VENTILATION SYSTEM PERFORMANCE

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Paper 38

VENTILATION SYSTEM AS AN AIR HEATING SYSTEM MEASURING RESULTS IN A RESIDENTIAL BUILDING.

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1. SYNOPSIS

This paper presents measuring results from experiments with integrated air heating and ventilation system in airtight well-insulated buildings in Stockholm (The Stockholm Project).
The experiments with air heating systems in the Stockholm Project has earlier been presented in a paper at the 9th AIVC conferance 1988 (2).

This paper presents further results from measuring and analyses of the indoor climate and temperature measurements. The results show that it is possible to get a good thermal comfort in winter without down draught protection below the windows and with air inlet at the inner wall of the room, even when the air flow is reduced to a level equal to the need of normal ventilation flow. This means that it is not necessary to mix the ventilation flow with return air from the apartment.

Comfort data has been collected during a period with outdoor temperatures of -10 to -20 dgrC.

The study has been carried out in cooperation with the evaluating group of the Stockholm Project at EHUB at the Royal Institute of Technology, Stockholm, Sweden.

2. INTRODUCTION

The Stockholm Project (1) is a large joint experimental research and demonstration project for evaluation of new energy saving technology in buildings. Primarily established products are used but in each of the six buildings one or more new methods of energy conservation is tested. The energy demand for heating and ventilation is considerably lower in these buildings compared to a larger group of buildings of similar types built during the same period in Stockholm. All the buildings are airtight and well insulated, some of them better than the Swedish Building Code require.

In two of the six buildings in the project the heating distribution is made as forced air heating system together with a mechanical supply air system.
In a paper presented at the 9th AIVC conferance (2) the in door climat in those buildings was compared to buildings where hydronic heating and mechanical ventilation is used.That study was based on interviews and thermal comfort measurements in the apartments during February 1988 from a period not colder then about -5 dgrC.

This paper presents further results from analyses of the indoor climat and thermal comfort based on measurements during December 1989 with outdoor temperatures of -10 to -20 dgrC.

The measurements are carried out in one of the two air heated buildings where two methods of air distribution are tested.

1: Exterior wall supply via floor level ventilators under windows.
2: Interior wall supply from overhead ventilators, thereby providing no direct downdraught protection beneath windows.

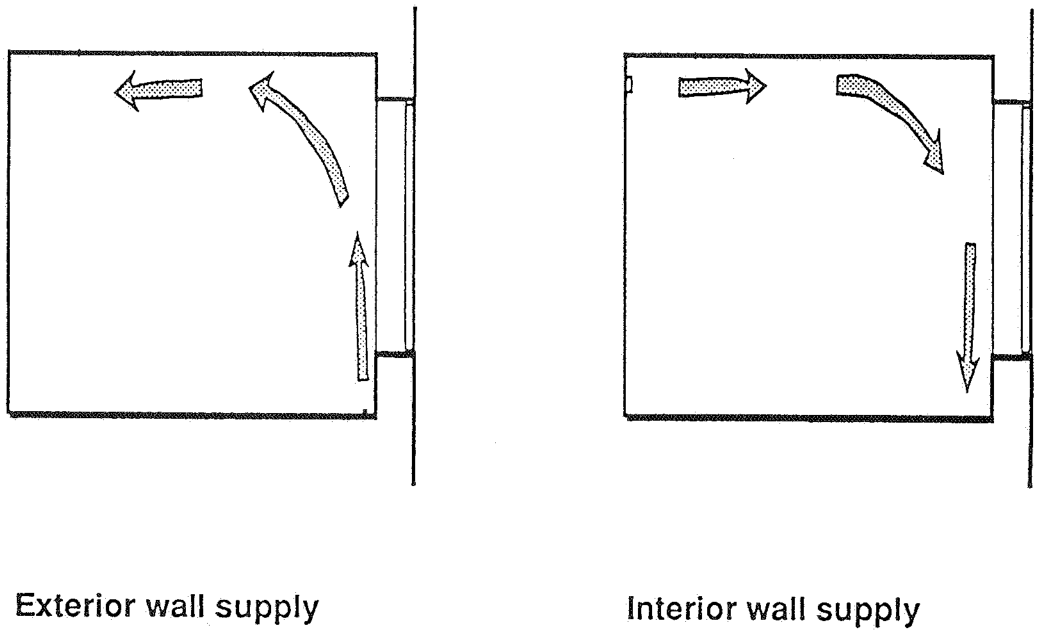

Fig.1. The two methods of air distribution.

The aim of this study was to :

1: Study the thermal comfort in the apartments and compare both types of air heating distribution, using detailed measurements of air mowment and temperature.

2: Give advise on further development and improvements of the air heating technic in combination with ventilation systems.

3. TECHNICAL DESCRIPTION OF THE BUILDING

The ten apartments in the building (3) are heated by forced warm air supplied by an air heating system. Each apartment has its own separate air heating unit, in which the incoming ventilation air, at a rate of 0.5 to 0.6 air changes per hour, is mixed with filtered recirculated air from the apartment to provide a total air flow rate equivalent to 1.3 air changes per hour (design data).

The ventilation supply air is preheated in a central ventilation unit with heatexchange between supply- and exhaust air.
The air temperature is controlled by thermostat to balance each apartments transmission losses.

In five apartments the supply air is distributed from exterior walls at floor level beneath the windows. In the other five apartments the air is supplied from ventilators placed at the interior walls of the room at ceiling level. Which means that there is no direct protection against cold downdraught, such as radiators beneath the windows.

Although during the measurement the total rate of air flow was only 0.7 to 0.8 air changes per hour. This was depending on a bad function of the central fan and wrongly adjusted dampers. This low air flow gave us a good opportunity to study if heating with warm air would function at a flow rate corresponding to a normal ventilation flow without extra recirculation air from the apartment.

If this work it will provide a much simpler instalation, excluding the recirculation unit in the apartments. There for no changes was made to increase the total air flow rate to 1.3 air changes per hour.

4. THERMAL COMFORT MEASUREMENTS

The study of the in door climate was made the 15th of December 1989 which was one day during a period with serval days of cold weather. The night before the 15th the outdoor temperature was below -20 dgrC and the outdoor temperature during the measurements was betwen -20 to -10 dgrC, most of the time around -15 dgrC.

The parameters studied were :
- Air speed close to the ventilators.
- Air speed and direction in the room.

- Air speed and direction at windows.
- Supply air temperatures.
- Air temperatures in occupant zone.
- Air temperatures at windows.

5. RESULTS

The results presents the measurements of air mowment and air temperature in some selected typical apartments in the building. The data from the measurements are also compared to the study made in 1988 (2).

5.1. Rooms with over head air supply on inteior wall

The study of the air movment in both livingrooms and bedrooms shows that with air supply at rooflevel there will be nearly no air velocity in the occupant zone (Fig 2 and 3). The warm air is flowing in a thin layer, 5-10cm, under the ceiling with a velocity of 0.35m/s to 0.15m/s.

The supply temperature is about 30 dgrC. After less than one meter the supply air has been mixed with the roomair so much that the temperature at ceiling level is not more than 2-3 dgrC higher than in the occupant zone.

There is a small downdrought velocity of 0.2-0.3m/s at the windowsurface (Fig 2) but it does not effect the occupant zone. The air velocity near the window in the occupant zone is less than 0.05m/s and the air temperature is more than 20 dgrC.

In one apartment, with a bad window construction with coldbridges and airleaking balconydoors (Fig 3), it was obvious that theese defects had a greater influence on the thermal comfort then the air heating system could have had.

The measurements results are also confirmed by the tenants who did not have any comfort problem during the past winters.

The results are very similar to the results from the previous study in February 1988 (2) when the air flow was hihger and the outdoor temperature was warmer.

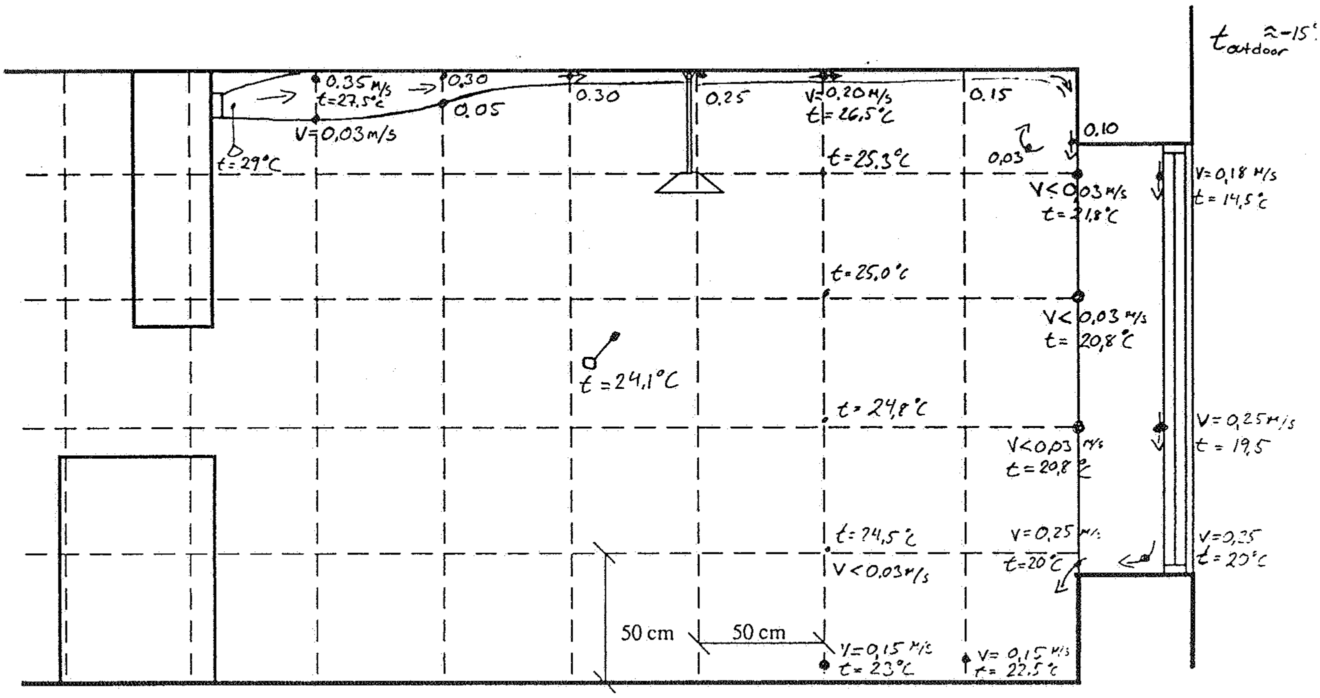

Fig 2. Section through a livingroom with interior wall supply. Air velocity (m/s) and air temperature (dgrC).

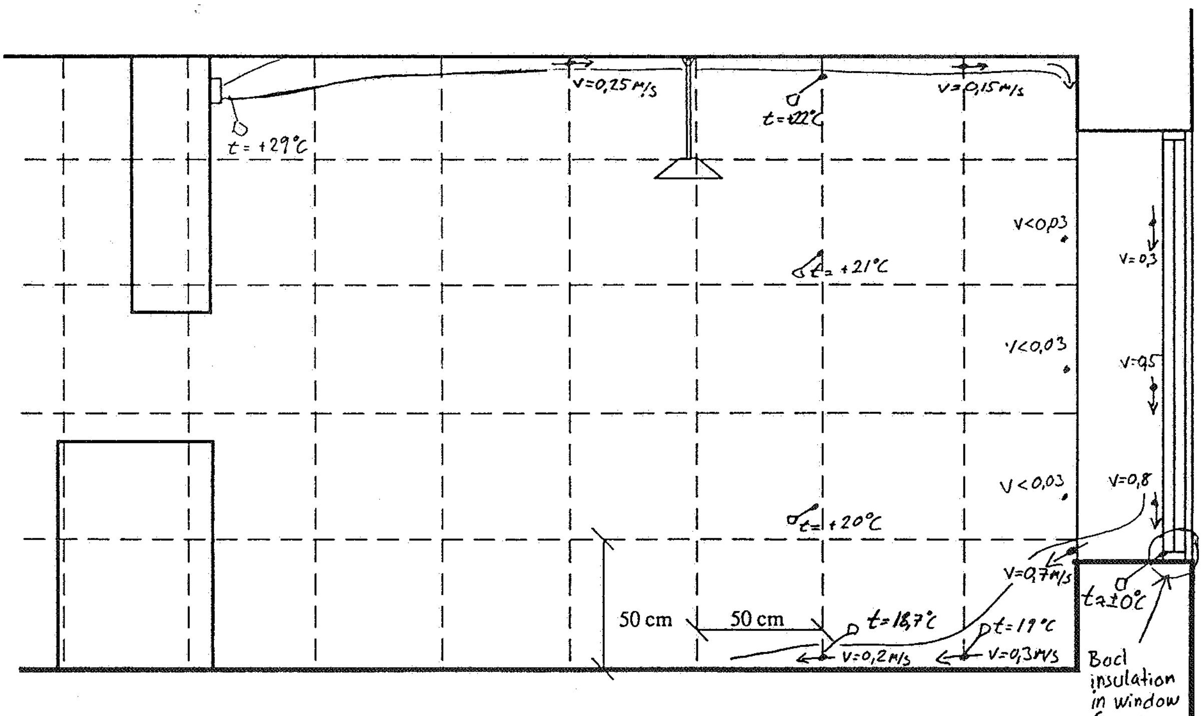

Fig 3. Section through a livingroom with interior wall supply and window with coldbridges. Air velocity (m/s) and air temperature (dgrC).

5.2 Rooms with air supply ventilators under windows

Air pattern in both livingrooms and bedrooms with ventilators at floor level under windows shows the same comfort problem as in the previous study in February 1988,(2). A small obstacle forces the air into an unwanted direction. Here a small protruding edge of the window-sill causes big draught problems in the occupant zone (Fig 4).

In one of the bedrooms we made an adjustment of the air stream direction with a piece of hard paper over the ventilator. Here by we could change the direction of the air stream and reduce the air velocity in the occupant zone (Fig 5). Instead we got a very high velocity, about 0.5-1.0m/s in front of the window.
In both cases no cold downdraught could be detected at the windows.

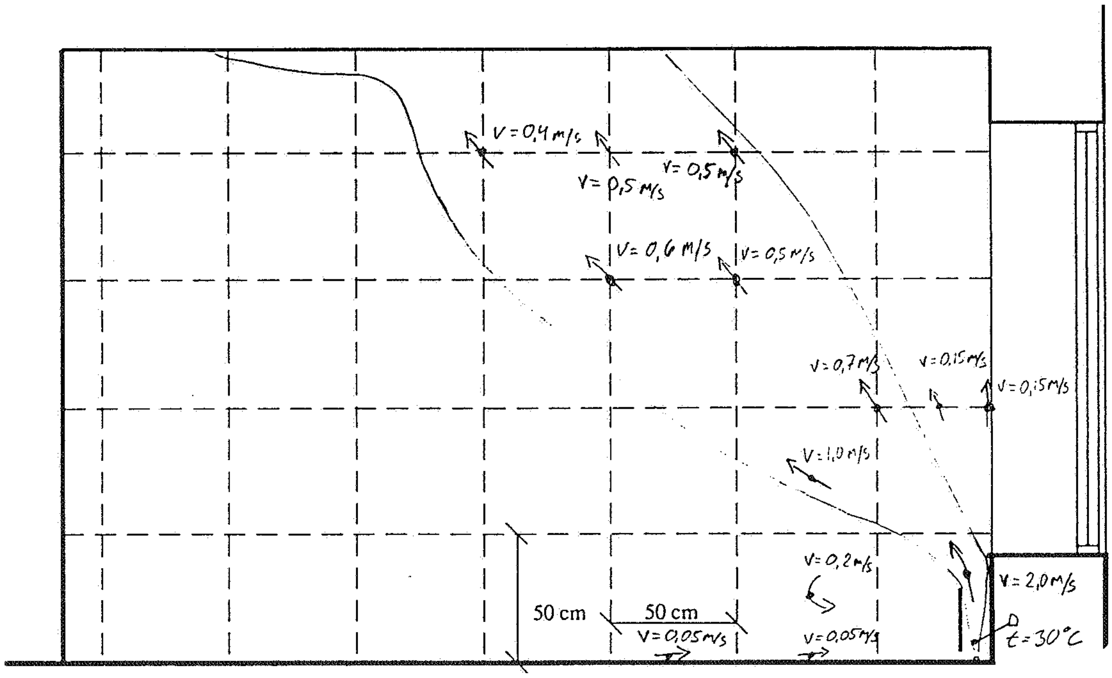

Fig 4. Section through a bedroom with exterior wall supply. Air velocity (m/s) and air temperature (dgrC).

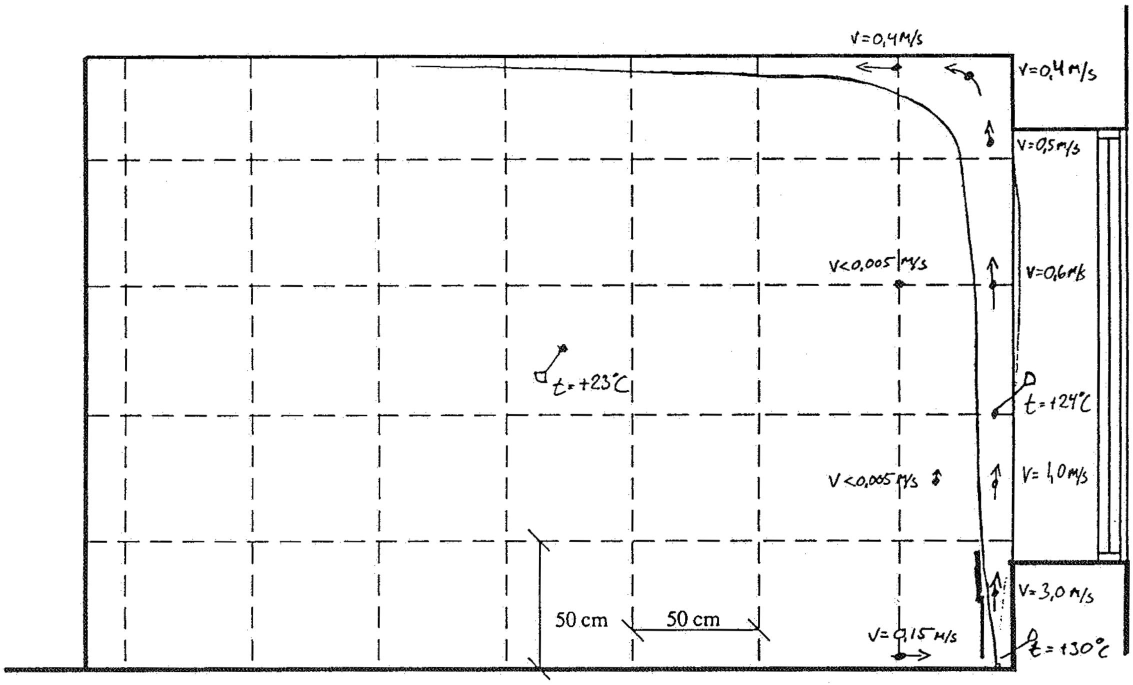

Fig 5. Section through a bedroom with exterior wall supply and with adjusted ventilator. Air velocity (m/s) and air temperature (dgrC).

6. DISCUSSION

One main result of the study is that even in very cold climat we can use air heating, with overhead air supply at interior wall without cold downdraught protection under the windows, with good thermal comfort.

An other important result is that the measurements also shows that we do not need more air flow then we use for normal good ventilation in an apartment.

This means that we can simplify the air heating system and make them without the air recirculation unit in each apartment.

Air leakages and coldbridges has a greater influence on the thermal comfort than the air heating system has, with variations that normaly occurs in the air distribution in systems with overhead air supply at interior walls.

Air distribution under windows can function if there is a careful design for both ventilators and for the details in their surroundings. But overhead air supply at interior wall seems to be a better solution for good thermal comfort.

7. REFERENCES

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