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## Experimental Study on the Influence of a Ventilated Window for Indoor Air Quality and Indoor Thermal Environment

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### Abstract

Indoor air quality has attracted more and more attention nowadays. Researches on the atmospheric haze occurred frequently in China show that the ventilated window has a great potential in improving indoor air quality. Experimental study on the effect of indoor air quality, indoor thermal environment and whole energy consumption of the test room, which are all tested under summer conditions. The results show that operating the ventilated window can filter PM<sub>2.5</sub> and reduce the indoor concentration of CO<sub>2</sub>; While outdoor and indoor air PM<sub>2.5</sub> concentration are about 100-300ug/m<sup>3</sup> and 40-130ug/m<sup>3</sup>, respectively, indoor air PM<sub>2.5</sub> concentration will decrease 25% at most in an hour, it is suitable for running ventilated window; While outdoor air PM<sub>2.5</sub> concentration is 300-600ug/m<sup>3</sup> and indoor air PM<sub>2.5</sub> concentration is less than 130ug/m<sup>3</sup>, the indoor air PM<sub>2.5</sub> concentration will increase 90%~128%, so the ventilation window should be shut down; Operating the ventilated window one hour indoor CO<sub>2</sub> concentration is reduced 46% at most, compared with that the ventilated window is shut down; Under summer conditions, operating the ventilated window has little influence on head-foot temperature difference and indoor thermal comfort; When a ventilated window runs 24 hours continuously, its power consumption is very low, and the overall consumption is smaller compared with the ventilated window is closed, and the energy consumption increases by 14% or so. Therefore the appropriate operation methods and time of ventilated windows need to be set to reduce energy consumption.

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### 1. Introduction

The central and eastern regions suffered serious atmospheric haze since 2013 in China, and the PM<sub>2.5</sub> fine particulate matter (particulate matter less than 2.5 microns) (Pui et al. 2014) concentration exceeds standard badly.

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Frequent hazy weather not only affect the urban environment, but also is the health killer (Qian et al. 2008). If the concentration of  $PM_{2.5}$  in the air more than  $100\mu g/m^3$  for a long time, the mortality risk will rise (Chueinta et al. 2008). But the haze of outdoor environment governance could take a long time. Person's life is most spend in indoors, so the indoor environment has a profound influence on people's life and work (Sundell et al. 2008). Although air conditioning system can provide a comfortable working environment, if working and living in it for a long time, people will suffer a lot of pathological reaction, such as sick building syndrome (SBS) (SAEED A. 1993). Traditional residential buildings depend on natural seepage wind or the natural ventilation of opening windows to achieve the exchange of indoor and outdoor air (Shen 2006). But with the increase of construction impermeability, there may be same indoor pollutants cannot be expelled incompletely and achieving good phenomenon of indoor air quality (ASHRAE, 1988). Natural ventilation with a window open, the ventilation rate is not stable. In cold or hot season, it is certainly to lead to heating or cooling energy waste. Especially in the haze and pollution, it is not suitable to open the window and ventilate (Handford et al. 1992). ASHRAE standard requests residential construction should be configured mechanical ventilation system (Wei et al. 2010). The ventilated window is equipped with the mechanical supply and exhaust, without the window open to achieve that discharging the indoor foul air rapidly and supplying the outdoor fresh air into indoor after being purified, which can solve the problem of ventilating for hazy weather and improve the indoor air quality, at the same time effectively improve limitations of the small scope and single function of the exhaust fans, air purifiers and other equipment (Wei et al. 2011).

## 2. Methods

The comprehensive laboratory of building energy is mainly divided into the test room, outdoor environmental chamber, and a new ventilation window three parts (Fig. 1-2). For a Convenient and accurate study , the all walls, floors, ceilings and doors of the test room and outdoor environmental chamber are heat preservation and insulation.

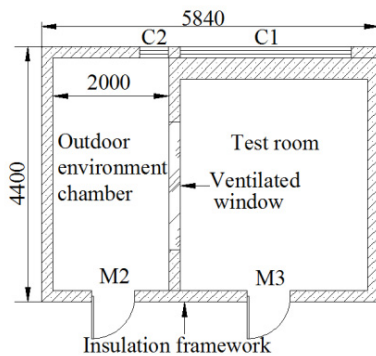


Fig. 1. The laboratory floor plan

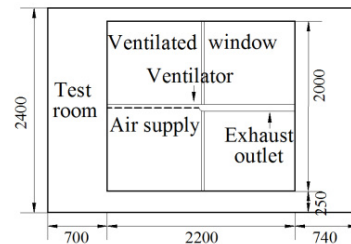


Fig. 2. The elevation of the partition

The ventilated window (Fig.3) is installed in the partition of the test room and outdoor environmental chamber (Fig.2) . Besides the lighting and ventilation of the ordinary window, it also added to the purification for outdoor air and heat exchange with indoor exhaust air through a ventilator that is installed in the window frame and the filter mesh and graphitic layers in the ventilator (Fig.4). According to different ventilation volumes, the operation mode of the ventilated window can be divided into three grades: the low-grade, the mid-grade, and the high-grade, the performance parameters of each mode are shown in table 1.

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