Window Design and Maintenance Conf. Gothenburg, 19-20th June, 1984.

AIR INTAKE ARRANGEMENTS OF THE SUPPLY AIR WINDOW FROM THE VIEW OF COMFORT AND VENTILATION EFFICIENCY

Common information of the supply air window and the main results of the last research work

Korkala Tapio M. Sc. (Eng.)
Saarnio Pekka M. Sc. (Eng.)
Siitonen Veijo M. Sc. (Eng.)

Technical Research Centre of Finland
Laboratory of Heating and Ventilating
Lämpömiehenkuja 3
02150 ESPOO 15, Finland

ABSTRACT

Buildings equipped with mechanical exhaust ventilation system or natural ventilation supply air intake should be accomplished with reasonable measures in a draughtless way and if possible with a good ventilation efficiency. One possible solution applicable to existing detached houses and residential multi-floor buildings would be a supply air window. According to the results of the recent research work /2/ made in Finland about 6,0 dm^3/s outdoor air per light area-m^2 can be taken draughtless in through a wooden constructed double-paned window. The incoming air was heated to about 50 % of the temperature difference between the in and outside air. Draught in room concentrated mainly to the ankle level and the air current along the floor could be considered dominant. The best alternative in view of control of the air stream figure was the alternative where air was taken from the air space into the room through holes in the upper sash of the inner pane after which there was a deflector directing the air upwards.

Key words: Ventilation, air intake, air flow, supply air window.

/on

INTRODUCTION

During a few years we have planned and built airtight structures and buildings. In many cases the envelope of an old, renovated building is tighter than before renovation. The energy consumption of these buildings may be small due to better insulation and smaller ventilation rate. When the building envelope is airtight, the performance of ventilation can be poor, if we have no controlled supply air intake in the building. There may occur high concentrations of impurities such as radon and formaldehyde. The moisture content of indoor air may be high. The housing of these buildings is difficult. Airration through windows is common.

The supply air intake of such buildings must be rearranged. For this purpose there are special devices. Especially for building renovation supply air window can be the best decision. In this text we present briefly supply air intake by using a supply air window and some results of recent studies made in Finland.

THE PRINCIPLE

A window, which is used to take in the supply air of a room through the airspace between the window panes, is called the supply air window. This principle is suitable for windows equipped with two or several panes. The flow of air in the air space between the panes can be arranged in different ways (see Fig. 1). Outside air into and out from the air space between the panes can be taken through the cracks between the frame and the casements, or by making different routes for air in the window sturcture. Fresh air devices designed for this purpose can also be installed in the window structure.

COMMON INFORMATION

Air stream between the window panes lowers the temperature of the airspace and the heat flow outdoors through the window vanishes. diminishes

At the same time air stream in the window air space takes a part of the heat flowing outside through the window and brings it back into the room. The heating of the supply air depends on the air flow rate, the forced convection in the air space and the heating arrangements of the room.

The sufrace temperature of the supply air window pane decreases due to the cold outside air, this may have a negative effect on thermal conditions in the room. The supply air window is also more vulnerable to moisture condensation than an ordinary weatherstripped window. On the window panes inside the airspace thes can be avoided by keeping the direction of the air flow from outside to inside.

Directing the supply air stream may have a favourable effect on the flow conditions in the room in view of thermal comfort (see Fig. 2). Upwards directed cold supply air comes into the room on the floor surface, which is a better situation as when the air flows straight into the room.

RESULTS OF THE LATEST RESEARCH WORK /2/

The aim of the work was to find solutions for a controlled outside air intake through the air space in the window. It should be accomplished with reasonable measures in a drauhgtless way and with a good ventilation efficiency. Solutions should be applicable to excisting detached houses and residential highrise buildings, that have only mechanical exhaust ventilation.

A literature survey was carried out and then suitable alternatives were studied in laboratory conditions. A wooden constructed double-pane window was chosen for measurements (see Fig. 3). The air was taken in mainly through the cracks between the frame and casement, which were not weatherstripped in proper places. Also holes bored in the upper sash of the inner pane were used, equipped with a deflector directing the air upwards. Under the window there was installed a heat radiator, whose heat power could be adjusted.

A sound amount of air that could be taken in draughtless was souhgt for all five alternatives (see Fig. 4) and the following values were measured for this situation:

- local velocity and temperature of the air stream
- operative temperatures
- surface temperatures of the floor and window
- incoming air values
- vertical temperature differences
- pressure differences over the window
- ventilation efficiency

The criterion used to evalute the sound amount of supply air was controlled at a distance of 0,5 m from the wall.

The tests were carried out at an outside temperature of - 10 °C, however, one of the alternatives was tested with two different outside temperatures. But the effect of outside temperature on the sound amount of supply air rate cannot be evaluated on the basis of this work.

An average about 5 dm^3/s per light area-m^2 could be taken drauhgtless in through the supply air window and by the best alternatives (cases b and e in Fig. 4) about 6 dm^3/s per light area-m^2.

It was found that the best alternative in view of the control of the air stream figure was the alternative where air was taken into the air space through a crack under the outer pane and into the room through the holes in the upper sash of the inner pane, after which there was a deflector directing the air upwards. When the air was taken in through the crack over the inner pane the spreading of air was liable to pressure variations due to differences in the crack height of the outflow opening.

The draught in the room concentrated mainly to the ankle level, and the air current along the floor could be considered dominant. When the cold air had fallen down near the window, the air current along the floor is in reality more comfortable or can be avoided, with more heating power under the window than in this work (110 W - 140 W).

The incoming air was heated to about 50 % of the temperature difference between the in- and outside air, as it came through the supply air window. In view of this, the best was the alternative where the air was taken in through the crack under the outer pane and into the room through the crack over the inner pane. The surface temperature of the window pane decreases due to the cold outside air. The difference between the average surface temperature of the inner pane and outside air was about 60 % of the temperature difference between in- and outside air.

With a sound amount of the supply air flow, the pressure differences over the window were adjusted between 10...20 Pa, which is considered to be suitable in practice. The pressure difference over the inner pane was about one half of the total pressure difference on average. The velocity of the incoming air measured at the distance of one cm from the outflow opening varied between 1.3 - 1.8 m/s.

With a sound flow rate of the supply air flow the mean operative temperature in the centre of the room varied between 21.7 °C...22.5 °C and at a distance of 0.5 m from the window between 20.8 °C...21.8 °C. The vertical temperature differences (between the levels 0.1 m and 1.8 m from the floor) in the centre of the room and at distance 0.5 m from the window were in all cases less than 1.5 K.

The local air diffusion efficiencies measured by tracer gas (SF_6) technique were between 72...90 % in the room. The studied alternatives showed that there was a great possibility of a closed circuit of air on the floor if the air was taken away from the room through the crack under the door. More efficient is an exhaust on the door.

CONCLUSIONS

According to the measurements, the supply air window will be a reasonable method for supply air intake in old residential buildings, that have only mechanical exhaust ventilation. About 6.0 dm^3/s per light area-m^2 can be taken draughtless in through the airspace between a double-paned window. The supply air window is more vulnerable to moisture condensation than an ordinary weatherstripped window, that is why the supply air window is not suitable for rooms were there is a constant high relative humidity in winter conditions.

Further measurements are planned to explore the effect of window structure on the supply air stream in the room and its thermal conditions.

REFERENCES:

1. Laukkanen, K. & Saarnio, P., 1982, Controlled supply air intake through building envelope. Preliminary study. Technical Research Centre of Finland, Research reports 129, 66 p, Espoo, (in Finnish).

2. Korkala, T., 1983, Air intake arrangements of the supply air window from the view of comfort and ventilation efficiency. Master's thesis, Helsinki University of Technology, Department of Mechanical Engineering, 150 p, (in Finnish).

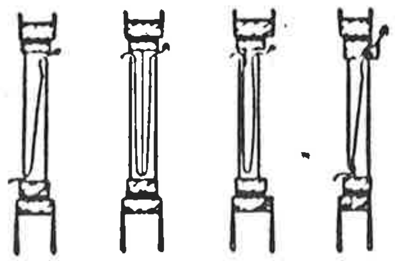

Fig. 1. Some principle solutions of supply air window.

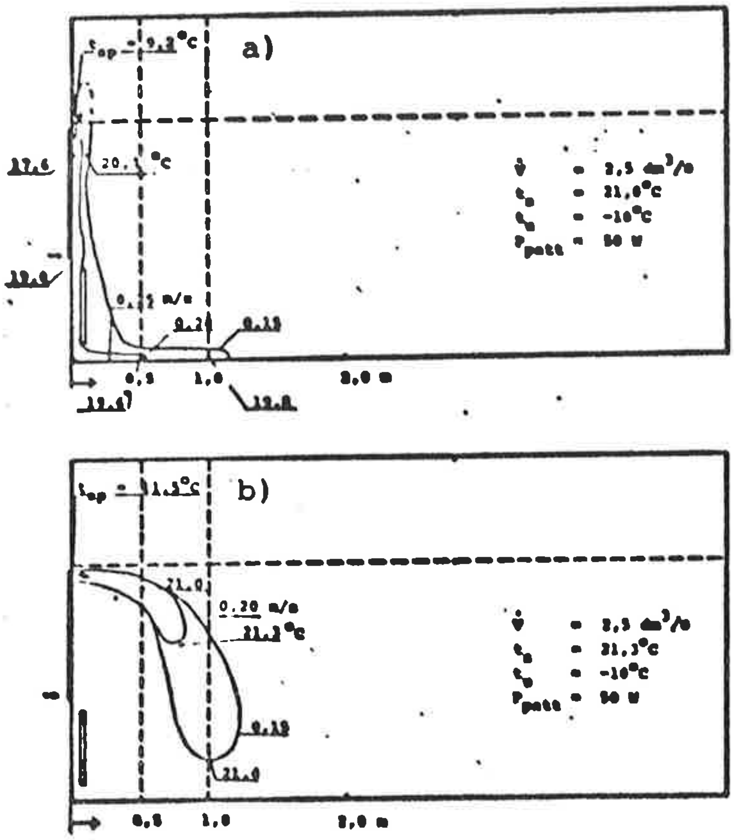

Fig. 2. Spreading of supply air in the room /1/. Air was taken into the room from the air space between a double-paned window through the holes bored in the upper sash.

Case a: window equipped with a flow defletor directing the air upwards.

Case b: window without a flow deflector.

$\dot{V}$ = supply air flow

t_s = indoor temperature

t_u = outdoor temperature

P_{patt} = heating power under the window

t_{sp} = outflow temperature

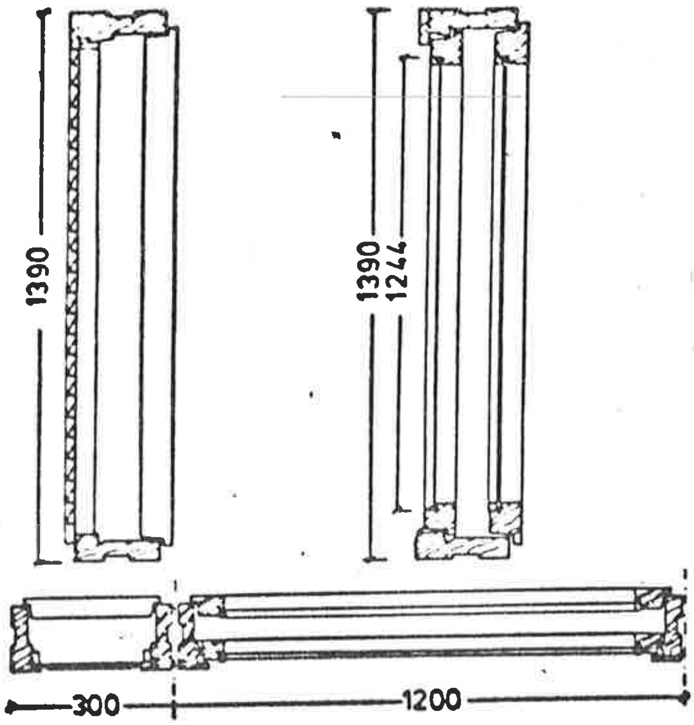

Fig. 3. Wooden constructed supply **air window used in measurements.**

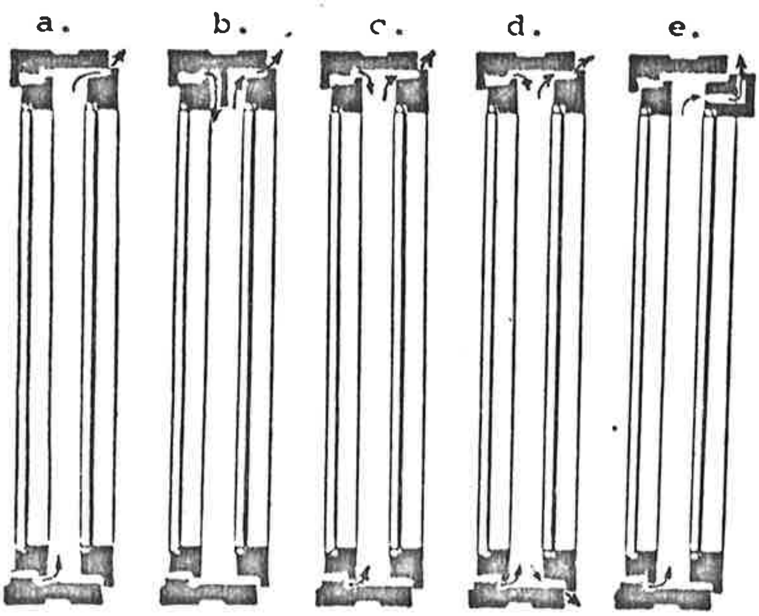

Fig 4. The various alternatives of the supply air window used in measurements.

a. The crack under the outer pane not weatherstripped, air into the room through the crack over the inner pane.

b. The crack over the outer pane not weatherstripped, a deflector directing the air downwards, air into the room as in case a.

c. The outer pane not weatherstripped, air into the room as in case a.

d. The outer pane not weatherstripped, the inner pane weather-stripped with a porous sealent.

e. The crack under the outer pane not weatherstripped, air into the room through the holes bored in the upper sash, a deflector directing the air upwards.