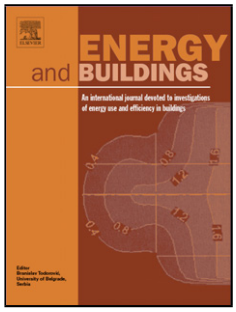

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Coaxial Personalized Ventilation System and Window Performance for Human Thermal Comfort in Asymmetrical Environment

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Performance of ceiling PV system is assessed in presence of radiation asymmetry
- CFD model is validated by experiments using a thermal manikin facing a hot surface.
- Measured and predicted skin and air temperatures around the manikin agreed well
- Different window glazing types were evaluated on perceived thermal comfort with PV
- PV system achieved 36% energy savings over MV for high performance window

Abstract

This paper assesses the energy performance and occupant comfort of a ceiling-mounted coaxial personalized ventilation (PV) system in presence of radiation asymmetry due to a large window for different glazing systems. Detailed 3-D computational fluid dynamics (CFD) simulations were performed to study the flow and thermal fields in the conditioned office space and evaluate longwave and diffuse shortwave radiation effect on the occupant seated directly below the PV nozzle. The CFD model was coupled to a bioheat model to predict the corresponding local and overall thermal comfort of human body parts subject to the asymmetrical environment. The CFD model is validated by conducting experiments in a climatic room equipped with the PV system and using a thermal manikin facing a hot surface. Predicted and measured values of segmental skin and air temperature at the vicinity of the thermal manikin are compared. Good agreement (less than 8% error) was found between the measured and predicted values.

Extensive simulations were performed to evaluate the effect of different types of window glazing on the perceived thermal comfort under various PV operating parameters. For high performance window, the coaxial PV system achieved remarkable energy savings up to 36% when was compared to mixing ventilation (MV) system at the same level of thermal comfort and environmental outdoor conditions.

Keywords: Ceiling personalized ventilation; segmental asymmetric comfort; window performance; energy savings

Nomenclature

CFD	computational fluid dynamics
E	energy transferred (J/kg)
f	body forces (N/m^3)
F_{kj}	surface-to-surface view factor
h_j	enthalpy (J/kg)
HVAC	heating ventilation and air conditioning
IAQ	indoor air quality
K	effective conductivity (J/m·K)
k_{eff}	effective thermal conductivity (W/m·K)