The effect of ventilation rates and window areas on building energy use

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Abstract

Natural ventilation is an effective method for energy conservation while potentially improving indoor air quality. Furthermore, a window has a significant impact on energy consumption. The purpose of this study is to reduce building energy use by changing ventilation rates and window areas. We analyzed the energy consumption and CO_2 emissions according to ventilation rates and window areas through using a computer program, HEED 3.0. The reference model had two windows of 1.2m× 1.5m, and assumed there was no ventilation except for the minimum ventilation rate of 0.35 ACH. In order to determine the combined effects of changes in ventilation rates and window areas, three ventilation rates; 1.0 ACH, 5.0 ACH, 20.0 ACH, and three window areas were studied. The findings were as follows: annual energy consumption was reduced by 10.6%, CO_2 emissions by 16.7% compared with the reference model by changing ventilation rates and window areas.

Keywords: natural ventilation, ventilation rates, window areas, building energy consumption

Introduction

Building energy conservation has been of increasing importance. Controlling of ventilation rates and window areas influences considerably on building energy use. The aim of this study is to contribute positively to building energy performance. Therefore, we will evaluate

building energy use and CO_2 emissions according to ventilation rates and window areas using a computer program, HEED 3.0

Methods

The reference model was a room of 5m×7m×2.6m, located in Kangnung, Korea. There were two windows of 1.2m×1.5m which were oriented southwest and northeast. Table.1 presents the properties of the window.

Table 1 The properties of the window

	Composition	**U-value**
Window	▪ Clear double pane with Low-E coating in plastic frame ▪ Cavity : 12mm	2.1 W/m^{2}K

This study investigated two parameters to reveal relationships between energy consumption, and ventilation rates and window areas. HEED 3.0 was used to estimate building energy use. Table.2 details parameters in this study.

Table 2 The details of parameters

Parameters	**Levels**	**Remark**
Ventilation rates	1 ACH	Minimum natural ventilation
	5 ACH	Good natural ventilation
	20 ACH	High natural ventilation
Window areas	7.2 m^2	1.2m x 3.0m, 1.2m x 3.0m
	5.4 m^2	1.2m x 3.0m, 1.2m x 1.5m
	3.6 m^2	1.2m x 3.0m

Results and Discussion

Figure 1 shows the variation in energy consumption according to changes in ventilation rates. The heating and lighting energy consumption were not changed significantly. However, the cooling energy was reduced by decrease of ventilation rates. The high ventilation rates of 20 ACH reduced cooling energy use and resulting CO_2 emissions by 39%, while heating energy was increased by 7% compared to the energy consumption for the reference model.

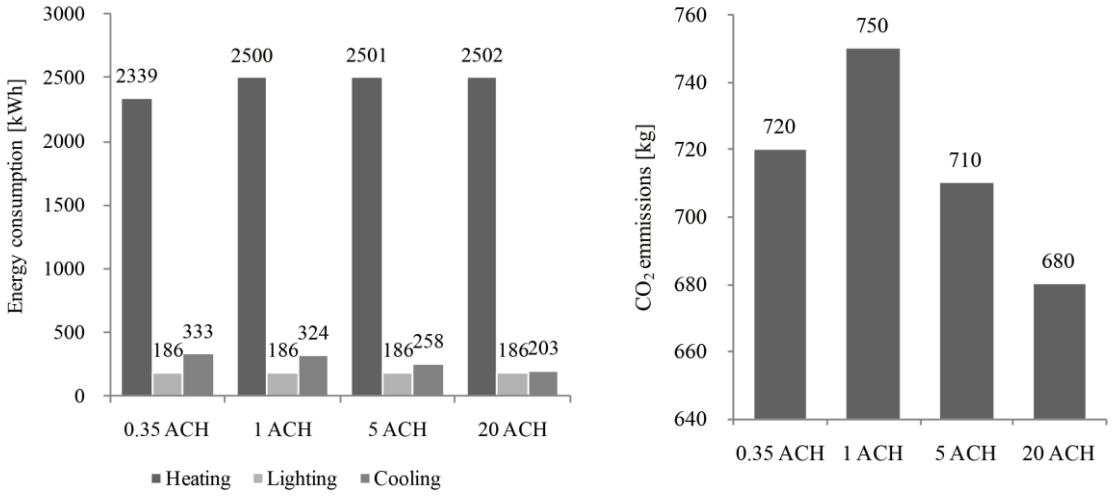

Fig. 1 The variation in energy consumption according to changes in ventilation rates

Figure 2 shows the variation in energy consumption according to changes in window areas. When a window area was reduced to 3.6m^2 from 7.2m^2, the annual energy consumption and CO_2 emissions were reduced by 13%.

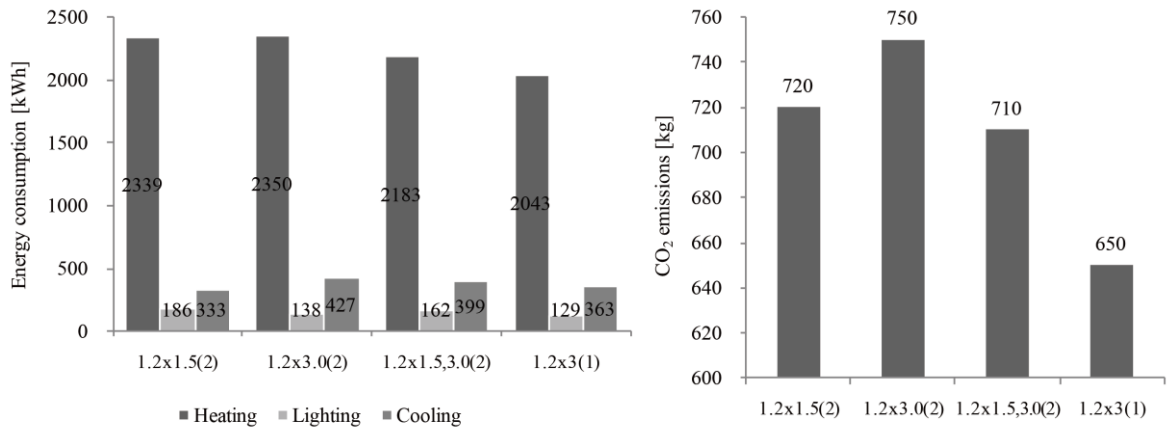

Fig. 2 The variation in energy consumption and CO_2 emissions according to changes in window areas

The combination of 20 ACH and a window of 3.6m^2 was the most energy efficient alternative. Reducing a glazing area and increasing a ventilation rate of a base case model is an effective method to reduce the total energy consumption. As shown in figure 3, both increasing a ventilation rate to 20 ACH and changing a window area of 3.6m^2 resulted in reducing the annual energy consumption by 10.6% and CO_2 emissions by 16.7% in comparison with the reference model.

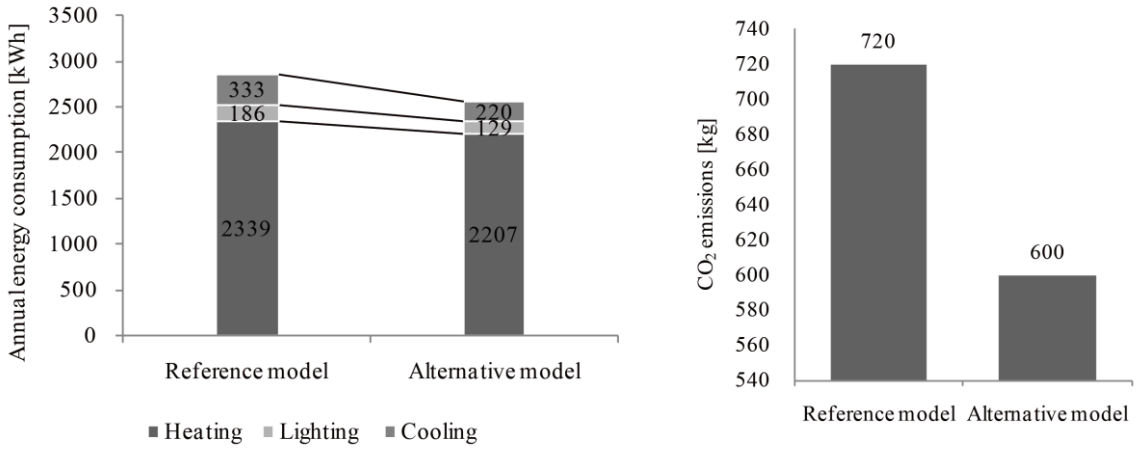

Fig. 3 The annual energy consumption and CO2 emissions of alternative model

Conclusions

The higher ventilation rates reduced the amount of electricity required for cooling. The heating and cooling energy consumption were reduced with a decrease in window areas. It is important to consider a combined effect of reducing window areas on ventilation rates, lighting energy requirements, and cooling energy consumption in the design process of a non-domestic building.

Acknowledgments

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References

1. Seppanen, O. A., et al., “Association of Ventilation Rates and CO_2 Concentrations with Health and Other Responses in Commercial and Institutional Buildings,” Vol. 9, No. 4, *Indoor Air*, 1999, pp.226~252.

2. Yoo, H.C., et al., “The optimal window system of office building considering energy efficiency,” Vol. 25, No. 4, *Journal of the Korean Solar Energy Society*, 2005, pp.53~60.