ENERGY EFFICIENT DOMESTIC VENTILATION SYSTEMS FOR ACHIEVING ACCEPTABLE INDOOR AIR QUALITY

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PAPER 14

FIELD TRIALS OF VENTILATION EFFICIENCY IN BUILDINGS EQUIPPED WITH MECHANICAL VENTILATION SYSTEMS

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Synopsis

By measuring the performance of ventilation systems in existing buildings we can discover systems not working properly. The gained experience from field trials gives us insight into how different systems work. This can help us avoiding to install bad systems in newly built houses.

Results from three case-studies regarding the ventilation efficiency air reported? In one of the cases it was possible to simulate three different positions of the supply register. In another case the supply air temperature was varied. The importance of both the location of the supply register and the supply air temperature are demonstrated.

1 INTRODUCTION

Today the designer of a ventilation system must take into consideration the cost of excessive ventilation rates. Lower ventilation rates imply that the designer also must be aware of the supplied air for the removal of pollution. Efficient utilization of the air means a high ventilation efficiency. With the today's measurement technique it is possible to study how the air is spread within a room.

The purpose of this paper is to report results from field trials of the performance of various mechanical ventilation systems. The measurements have been carried out in buildings built during the seventies. All buildings were equipped with mechanical supply and extract systems.

In one of the tests it was possible to change the position of the supply register and in another test the supply air temperature was varied. All tests were carried out with the rooms in their normal use and with the doors between the rooms closed.

2. MEASUREMENT TECHNIQUE

The tests were carried out by adoption tracer gas technique. A burst of gas (N_2O) was admitted to the room and with the aid of mixing fans the gas was mixed to a uniform initial concentration C_0. Then the fans were turned off and the decay of the concentration was recorded at several points.

The local ventilation rate (LVRT) at an arbitrary point j was calculated as:

$$r_j = \frac{C_o}{A_j}$$

when

C_o = Initial concentration

A_j = Total area under the curve

The total area was calculated as (see figures 1 and 2)

$$A = A_{\tau_0} + A_T$$

$A\tau_0$ = measured area

$$A_T = \frac{C_{\tau_0}}{\lambda}$$

$C\tau_0$ = Final concentration

λ = Slope of ln concentration curve in the exponential decay region, see figure 2.

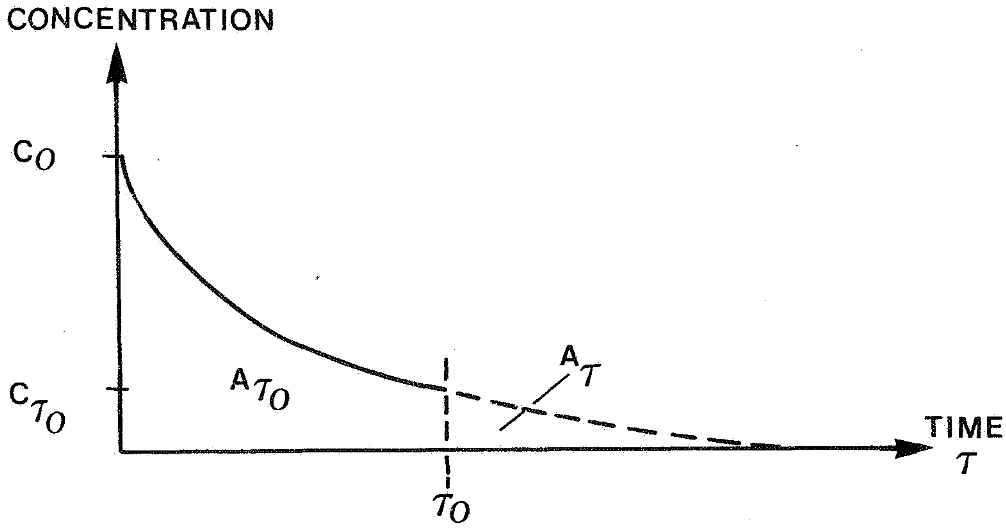

Figure 1. Concentration versus time

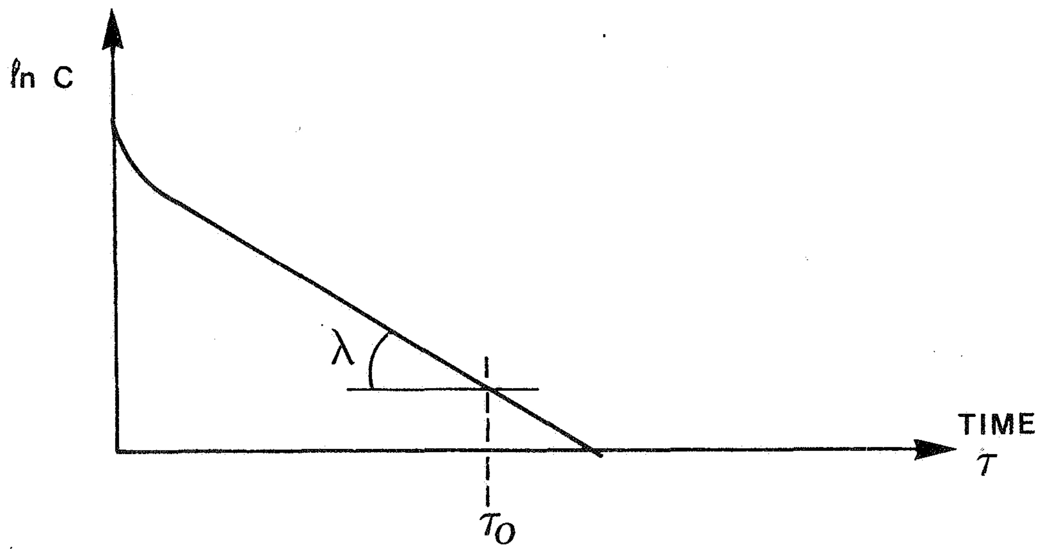

Figure 2. Concentration versus time in a linear/logarithmic diagram

The nominal ventilation rate, defined as the total outdoor air entry into the room directed by the volume of the room, was measured in exactly the same manners as described above, except that the mixing fans now were in operation the whole time.

The ventilation efficiency, ε_j, at air arbitrary point j is defined as

$$\varepsilon_j = \frac{r_j}{n} \times 100 \qquad (\%)$$

n is the nominal ventilation rate.

3. RESULTS

3.1 Ventilation efficiency as a function of the location of the supply register

The room is shown in figure 3 and the air is normally supplied into the room at two points. Above the door there is an ordinary supply register and under the door there is a slot where air also enters.

The efficiency has been measured in four points, see figure 3.

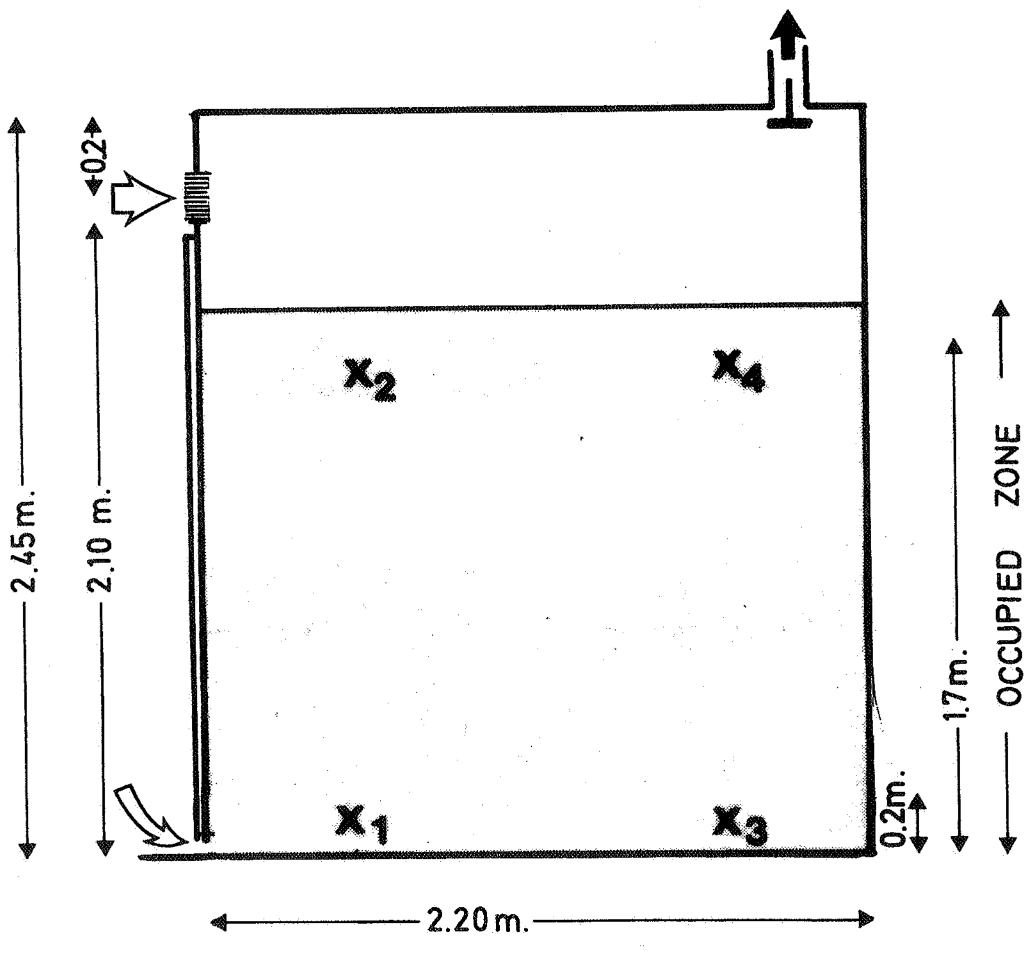

Figure 3. Test room with measurement points

Beside the normal operational mode two other cases have been simulated. The supply register above the door and the slot under the door have alternatively been taped. The cases are

Case a: Air supplied only through the register above the door.

Case b: Air supplied both through the register and the slot under the door.

Case c: Air supplied only through the slot under the door.

The measurements were carried out under isothermal conditions. Obtained results are shown in diagram 1 below.

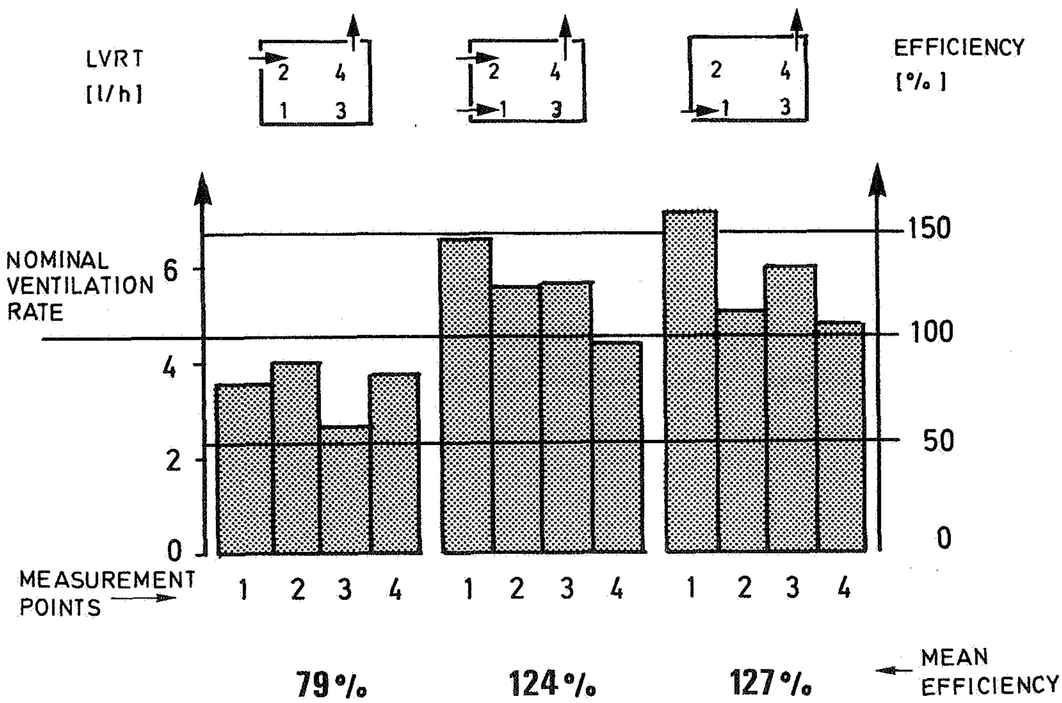

Diagram 1. Ventilation efficiency in three cases

From the results in diagram 1 we can conclude.

Case a) which is the most common placing of registers, gives a mean ventilation efficiency (79 %) which is less than the nominal ventilations efficiency (100 %). This can be ascribed to a short-circuiting effect.

Case b) gives a satisfactory mean ventilation efficiency (124 %).

Case c) gives the highest ventilation efficiency (mean 127 %) of all the cases.

By comparing the cases we can conclude that the simplest arrangement, a slot under the door, gives the highest efficiency. Therefore the cost for both registers and labour could have been saved in this particular case.

3.2 Ventilation efficiency as function of supply air temperature

Figure 4 shows the test room in this case. The room is a hospital ward room. Both supply and extract registers are located in the ceiling. The supply air is blown horizontally against the centre of the room. The room is heated with panel radiators located under the windows.

The tests were carried out with temperature difference between supply air and the mean room temperature of -1.8°C (case d) and +3.0°C (case e) respectively. In the later case the radiator heating was on.

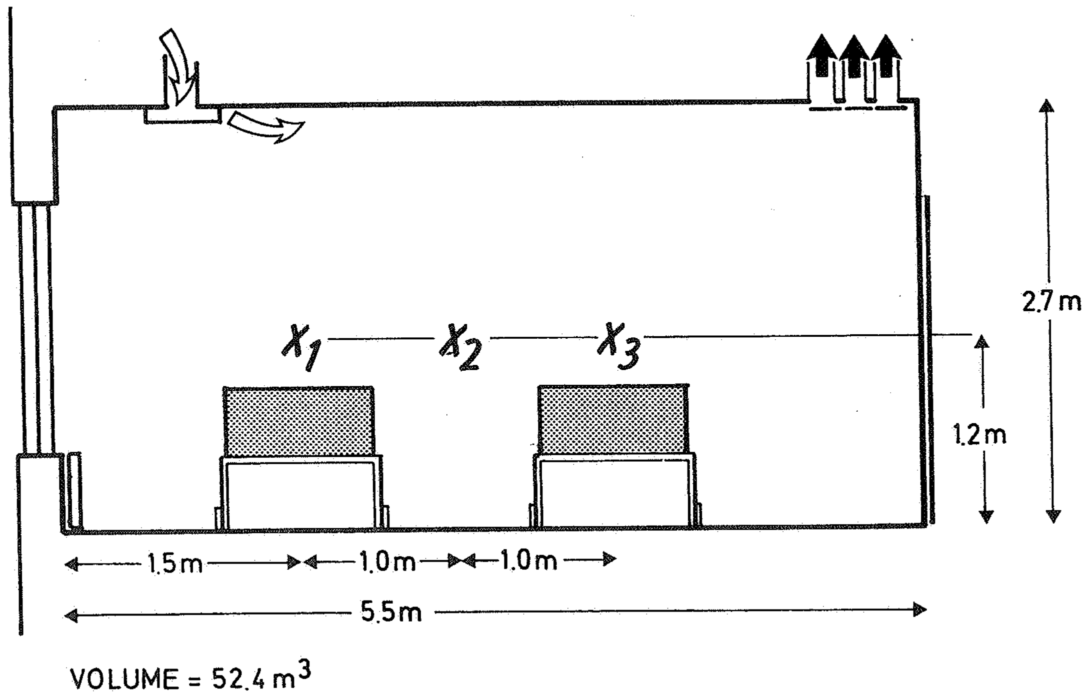

Figure 4. Test room with measurement points

The obtained results appear in diagram 2 below.

When undertemperature occurs the result is according to what one should expect. Case e shows that the air motion cauted by the radiators is not sufficient to prevent the short-circuiting effect due to the higher supply air temperature.

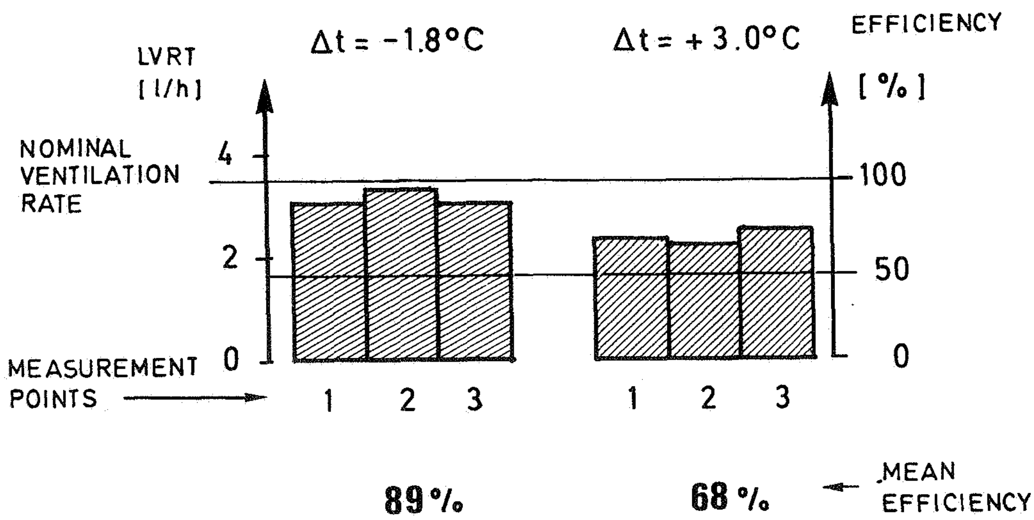

Diagram 2. Ventilation efficiency in two cases

3.3 A case with the supply and extract registers placed on the same wall

The room is shown in figure 5. The room is heated with panel radiators under the windows and the registers are placed on the opposite wall.

The measurements were made at isothermal conditions (no heating on). The results, also presented in figure 5, show that we in this case achieve a very uniform ventilation efficiency.

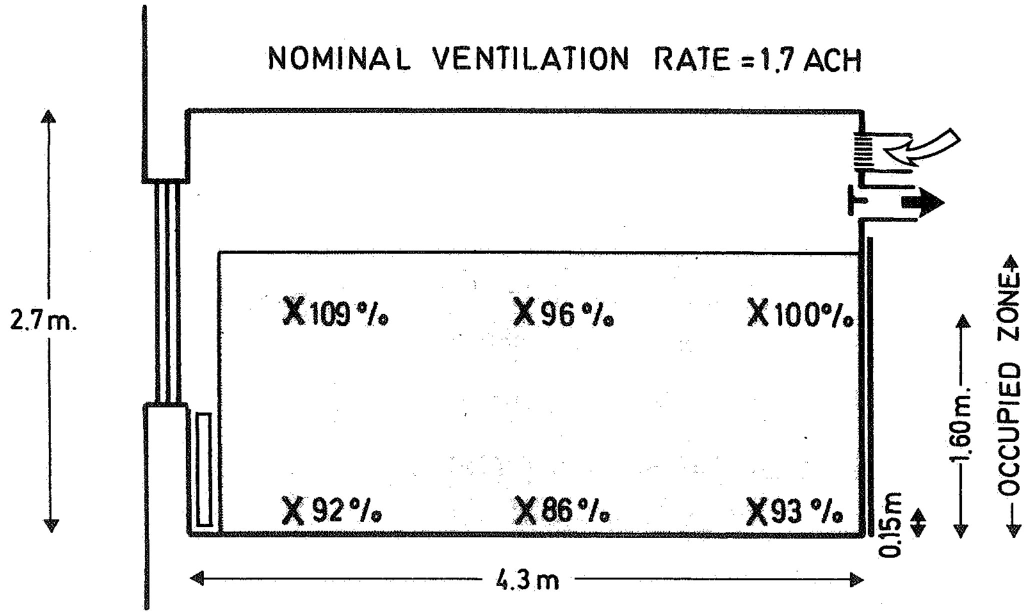

Figure 5. Test room with measurement points and ventilation efficiency results

Conclusions

The findings show that with regard to the ventilation efficiency:

a) The location of the registers are important even at isothermal conditions.

b) Air motions cauted by radiators do not always prevent short-circuiting effects due to a higher supply air temperature.

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