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Experimental study on the influence of ventilated window on indoor air quality and energy consumption

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Abstract

The ventilated window has great potential on improving indoor air quality, but it may increase energy consumption. This paper studies the influence of different running modes of ventilated window on indoor PM2.5 and CO_2 concentration and the overall energy consumption. When indoor PM2.5 concentration was more than 90ug/m^3, and outdoor PM2.5 concentration was less than 300ug/m^3 after ventilated window operating for an hour, indoor PM2.5 concentration decreased for 9-16%, it is appropriate to operating the ventilated window, but it was still 0.18-0.27 times more than the secondary standard. Operating the ventilated window for 55mins on mid-grade and high-grade respectively could reduce the increment of CO_2 concentration for 3.31% and 22.19% than that without ventilated window operating. When the ventilated window operateing on low-grade, the increment of CO_2 concentration was 11.34% larger than that without ventilated window operating. By increasing air volume and operating time of different modes, indoor air quality can be improved. Comparing with the condition with ventilated window off, the maximum energy consumption after ventilated window operating for 24 hours on high-grade was 2.462 $kW \cdot h^{-1}$ (2.054 $kW \cdot h^{-1}$ for air conditioning consumption). Appropriate operating mode and running time can be chosen to reduce energy consumption effectively.

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Keywords: Indoor air quality, Energy consumption; Ventilated window; PM2.5, CO_2;

1. Introduction

There are heavy hazy weathers in mid-eastern China since 2013. The concentration of PM2.5 in air exceeds the standard seriously[1]. It not only influences city weather but also human health[2]. In order to reduce energy

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consumption[3], air tightness of the building structure is more and more high which leads to bad indoor air quality[4]. It's easy to get sick building syndrome(SBS) when ventilation is not enough[5-6]. And it's not suitable to open window at all on hazy weather. Ventilated window can not only send fresh air in, but also purify it. Thus it solves the window-open problem on hazy weather. Besides, it also solves the small range and limited function problem of Exhaust fan and air purifiers[7]. Influence of nature ventilation and bidirectional ventilated window ventilation on indoor CO_2 concentration is analyzed[8]. The results show that bidirectional ventilated window has an effective improvement on indoor air quality. Experimental study on the importance of bidirectional ventilated window parameters on energy saving is done[9]. Two new types of solar ventilated window can reduce cooling load and energy consumption effectively[10]. Thermal performance of bidirectional ventilated window is valued by experiment combined with simulation[11]. Most of the ventilated windows above can reduce indoor CO_2 concentration and energy consumption but have no purifying function. This paper studied a new type of ventilated window with purifying function, which has a considerable filtering effect.

2. Method

The comprehensive laboratory is composed by the test room, outdoor environmental chamber, a new ventilated window and monitor room (Fig. 1-2). For convenient and accurate study, all walls, floors, ceilings and doors of the test room and outdoor environmental chamber are heat preservation and insulation.

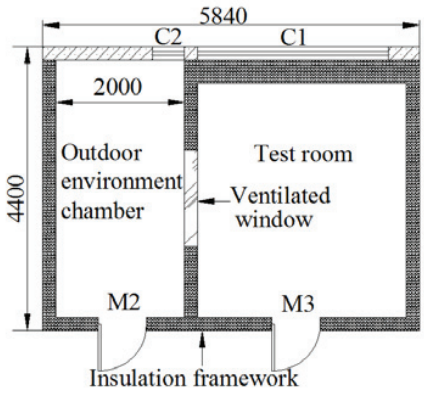

Fig 1. The comprehensive laboratory of building energy

Fig 2. The new ventilated window

2.1. The new ventilated window

Table 1 Performance parameters of the new pattern ventilated window

Mode / Parameters	Low-grade	Mid-grade	High-grade
Ventilation volume	0.54m^3/h	0.74m^3/h	0.95m^3/h
Filter efficiency	78.6%	77.4%	75.2%

The new ventilated window (Fig. 2) is installed in the partition of the test room and outdoor environmental chamber. It has lighting effect of the ordinary window, and it can purify the air through ventilator (Fig. 3) installed in the window frame. Using mechanical air supply, fresh air can be sent in after purification without opening the window (Fig. 4), and the filter efficiency of ventilator is medium efficiency. The new ventilated window has three operating modes, the performance parameters of each mode are shown in Table 1.