VERIFICATION OF NATURAL VENTILATION TECHNIQUE IN COLD DISTRICT

T .Sasaki[1] , T. Saito [2]

[1] Iwate Prefectural University , Takizawa 020-0193 JAPAN
[2]GOODMAN Inc., Sapporo 064-0804 JAPAN[3]

ABSTRACT

Air-tightening and setting of the ventilation routes are very important problems in the cold district. Especially, the ventilation routes are obstructed easily according to the life-style etc., and there will be that the necessary ventilation rate may not be enough.

This is a development research for the ventilation opening with the mechanism that fills the necessary ventilation rate by the temperature difference. It is not preferable for the amount of necessary ventilation in the building to rely on electric energy. This ventilation opening proposing in this report, has a function as an inlet and an outlet multiply. And the authors have done a basic experiment, and confirmed that the occurring the room-air goes from the opening and comes fresh-air from outdoor multiply. The result of the total verification in the case study house where the experiment (temperature distribution and ventilation rate per several conditions) with this ventilating opening was constructed in Sapporo, is described in this report.

It has been understood from a result of the observation in winter that the ventilation performance in the ventilating opening is very high and effective. It is necessary to reduce in the energy related to the building to achieve the Kyoto Protocol's object. The energy related to ventilation is requested to use natural energy in this century.

INTRODUCTION

Now that Kyoto Protocol has come into effect, the target value of the reduction of CO2 will not be achieved unless the energy use in houses is drastically reduced. In this study the authors suggest an efficient vent whose ventilation rate is satisfactory without electric energy; it basically works as natural ventilation by temperature differences.

The authors measured basic ventilation performances of the vent and proved that it has a simultaneous air supply and exhaust function. This function is essential for air-tight buildings, where the obstruction of the whole ventilation route sometimes happens. Furthermore, experiments using the vent were made in a test house in Sapporo mostly in winter and the results showed its high ventilation efficiency.

METHODS

AN OUTLINE OF THE TEST HOUSE

The test house is made of concrete blocks and its heat loss coefficient is 10kcal/h℃m2. Figure 1 shows a photo and the cross section. The main ventilation route was supposed to be an air flow from a vent on the first floor, through a stairway in the center and out through a vent on the third floor. The doors of the rooms are usually opened but closed at night.

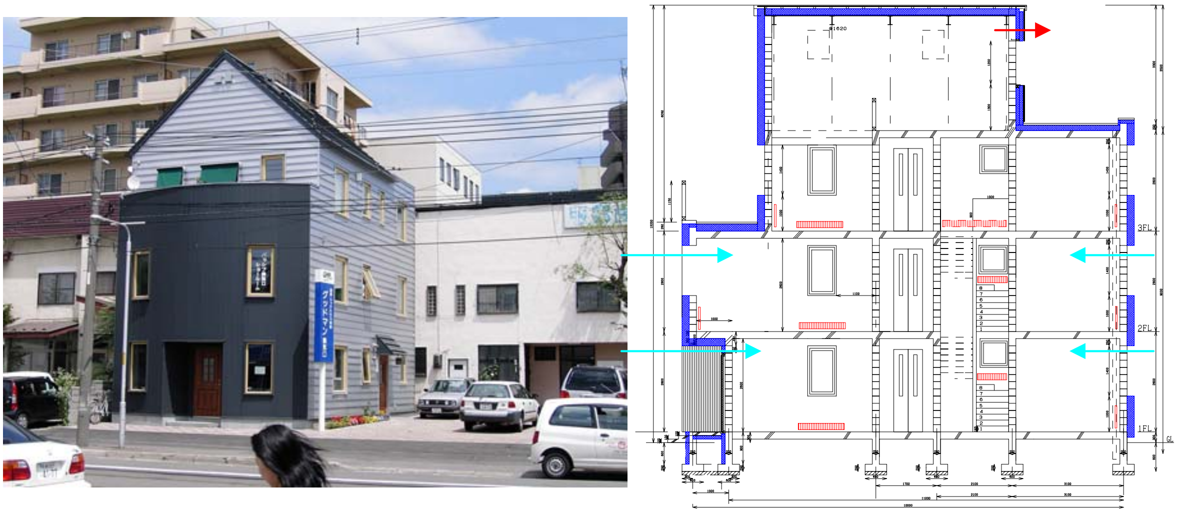

Figure 1 Outline of test-house in Sapporo

Figure 2 shows its heat efficiency, that is, the relationship of the temperature difference between indoors and outdoors with the amount of kerosene consumption. Its heat loss coefficient was the same as was expected when it was designed. Its indoor temperature without heating or cooling was about 10℃, so the authors' intention of the plan is thought to be realized.

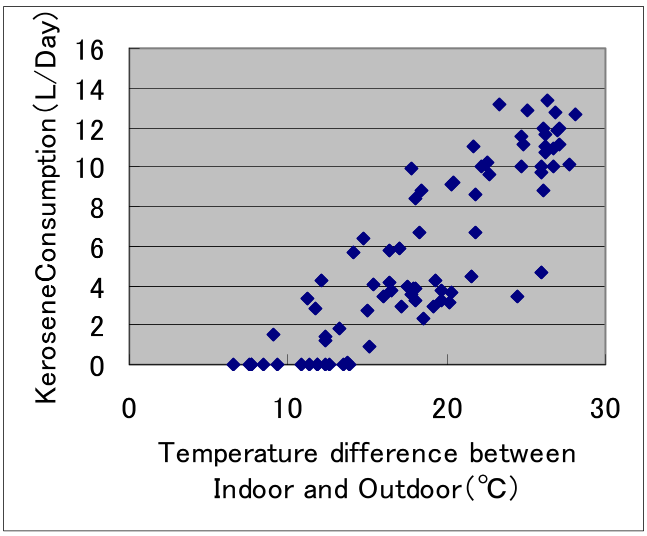

Figure 2 Energy consumption and temperature difference between indoor and outdoor

AN OUTLINE OF THE VENTILATION SYSTEM

While the vent currently in use works as an air exhaust vent or as an air supply vent (what is called 'a one-way system'), the vent in this study works as a system which supplies and exhausts air simultaneously when the ventilation route is closed for some reasons. The principle of the system is 'stack effect'. The neutral height in the vertical center of the vent causes a simultaneous air supply and exhaust action.

Four vents are equipped on the first floor, two on the second floor, and six on the third floor and ventilation rate is appropriately adjusted by opening or closing them.

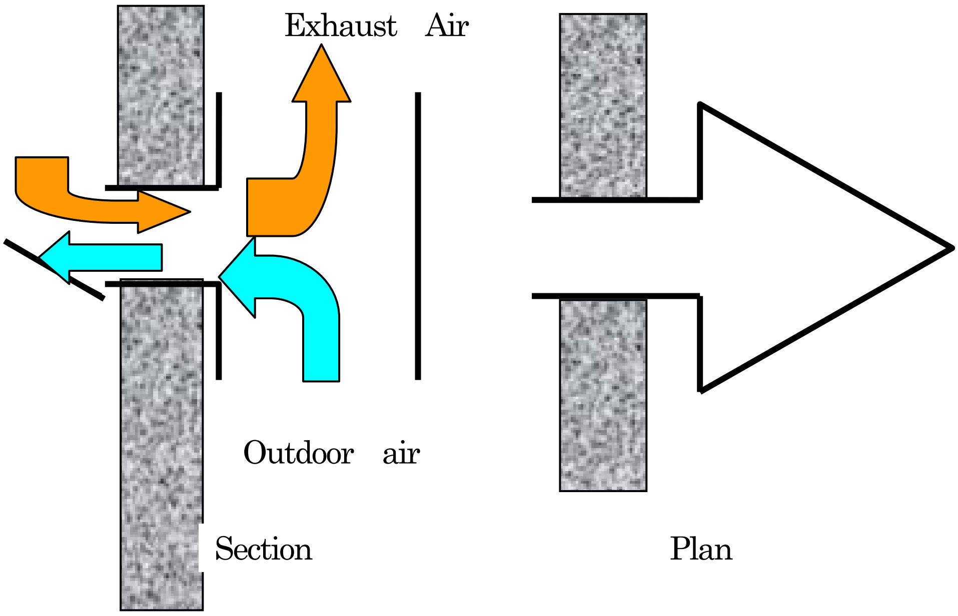

Figure 3 Plan and section of ventilation opening

Figure 4 shows the basic relationship between the pressure difference and the air flow rate at the vents. The equivalent opening area is about 40cm2 and its air resistance is little, so its ventilation efficiency is obviously high.

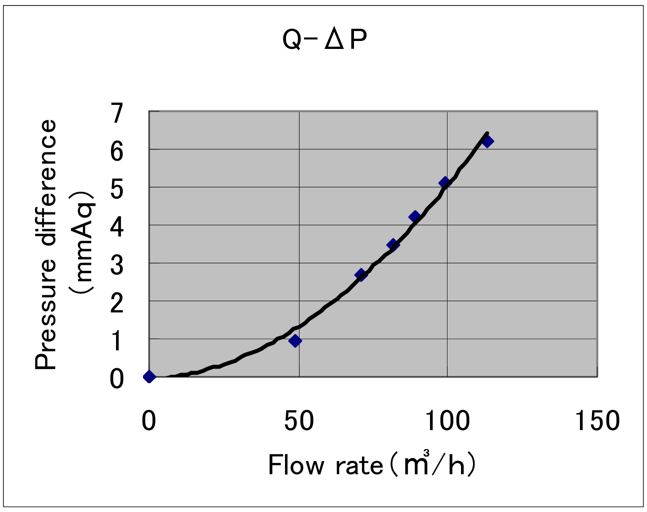

Figure 4 Fundamental flow characteristic of ventilation opening (100Φ)

MEASUREMENT RESULTS OF THE VENTILATION EFFECTS OF THE VENT ITSELF

The concrete measurement results of the ventilation effects are shown below. Figure 5 shows how the concentration of a tracer gas decreased in the room of another house, of which windows were sealed in order to prevent the flow-back of the tracer gas when the temperature difference between indoors and outdoors is 10℃.

Under the condition that the temperature difference stays around 10℃, the number of the ventilation times was 0.45 times/h in average in Room A (volume 16.9m3) and 0.19 times/h in Room B (68.5m3). It is needless to say that the ventilation rate increased when the temperature difference was more than 20℃ in winter. The calculated ventilation rate from the number of the ventilation times was 7.6 m3/h in average in Room A and 13.0 m3/h in Room B, and the ventilation rate per vent turned out to be 7 to 8 m3/h. In the case of the whole house without sealing, the ventilation rate will be more and will meet enough of the necessary ventilation rate.

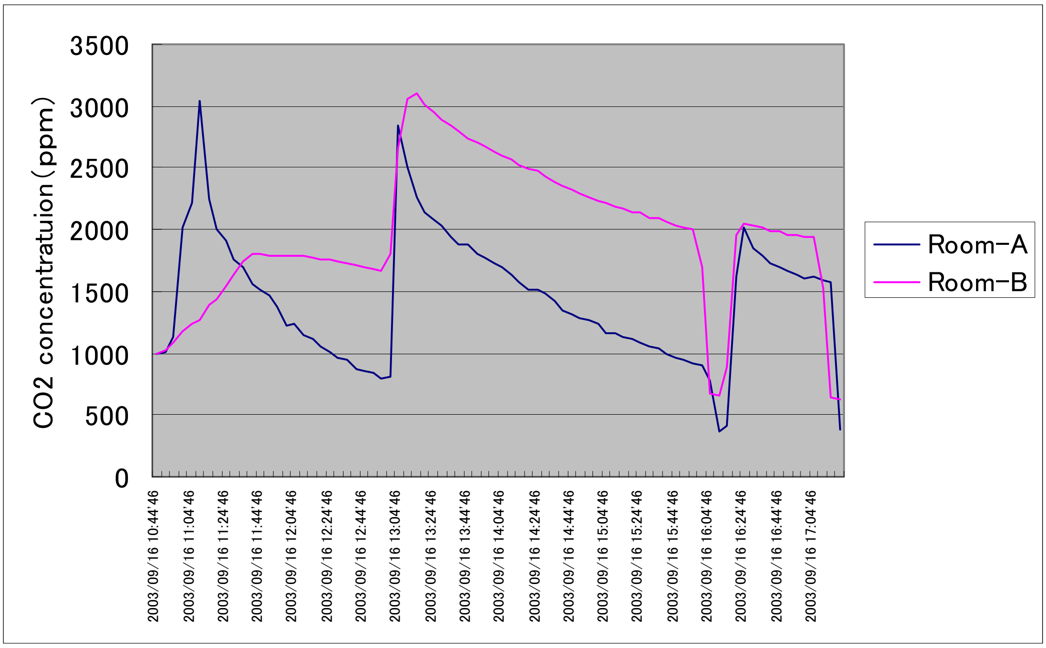

Figure 5 concentration decay

AN OUTLINE OF THE MEASUREMENTS OF THE VENTILATION RATE AND THE RESULTS

The ventilation rate of the whole test house was measured. The concentration of CO_2 was continuously measured with people living in and the wind velocity at a vent equipped at the highest point (h=12m) was measured because air comes in and out only through the vents in this house.

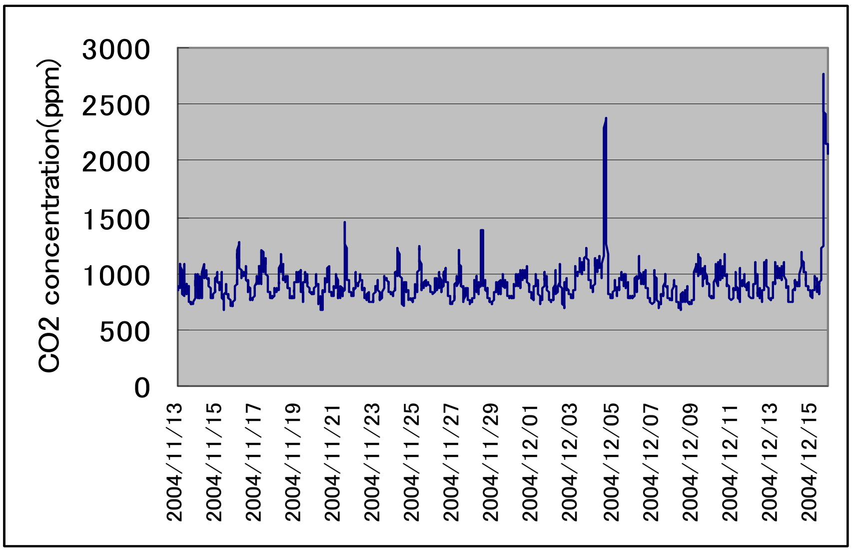

Figure 6 CO2 concentration in winter

Figure 6 shows the measurement results of the concentration of CO2 in winter. Its concentration value was around 1000ppm, so it can be said that enough ventilation rate was got except the time the number of people in the room was large.

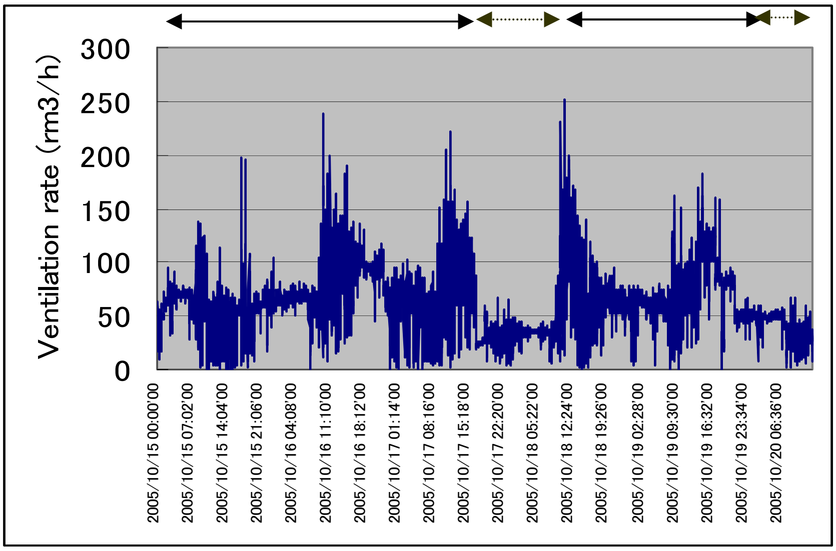

Figure7 Change of Ventilation rate (←→double opening ←---→ single opening)

Figure 7 shows the results of the concentration of CO2 and the ventilation rate at a vent measured continuously when the temperature difference between indoors and outdoors was 10 to 18℃. The ventilation rate was changed with the wind or opening and closing the doors, but the ventilation rate was around 70m3/h when two vents on the loft were opened, and it was 40m3/h when one vent was opened. If several vents are used, further ventilation rate will be got. The authors thought the relationship of the temperature difference between indoors and outdoors with the ventilation rate is influenced by stack effect but the influence was not proved in these measurement results.

External influences such as the wind must have caused it. The indoor temperature effective to the chimney effect was almost steady in the measurement period.

CONCLUSION AND IMPLICATIONS

Almost satisfactory results were got about the ventilation effect by natural ventilation with a simultaneous air supply and exhaust vent equipped in a general house. Enough ventilation rates were got by natural ventilation using temperature differences even without electric energy.

In the cold regions indoor temperature is generally kept steady and the ventilation by stack effect has been in use since the old days. Recently, however, ventilation rate is adjusted less in most houses on the viewpoint of energy saving, so effective ventilation is necessary.

DISCUSSION

The natural vent shown above is also available for the dehumidification by ventilation because it keeps the ventilation rate continuously steady. Furthermore the shape of the popular current vents allows air to flow in one way, as mentioned above, and their ventilation rate is very low. It is very important to deal immediately with the closing of a ventilation route in more air-tight houses in particular.

It is thought that since the upper and lower part of the vent in this study is open outside, it keeps a distance from neutral height, and that once air supply or exhaust starts a kind of siphon effect keeps airflow steady. The vent is apt to be an air supply vent below the neutral height and an air exhaust vent in other places in a general house of more than two stories, but under the third ventilation system it will be an air supply vent and furthermore when the ventilation route is closed, it can supply and exhaust air simultaneously.

REFERENCES

・Sasaki, T. and Saito, T.: Study on ventilation method , part 1, ventilation effect of opening by natural force, Proc. Hokkaido Chapter AIJ 1993

・Sasaki,T. and Saito,T.:Study on ventilation method, part 2, effect by wind pressure, ibid. 1994

・Sasaki, T. and Saito, T.: Effect of the natural ventilation in a school lunch room, Proc. Tohoku Chapter AIJ 2003

・Sasaki,T. and Saito,T.:Ventilation rate of ventilation opening whitch makes fresh air supply and exhaust roll simultaneously, ibid. 2004

・Saito,T , Kamimura M. and Sasaki,T..: Dehumidifying effect of the ventilation opening which makes fresh air supply and exhaust roll simultaneously, Proc. Japan Society of Snow Engineering 2005