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Impact Of The Heat Transfer Method And The Placement Of Personal Comfort Systems (PCS) On Comfort Temperature Improvement For Achieving Maximum Energy Efficiency

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Abstract : Buildings use 40% of the world's energy and HVAC systems contribute to approximately half of this. However, these systems alone satisfy only about 80% of occupants. Personal Comfort Systems (PCS), which provide targeted heating or cooling to specific body parts, have emerged as a promising solution to enhance occupant comfort while potentially reducing energy use by 4–60%. This study investigates the impact of heat transfer methods (thermal conduction, convection, and radiation) and the placement of the PCS on comfort temperature improvement and their energy performance in both heating and cooling modes. It addresses a critical gap in understanding optimal PCS configurations and heat transfer mechanisms to achieve thermal comfort and energy efficiency. A meta-analysis was conducted, extracting data from previous research to evaluate the effects of PCS on thermal sensation votes (TSV) and comfort temperatures. The Griffiths equation was used to calculate comfort temperatures (Tc) under the conditions with and without PCS, and relevant distances of the PCS to subjects and power values were analyzed. At 9–20°C ambient temperatures, PCS increased Tc by 0.9–2.8°C in heating mode and by 1–1.6°C in cooling mode at 25–32°C ambient temperatures. According to the regression analysis, PCS could modify Tc by 0.4–2.8°C in heating mode and 0.6–2°C in cooling mode, enabling broader ambient temperature setpoints while maintaining comfort. This adjustment could result in up to 20% energy savings. The efficiencies of PCS were evaluated, revealing a corrective power efficiency range of 1.8–80.2 W/°C. Convection was found to be the most effective heat transfer method, and PCS placement at minimal distances achieved the highest effectiveness. As the distance increased, the corrective power decreased. PCS were shown to have significantly lower power consumption compared to traditional HVAC systems, making them an efficient alternative for achieving thermal neutrality. The findings underscore the potential of carefully selecting PCS types and optimizing their placement to improve thermal comfort and achieve substantial energy savings in buildings.

Keywords : comfort temperature, energy savings, personal comfort systems, thermal comfort
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