Parametric analysis of the operation of nocturnal radiative cooling panels coupled with in room PCM ceiling panels - DTU Orbit (14/12/2018)

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

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