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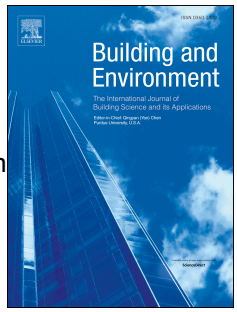

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Quantifying the cooling efficiency of air velocity by heat loss from skin surface in warm and hot environments

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Abstract

In warm and hot environments, the possibility of increasing air velocity reduces energy consumption without compromising occupants' thermal comfort; whereas the cooling efficiency pertains to the temperature limits. To address the coupling effect of air velocity and temperature on thermal comfort and evaluate the cooling efficiency objectively, 9 experimental conditions with side air supply (piston flow) were conducted in a well-controlled climate chamber, covering temperatures from warm (28 ^{o}C) to hot (34 ^{o}C). Both skin temperatures and questionnaires were measured on 20 subjects. The results showed the cooling efficiency by airflow was significantly affected by temperatures. Subjects' mean skin temperatures(MST) and thermal sensations (TSV) were improved by increasing air velocities when temperature was lower than or equal to 32 ^{o}C, but no significant differences were found between different air velocities at each temperature level (except for MST at 28 ^{o}C). The air velocity failed to modify subjects' thermal responses but caused negative thermal and pressure due to higher air temperature and airflow at 34 ^{o}C. Thanks to the uniform air movement, subjects' total heat loss from skin surface(Q_{skin}) was quantified that significantly reduced from 46.98W/m^2 at 28 ^{o}C/0m/s, to 31.45W/m^2 at 34 ^{o}C/1.4m/s, indicating the poor cooling efficiency of air velocity in hot environments. The relation between air velocity and temperature with a prerequisite of neutral thermal sensation was obtained based on Q_{skin}, which can reserve as a reference for air velocity design in warm and hot environments considering thermal comfort, cooling efficiency and energy savings.

Keywords

Warm and hot environments, Air velocity, Thermal responses, Skin heat loss, Cooling efficiency