Air distribution in room ventilated by fabric air dispersion system

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ABSTRACT
Several researches about airflow distribution in a room generated by fabric air dispersion system (FADS) were reported, but details about the simulation in computer fluid dynamics (CFD) method were not elaborated. In present work The commercial software FLUENT with standard k – ε turbulence model is applied to predict air distribution in a room ventilated by FADS in penetration mode, where FADS is described with the porous media model based on the modified Forchheimer equation. And more details about the simulation are given. Flow visualization near the region of FADS is conducted using dry-ice as a smoking material. The distribution of indoor air velocity and temperature and draught rating (DR) around the ankle and neck level are predicted. The simulation well matches the corresponding experimental value and results of earlier work. Results showed that air is radially discharged out in the direction perpendicular to the spatial cambered porous fibre in lower velocity, and evenly distributed along its length direction when air is distributed by FADS in penetration mode. The velocity of indoor air is very low, and the vertical air temperature difference is small (less than 2 K), DR around the ankle and neck is immune to supply air flow rate and location, which is less than the comfort limit of ASHRAE Standard 55-2004. In addition, airflow pattern is greatly impacted by the location and strength of heat load.

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Practical implications
The FADS in penetration mode is an effective air ventilation terminal made of polymer, where micro-organisms accumulated are ease to be removed by routine cleanings. As a result, the potential problem of secondary pollution can be effectively avoided. FADS may create a clean, health, and comfort indoor environment with low velocity, uniform temperature and small draught rating, it is an ideal alternative ventilation terminal for some spaces where the airflow quality is highly demanded, such as the surgeon room, food factory, electronic equipment factory, and aircraft cabin.

1. Introduction
Indoor air quality (IAQ) and thermal comfort become the most important characteristics of indoor environment because people spend more than 90% time indoors. Compared to mixing ventilation, other innovative ventilation methods such as personalized ventilation [1], displacement ventilation [2], stratum ventilation [3] are developed recently in order to obtain better IAQ. Among them, the design of ventilation terminal devices is one important issue that will have an impact on airflow pattern, IAQ, and thermal comfort. Many studies have shown that the prediction of air velocity and temperature distribution is highly influenced by the location and type of air diffusers. For instance, Sun et al. [4] studied the air flow characteristics close to the square cone diffuser, they found that the offset and lips of the diffuser work together to determine the discharge air angles. Jiang et al. [5] studied the effect of various diffusers on the indoor air environment or local airflow pattern close to them. Compared with the conventional air diffusers, the fabric air dispersion system (FADS), a special ventilation terminal made of polymer, can not only transmit the air, but also distribute the air into the designed zone. It offers a variety of advantages over the conventional ventilation system [6]. Several researches about the comfort and IAQ using FADS as a ventilation terminal have been conducted. Notably, Nielsen et al. [7] experimentally studied the air distribution in a room generated by a textile terminal (FADS), and compared the results with that of ventilation generated by other air diffusers. They concluded that the system based on FADS was able to generate comfortable velocity and temperature conditions. Computational fluid dynamics (CFD) method has been