constitutive models, Crack initiation, Finite element method, Reinforced concrete, Reinforcement, Fracture energy

DOI: 10.1061/(ASCE)EM.1943-7889.0000578
Source: dtu
Source-ID: n::oai:DTIC-ART:compendex/394972092::36199
Evaluation of the Onset of Flashover in Room Fire Experiments

Two series of full scale room fire tests comprising 16 experiments are used for a study of the onset of flashover. The fire loads were varied and represented seven different commercial applications and two non-combustible linings with significantly different thermal inertia were used. The test results showed that by lowering the thermal inertia and thereby lowering the heat loss from the room and at the same time increasing the thermal feedback, a thermal runaway occurred before significant fire spread; but only for objects composed of a mixture of plastic/rubber/textiles and wood/celluloses. In these cases the onset of thermal runaway was found to occur at room temperatures in the range 300°C to 420°C, supporting that the room temperature at the onset of thermal runaway is strongly dependent on the thermal inertia. It also shows that the onset of thermal runaway cannot in all cases implicitly be predicted by the traditional flashover temperature criterion of 500°C to 600°C. For fire loads composed of pure wood/celluloses the onset of flashover occurred about the same time as fire spread irrespectively of linings and at significantly higher room temperatures (725°C). This can be explained by flammability parameters making wood/celluloses less sensitive to thermal feedback.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, National Research Council of Canada
Contributors: Poulsen, A., Jomaas, G., Bwalya, A.
Number of pages: 15
Publication date: 2013
Peer-reviewed: Yes

Publication information
Journal: Fire Technology
Volume: 49
Issue number: 4
ISSN (Print): 0015-2684
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.51 SJR 0.658 SNIP 1.546
Web of Science (2017): Impact factor 1.483
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.3 SJR 0.66 SNIP 1.396
Web of Science (2016): Impact factor 1.471
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 0.77 SJR 0.455 SNIP 0.825
Web of Science (2015): Impact factor 1.016
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.06 SJR 0.533 SNIP 1.433
Web of Science (2014): Impact factor 1.297
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 1.06 SJR 0.401 SNIP 1.46
Web of Science (2013): Impact factor 1
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 0.83 SJR 0.432 SNIP 1.425
Web of Science (2012): Impact factor 0.695
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Experimental Study on the Influence of Thermal Feedback on the Burning Behavior of Flexible Polyurethane

A series of experiments were carried out to study the effect of thermal feedback on the flame spread rate and the heat release rate for a horizontally positioned slab of polyurethane under pre-flashover conditions. Two experiments were performed in a slightly modified ISO 9705 Room Corner Test facility with a compartment measuring 2400 mm wide x 2800 mm deep x 2400 mm high. The room had a rectangular vent (opening under a calorimeter hood) measuring 740 mm wide x 1500 mm high that was located in one of the 2400 mm walls. In each of the two experiments, the room was lined with a material that had a different thermal inertia. The third experiment was performed as a free burn under a hood. The experiments showed that the flame spread rate increased in the room experiments as compared with the free burn experiments. Also, the experiments showed that the thermal feedback may increase the heat release rate and lead to flashover conditions, something which may not be predicted based on free burn experiments. Given the profound difference between the results from the different experimental conditions, it is recommended to take detailed room effects, such as thermal feedback, into considerations for the selection of design fires.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, National Research Council of Canada
Contributors: Poulsen, A., Bwalya, A., Jomaas, G.
Number of pages: 6
Pages: 669-674
Publication date: 2013

Host publication information
Title of host publication: Proceedings of the 13th International Interflam Conference
Publisher: Interscience Communications
Source: dtu
Source-ID: u::8374
Research output: Research - peer-review › Article in proceedings – Annual report year: 2013
Experimental Study on the Influence of Thermal Feedback on the Burning Behavior of Flexible Polyurethane

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, National Research Council of Canada
Contributors: Poulsen, A., Bwalya, A., Jomaas, G.
Number of pages: 6
Publication date: 2013
Peer-reviewed: Yes
Event: Poster session presented at Interflam 2013, Nr Windsor, United Kingdom.
Electronic versions:
prod1137646873547.Experimental_Study_on_the_Influence_of_Thermal_Feedback_vers3_1.pdf
Research output: Research - peer-review › Poster – Annual report year: 2013

Unmanned Vehicle Material Flammability Test

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design, NASA Glenn Research Center, University of California at Berkeley, University of Queensland, University of Edinburgh, Belisama R&D, European Space Agency - ESA, Universite Pierre et Marie Curie, University of Bremen, Lomonosov Moscow State University, Hokkaido University, Case Western Reserve University
Number of pages: 1
Publication date: 2013
Peer-reviewed: Yes
Event: Poster session presented at 8th US National Combustion Meeting, Park City, United States.
Electronic versions:
prod11396357920449.SFS_Demo_National_Meeting_Poster_2013_final.pdf
Source: dtu
Source-ID: u::10980
Research output: Research - peer-review › Poster – Annual report year: 2014

Experimental Study of the Effects of Flame Retardants Applied to Chipboard

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Design
Contributors: Leisted, R. R., Bengtsson, H., Jomaas, G.
Number of pages: 1
Publication date: 2012
Peer-reviewed: Yes
Electronic versions:
Research output: Research - peer-review › Conference abstract for conference – Annual report year: 2012

Fire Models and Design Fires: An Experimental Investigation on the Influence of Thermal Feedback on Pre-Flashover Fires
The aim of this project is to perform an experimental study on the influence of the thermal feedback on the burning behavior of well ventilated pre-flashover fires. For the purpose an experimental method has been developed. Here the same identical objects are tested under free burn conditions and in two different rooms, which only are varied by linings of significantly different thermal inertia. As all linings were non-combustible the heat release rate could be found without the influence of thermal feedback and for two different levels of thermal feedback. The ISO 9705 Room Corner Test facility was chosen as the same measuring equipment could be used for all the tests. Using this method, 10 experiments were performed with three different sizes of heptane pools and three experiments were carried out with a block of flexible polyurethane foam. In addition to these 13 experiments, 16 experiments carried out by Carleton University and NRC-IRC performed on seven different types of fire loads representing commercial premises, comprise the tests used for the study. The results show that for some of the room test the heat release rate increased due to thermal feedback compared to free burn for a pre-flashover fire. Two phenomena were observed, that relate well to theory was found. In an incipient phase the heat release rate rose with the temperature of the smoke layer/enclosure boundaries. This increase was also found to depend on the flammability properties of the burning object. The results also documented a simple relation that can be used for estimating the impact of thermal feedback for pre-flashover design fires.
A rapid increase of the heat release rate commenced after the incipient phase. This is seen as thermal runaway caused by the energy gain in the smoke layer exceeding the energy that can be lost through the boundaries. The increase of the heat release rate after the onset of thermal feedback did not seem to be dominated by either temperature of the smoke layer/enclosure boundaries or the type of materials of the burning object. The onset point of thermal runaway was found to depend on the thermal inertia of the linings as well as the flammability parameters of the burning object. This correlates well with theory. At the onset point of thermal runaway the smoke layer temperature was found to be as low as 300°C for linings with very low thermal inertia, which makes the onset point significantly below the traditional flashover criterion for the smoke layer of 5-600°C. This indicates that caution should be used when using this criterion for rooms with very low thermal inertia.

Given the profound difference between room burn conditions and free burn, the results show that free burn results should also be used with caution for prediction of pre-flashover design fires in rooms.

**General information**

State: Published  
Organisations: Department of Civil Engineering, Section for Building Design  
Contributors: Poulsen, A., Hertz, K. D., Jomaas, G.  
Number of pages: 179  
Publication date: 2012

**Publication information**

Place of publication: Kgs. Lyngby  
Publisher: Technical University of Denmark (DTU)  
Original language: English  
Electronic versions:  
Annemarie_Poulsen_s_PhD.pdf  

**Large Scale Experiments on Spacecraft Fire Safety**

Full scale fire testing complemented by computer modelling has provided significant knowhow about the risk, prevention and suppression of fire in terrestrial systems (cars, ships, planes, buildings, mines, and tunnels). In comparison, no such testing has been carried out for manned spacecraft due to the complexity, cost and risk associated with operating a long duration fire safety experiment of a relevant size in microgravity. Therefore, there is currently a gap in knowledge of fire behaviour in spacecraft. The entire body of low-gravity fire research has either been conducted in short duration ground-based microgravity facilities or has been limited to very small fuel samples. Still, the work conducted to date has shown that fire behaviour in low-gravity is very different from that in normal-gravity, with differences observed for flammability limits, ignition delay, flame spread behaviour, flame colour and flame structure. As a result, the prediction of the behaviour of fires in reduced gravity is at present not validated. To address this gap in knowledge, a collaborative international project, Spacecraft Fire Safety, has been established with its cornerstone being the development of an experiment (Fire Safety 1) to be conducted on an ISS resupply vehicle, such as the Automated Transfer Vehicle (ATV) or Orbital Cygnus after it leaves the ISS and before it enters the atmosphere. A computer modelling effort will complement the experimental effort. Although the experiment will need to meet rigorous safety requirements to ensure the carrier vehicle does not sustain damage, the absence of a crew removes the need for strict containment of combustion products. This will facilitate the possibility of examining fire behaviour on a scale that is relevant to spacecraft fire safety and will provide unique data for fire model validation. This unprecedented opportunity will expand the understanding of the fundamentals of fire behaviour in spacecraft. The experiment is being developed by an international topical team that is collaboratively defining the experiment requirements and performing supporting analysis, experimentation and technology development. This paper presents the objectives, status and concept of this project.

**General information**

State: Published  
Organisations: Department of Civil Engineering, Section for Building Design, NASA Glenn Research Center, European Space Agency - ESA, University of California at Berkeley, Case Western Reserve University, University of Edinburgh, Universite Pierre et Marie Curie, University of Bremen, Lomonosov Moscow State University, Hokkaido University, Belisama R&D  
Number of pages: 6  
Publication date: 2012

**Host publication information**

Title of host publication: Proceedings of the 63rd International Astronautical Congress  
Publisher: International Astronautical Federation  
ISBN (Print): 978-1-62276-979-7  
URLs:  
Microgravity Flammability Experiments for Spacecraft Fire Safety

As fire behaviour in manned spacecraft still remains poorly understood, an international topical team has been created to design a validation experiment that has an unprecedented large scale for a microgravity flammability experiment. While the validation experiment is being designed for a re-supply vehicle like the ATV or Orbital’s Cygnus, a series of supporting experiments are being planned and conducted by the team members. In order to answer the appropriate scientific and engineering problems relevant for spacecraft fire safety, a canonical scenario that can improve the understanding of flame spread, and thus also the modeling thereof, in realistic conditions is described. Some of the parameters governing the flame spread are also identified and their scaling against the dimensions of the test specimen is briefly questioned. Then several of the current and scheduled efforts are presented in terms of their relevance for the flame spread problem. Further, it is explained how the results can be combined to enhance the understanding of fire spread in the real scale configuration and thus improve the fire safety onboard spacecrafts. The results and particularly the ones from the large scale validation experiment are crucial to the ultimate goal of the project, which is the development of predictive tools that should be capable of selecting an adaptive response to fire spread in any manned spacecraft.
Comparative Evaluation of Prescriptive, Performance-Based and Risk-Based Fire Safety in an Office Building

General information
State: Published
Organisations: Section for Building Design, Department of Civil Engineering, NIRAS A/S
Contributors: Hede, M., Valkvist, M., Steffensen, F., Jomaas, G.
Publication date: 2011
Peer-reviewed: No
Event: Poster session presented at 10th International Symposium on Fire Safety Science, Maryland, United States.
Electronic versions: Comparative Evaluation of Prescriptive.pdf
Source: orbit
Source-ID: 316463
Research output: Research › Poster – Annual report year: 2011

Describing Function Analysis of Limit Cycles in a Multiple Flame Combustor

General information
State: Published
Organisations: Centre National de la Recherche Scientifique
Contributors: Boudy, F., Durox, D., Schuller, T., Jomaas, G., Candel, S.
Publication date: 2011
Peer-reviewed: Yes

Publication information
Journal: Journal of Engineering for Gas Turbines and Power
Volume: 133
Issue number: 6
ISSN (Print): 0742-4795
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.15 SJR 0.686 SNIP 1.318
Web of Science (2017): Impact factor 1.74
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.66 SJR 0.575 SNIP 1.161
Web of Science (2016): Impact factor 1.534
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.55 SJR 0.933 SNIP 1.488
Web of Science (2015): Impact factor 1.022
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.45 SJR 0.687 SNIP 1.576
Web of Science (2014): Impact factor 0.804
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 1.33 SJR 0.762 SNIP 1.502
Experimental Study on the Burning Behavior of Pool Fires in Rooms with Different Wall Linings

An experimental test series, comprising 10 experiments with varying pool sizes, lining materials and amounts of liquid burning, was conducted under free burn and room burn conditions. The thermal feedback from the enclosure (ISO 9705 Room Corner Test facility) enhanced the burning rate of the pools and resulted in a thermal runaway in some of the runs. The onset of the thermal runaway, which can be associated with flashover, varied with all the input parameters. The lining with the lowest thermal inertia lead to the fastest increase in the heat release rate (HRR) in the enclosure and caused flashover in the shortest time. Given the profound difference between the enclosure tests and the free burn tests and also between enclosure tests with different linings, it is recommended to show great caution if free burn tests are to be used in design fire scenarios.

General information
State: Published
Organisations: Section for Building Design, Department of Civil Engineering
Contributors: Poulsen, A., Jomaas, G.
Pages: 419-439
Experimental study on the role of thermal feedback from different wall linings in a room fire

General information
State: Published
Organisations: Section for Building Design, Department of Civil Engineering
Contributors: Poulsen, A., Jomaas, G.
Publication date: 2011
Peer-reviewed: No
Event: Poster session presented at 10th International Symposium on Fire Safety Science, Maryland, United States.
Electronic versions:
Poster IAFSS_1055_111_AMP_GRUJO.pdf
Source: orbit
Source-ID: 278433
Research output: Research › Poster – Annual report year: 2011

Material Modelling of the Post-Peak Response of Reinforced Concrete at Elevated Temperatures

General information
State: Published
Organisations: Section for Building Design, Department of Civil Engineering, University of Edinburgh
Contributors: Carstensen, J. V., Pankaj, P., Jomaas, G.
Publication date: 2011
Peer-reviewed: No
Event: Poster session presented at 10th International Symposium on Fire Safety Science, Maryland, United States.
Electronic versions:
carstensen_poster.pdf
URLs:
http://www.iafss.org/html/Maryland/marylandhome.htm
Source: orbit
Source-ID: 278510
Research output: Research › Poster – Annual report year: 2011

On Self-Acceleration of Cellular Spherical Flames
An expanding spherical flame is hydrodynamically unstable in the flame-sheet limit, attained either as the flame reaches a sufficiently large dimension as compared to the flame thickness, and/or when it propagates in a high-pressure environment such that its thickness is correspondingly reduced. The cells that continuously develop over the flame surface increase its area and thereby the global propagation rate, resulting in the possibility of self-acceleration. The present study examines whether this self-acceleration could be self-similar, and if so whether it could also be self-turbulizing. A critical appraisal of the experimental and computational results in the literature on these issues was performed, and experiments were conducted for hydrogen/air mixtures over an extensive range of elevated pressures. Results demonstrate the strong possibility of self-similar flame acceleration, moderate influences of diffusionalthermal instability and of the system pressure, and a corresponding moderate spread in the power-law acceleration exponent.

General information
State: Published
Organisations: Princeton University
Contributors: Wu, F., Jomaas, G., Law, C. K.
Publication date: 2011
Spacecraft performance analysis for extreme events by integration and combination of sensing, modelling and optimisation: SAFE-COSMOS

To supersede the current state-of-the-art of fire safety in spacecrafts, ESA has commissioned a topical team to define an unprecedented series of demonstration and validation experiments. This initiative aims to move fire safety away from test standards and into a truly scientific selection of both passive and active fire protection strategies. Material selection based on intrinsic material properties and performance will revolutionise traditional passive fire protection strategies that currently rely on pass/fail test methodologies. Active fire protection strategies will be generated by computational models, calibrated to recreate the unfolding emergency scenario using live streams of sensor data. The research roadmap of extensive microgravity testing programme and model development necessary to achieve these goals is presented.

Describing function analysis of limit cycle in a multiple flame combustor

Observation and regime classification of pulsation patterns in expanding spherical flames
Critical radius for sustained propagation of spark-ignited spherical flames

General information
State: Published
Organisations: Princeton University
Contributors: Kelley, A. P., Jomaas, G., Law, C. K.
Pages: 1006-1013
Publication date: 2009
Peer-reviewed: Yes

Publication information
Journal: Combustion and Flame
Volume: 156
Issue number: 5
ISSN (Print): 0010-2180
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 5.27 SJR 2.427 SNIP 2.176
Web of Science (2017): Impact factor 4.494
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 4.41 SJR 1.117 SNIP 2.184
Web of Science (2016): Impact factor 3.663
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.12 SJR 2.807 SNIP 2.379
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 3.78 SJR 1.335 SNIP 2.34
Web of Science (2014): Impact factor 3.082
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 4.85 SJR 2.722 SNIP 2.572
Web of Science (2013): Impact factor 3.708
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 4.12 SJR 1.361 SNIP 2.797
Web of Science (2012): Impact factor 3.599
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
Nonlinear analysis of combustion instabilities in a confined multipoint injection configuration

General information
State: Published
Organisations: Section for Building Design, Department of Civil Engineering
Contributors: Jomaas, G.
Publication date: 2009
Peer-reviewed: No
Event: Abstract from 1st Joint Meeting of the Scandinavian-Nordic and French Sections of the Combustion Institute, Snekkersten, Denmark.
Electronic versions:
Boudy_Jomaas_Durox_Schuller_Candel_Copenhagen.pdf
Source: orbit
Source-ID: 250666
Research output: Research › Journal article – Annual report year: 2009

High-pressure laminar flame speeds and kinetic modeling of carbon monoxide/hydrogen combustion

General information
State: Published
Organisations: Princeton University
On transition to cellularity in expanding spherical flames

General information
State: Published
Organisations: Princeton University, New Jersey Institute of Technology
Contributors: Jomaas, G., Law, C., Bechtold, J.
Publication date: 2007
Peer-reviewed: Yes

Publication information
Journal: Journal of Fluid Mechanics
Volume: 583
ISSN (Print): 0022-1120
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.33 SJR 1.591 SNIP 1.702
Web of Science (2017): Impact factor 2.893
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.82 SJR 1.744 SNIP 1.671
Web of Science (2016): Impact factor 2.821
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 2.57 SJR 1.896 SNIP 1.639
Web of Science (2015): Impact factor 2.514
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 2.66 SJR 1.864 SNIP 1.805
Web of Science (2014): Impact factor 2.383
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 2.71 SJR 1.853 SNIP 1.88
Web of Science (2013): Impact factor 2.294
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Spiral waves in expanding hydrogen-air flames: Experiment and theory

General information
State: Published
Organisations: New Jersey Institute of Technology, Princeton University
Contributors: Jomaas, G., Bechtold, J., Law, C.
Pages: 1039-1046
Publication date: 2007
Peer-reviewed: Yes

Publication information
Journal: Proceedings of the Combustion Institute
Volume: 31
Spiral Waves Over Propagating Hydrogen-Air Flames

General information
State: Published
Organisations: Section for Building Design, Department of Civil Engineering
Contributors: Jomaas, G.
Publication date: 2007
Peer-reviewed: No
Source-ID: 249729
Research output: Research » Poster – Annual report year: 2007

Cellular instabilities of expanding hydrogen/propane spherical flames at elevated pressures: Theory and experiment

General information
State: Published
Organisations: Princeton University, New Jersey Institute of Technology
Contributors: Law, C., Jomaas, G., Bechtold, J.
Pages: 159-167
Publication date: 2005
Peer-reviewed: Yes

Publication information
Journal: Proceedings of the Combustion Institute
Volume: 30
Issue number: 1
ISSN (Print): 1540-7489
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 5.63 SJR 2.588 SNIP 2.956
Web of Science (2017): Impact factor 5.336
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.63 SJR 0.923 SNIP 2.676
Web of Science (2016): Impact factor 3.214
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 4.53 SJR 2.515 SNIP 2.647
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 3.18 SJR 1.064 SNIP 2.974
Web of Science (2014): Impact factor 2.262
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 4.39 SJR 2.374 SNIP 3.456
Experimental determination of counterflow ignition temperatures and laminar flame speeds of C2-C3 hydrocarbons at atmospheric and elevated pressures

General information
State: Published
Organisations: Princeton University
Pages: 193-200
Publication date: 2005
Peer-reviewed: Yes

Publication information
Journal: Proceedings of the Combustion Institute
Volume: 30
Issue number: 1
ISSN (Print): 1540-7489
Ratings:
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<td>2009</td>
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<td>2008</td>
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<td>Indexed yes</td>
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<td>2006</td>
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<td>2003</td>
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<td>2002</td>
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<td>1999</td>
<td>1</td>
<td>Indexed yes</td>
<td>SJR 0.544 SNIP 1.334</td>
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Effect of Smoke Source and Horn Configuration on Enhanced Deposition, Acoustic Agglomeration, and Chladni Figures in Smoke Detectors

General information
State: Published
Pages: 309-346
Publication date: 2003
Peer-reviewed: Yes

Publication information
Journal: Fire Technology
Volume: 39
Issue number: 4
ISSN (Print): 0015-2684
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.51 SJR 0.658 SNIP 1.546
Web of Science (2017): Impact factor 1.483
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.3 SJR 0.66 SNIP 1.396
Web of Science (2016): Impact factor 1.471
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 0.77 SJR 0.455 SNIP 0.825
Web of Science (2015): Impact factor 1.016
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.06 SJR 0.533 SNIP 1.433
Web of Science (2014): Impact factor 1.297
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 1.06 SJR 0.401 SNIP 1.46
Web of Science (2013): Impact factor 1
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 0.83 SJR 0.432 SNIP 1.425
Web of Science (2012): Impact factor 0.695
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 0.52 SJR 0.216 SNIP 0.56
Web of Science (2011): Impact factor 0.426
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
A STUDY OF THE MECHANISMS LEADING TO RE-IGNITION IN A "WORST CASE" FIRE SCENARIO

General information
State: Published
Organisations: Section for Building Design, Department of Civil Engineering
Contributors: Jomaas, G.
Publication date: 2000

Publication information
Original language: English
URLs:
http://www.era.lib.ed.ac.uk/bitstream/1842/2153/1/Jomaas%20et%20al%202001.pdf
Source: orbit
Source-ID: 250691
Research output: Research - Report – Annual report year: 2000

Flow Parameters Controlling a Diffusion Flame Established behind a Backward Facing Step

General information
State: Published
Organisations: Unknown
Contributors: Jomaas, G.
Publication date: 2000

Host publication information
Title of host publication: Proceedings of the 34th ASME National Heat Transfer Conference
Source: orbit
Source-ID: 250671
Research output: Research - peer-review › Article in proceedings – Annual report year: 2000

Projects:
Fire Performance of Assemblies Incorporating Insulation Products
Leisted, R. R., PhD Student, Department of Civil Engineering
Jomaas, G., Main Supervisor, Department of Civil Engineering
Torero, J. L., Supervisor
Sørensen, L. S., Examiner, Department of Civil Engineering
Hadden, R. M., Examiner
Hees, P. V., Examiner
Hadden, R. M., Examiner
Hees, P. V., Examiner
Samfinansierede - Virksomhed
01/10/2014 → 06/09/2018
Award relations: Fire Performance of Assemblies Incorporating Insulation Products
Project: PhD

In-Situ Burning of Crude Oils under arctic Conditions
van Gelderen, L., PhD Student, Department of Civil Engineering
Jomaas, G., Main Supervisor, Department of Civil Engineering
Fritt-Rasmussen, J., Supervisor, Department of Civil Engineering
Rangwala, A., Supervisor
Kirkelund, G. M., Examiner, Department of Civil Engineering
Brandvik, P. J., Examiner
Torero, J. L., Examiner
Institut stipendie (DTU)
01/01/2014 → 20/04/2017
Award relations: In-Situ Burning of Crude Oils under arctic Conditions
Project: PhD

Fire Models and design Fires
Poulsen, A., PhD Student, Department of Civil Engineering
Hertz, K. D., Main Supervisor, Department of Civil Engineering
Jomaas, G., Supervisor, Department of Civil Engineering
Munk, K., Supervisor
Karlsson, B., Examiner
Bontempi, F., Examiner
Institut stipendie (DTU) Samf.
01/03/2008 → 24/08/2012
Award relations: Fire Models and design Fires
Project: PhD

FP1404: Cost actionFP1404 - Fire safe use of bio-based building products
Markert, F., Project Participant, Department of Management Engineering, Production and Service Management, Risk Research Group, Implementation and Performance Management
Jomaas, G., Project Participant, Department of Civil Engineering, Section for Building Design
05/12/2014 → 04/12/2018
Project: Research

Intumescent Paint: Experimental and Numerical Study of the Thermal Resistance of Intumescent Coatings
Funded by COWI Fonden
Giuliani, L., Project Coordinator, Department of Civil Engineering, Section for Building Design
Jomaas, G., Project Participant, Department of Civil Engineering, Section for Building Design
01/01/2014 → 30/04/2015
Keywords: Intumescent paint, Fire test, Thermal resistance
Project: Research

Activities:

Fire Safety in Space—Beyond Flammability Testing of Small Samples
Period: 28 Jul 2014
Grunde Jomaas (Invited speaker)
Department of Civil Engineering
Section for Building Design

Description
Plenary Lecture at Conference
Documents:
Jomaas_StPetersburg_July_28_2014
космич_конф_2014
Links:
http://sfs-2014.ru/structure/

Related event
International Symposium on Space Flight Safety
28/07/2014 → 31/07/2014
St. Petersburg, Russian Federation
Activity: Talks and presentations › Conference presentations

Design Fires and Flashover in Modern Building Design
Period: 12 Apr 2012
Grunde Jomaas (Lecturer)
Department of Civil Engineering
Section for Building Design

Description
Invited lecture/presentation at Johns Hopkins University.
Links:

Related external organisation
Unknown external organisation
Activity: Talks and presentations › Conference presentations

Automated Transfer Vehicle Material Flammability Experiment
Period: 9 Jan 2012 → 12 Jan 2012
Grunde Jomaas (Speaker)
Department of Civil Engineering
Section for Building Design

Description
Note: Invited talk
Place: 50th AIAA Aerospace Sciences Meeting and Exhibit, Nashville Tennessee
Documents:
prod21326926620553.AIAA.pdf

Related external organisation
Unknown external organisation
Activity: Talks and presentations › Conference presentations

Propagation and Stability of Spherical Flames – Experimental Observations
Period: 9 Dec 2009
Grunde Jomaas (Speaker)
Department of Civil Engineering
Section for Building Design

Description
Place: Haldor Topsøe
Related external organisation

Unknown external organisation
Activity: Talks and presentations › Conference presentations

12th CECOST Seminar 2009
Period: 8 Dec 2009
Grunde Jomaas (Participant)
Department of Civil Engineering
Section for Building Design
Links:

Related event

12th CECOST Seminar 2009
08/12/2009 → 08/12/2009
Activity: Attending an event › Participating in or organising a conference

1st Joint Meeting of the Scandinavian-Nordic and French Sections of the Combustion Institute
Period: 9 Nov 2009 → 10 Nov 2009
Grunde Jomaas (Participant)
Department of Civil Engineering
Section for Building Design

Related event

1st Joint Meeting of the Scandinavian-Nordic and French Sections of the Combustion Institute
Snekkersten, Denmark
Activity: Attending an event › Participating in or organising a conference

The 2009 Society of Fire Protection Engineers (SFPE) Annual Meeting, Professional Development Conference and Exposition
Grunde Jomaas (Participant)
Department of Civil Engineering
Section for Building Design
Links:

Related event

The 2009 Society of Fire Protection Engineers (SFPE) Annual Meeting, Professional Development Conference and Exposition
18/10/2009 → 23/10/2009
Scottsdale, Arizona, USA
Activity: Attending an event › Participating in or organising a conference

Experimental Observations of Propagation and Stability of Spherical Flames
Period: 26 Aug 2009
Grunde Jomaas (Speaker)
Department of Civil Engineering
Section for Building Design

Description
Place: University of Edinburgh
Related external organisation

Unknown external organisation
Activity: Talks and presentations › Conference presentations

Press clippings:

Fire Experiments with Sandwich Panels
Grunde Jomaas
01/01/2014
Department of Civil Engineering, Section for Building Design

Media contribution (1)

Fire Experiments with Sandwich Panels
01/01/2014
Print
Grunde Jomaas
Department of Civil Engineering, Section for Building Design
Press/Media: Press / Media

Brandsikkerhed ved brug af flammehæmmere
Grunde Jomaas
01/01/2012
Department of Civil Engineering, Section for Building Design

Media contribution (1)

Brandsikkerhed ved brug af flammehæmmere
01/01/2012
Print
Grunde Jomaas
Department of Civil Engineering, Section for Building Design
Press/Media: Press / Media