Impact of thermally activated furniture system on the occupant thermal comfort – A study using thermoregulation model and computational fluid dynamics

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Abstract

Air-conditioned buildings are conventionally designed and operated to maintain homogeneous thermal conditions. Maintaining the occupied and unoccupied zones at the same thermal conditions leads to higher energy consumption. More importantly, homogeneous thermal conditions do not address the need for individual thermal comfort preferences. A personal comfort system (PCS) allows the occupants to create desired localized thermal conditions around workstations in the office environment. Using computational fluid dynamic (CFD) and multi-node thermoregulation models, this paper evaluates the feasibility of a PCS with a radiantly cooled partition panel system to achieve thermal comfort. All input parameters for the model were derived from real-life measurements, including thermal characteristics of the room, work desk with radiantly cooled partition, and HVAC systems. A combination of scSTREAM™ and scTETRA™ was used to model the room and the human body (Cradle MSC Software, 2017). The simulation model had a mannequin in a seated position having summer clothing values and office activity metabolic rate. Combinations of three ambient room air temperatures and five panel surface temperatures were investigated to estimate the impact of radiant panels on overall thermal comfort and various body parts of the mannequin. The body parts like the thighs, chest, back, and pelvis showed a low thermal variation in the range of 0.9-1.2°C. The parts such as the head, neck, shoulders, arms, and legs showed a thermal variation in the range of 1.6-2.7°C, while the body parts farthest from the warm torso-the feet, experienced the highest variation in the range of 4.4-4.5°C. It was observed that the back side of the body was distinctly warmer than the front side of the body throughout the studied cases due to the action of front-placed radiant panels. It also indicates that at a given room air temperature with an increase in the difference between surface and air temperature, from 0°C to 8°C, all the body parts experience a reduction in the body part surface temperature. Introduction:

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