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Experimental study of an intermittent ventilation system in high occupancy spaces

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Abstract

Spaces with high occupancy density like classrooms are challenging to ventilateand use a lot of energy to maintain comfort. Usually, a compromise is made between low energy use and good Indoor Environmental Quality (IEQ), of which poor IEQ has consequences for occupants' health, productivity and comfort. Alternative strategies that incorporate elevated air speeds can reduce cooling energy demand and provide occupant's comfort and productivity at higher operative temperatures. A ventilation strategy, Intermittent Air Jet Strategy (IAJS), which optimizes controlled intermittent airflow and creates non-uniform airflow and non-isothermal conditions, critical for sedentary operations at elevated temperatures, is proposed herein.

The primary aim of the work was to investigate the potential of IAJS as a ventilation system in high occupancy spaces. Ventilation parameters such as air distribution, thermal comfort and indoor air quality are evaluated and the system is compared with a traditional system, specifically, mixing ventilation (MV). A 3-part research process was used: (1) Technical (objective) evaluation of IAJS in-comparison to MV and displacement ventilation (DV) systems. (2) An occupant response study to IAJS. (3) Estimation of the cooling effect under IAJS and its implications on energy use. All studies were conducted in controlled chambers.

The results show that while MV and DV creates steady airflow conditions, IAJS has cyclic airflow profiles which results in a sinusoidal temperature profile around occupants. Air distribution capability of IAJS is similar to MV, both having a generic local air quality index in the occupied zone. On the other hand, the systems overall air change rate was higher than a MV. Thermal comfort results suggest that IAJS generates comfortable thermalclimate at higher operative temperatures compared to MV. Occupant responsesto IAJS show an improved thermal sensation, air quality perception and acceptability of indoor environment at higher temperatures as compared to MV. A comparative study to estimate the cooling effect of IAJS shows that upper HVAC setpoint can be increased from 2.3 – 4.5 oC for a neutral thermal sensation compared to a MV. This implies a substantial energy saving potential on the ventilation system. In general, IAJS showed a potential for use as a ventilation system in classrooms while promising energy savings.

Keywords: Intermittent airflow, Indoor air quality, Perceived air quality, Thermal sensation, thermal comfort, Air movement acceptability, Convective cooling, Cooling effect

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