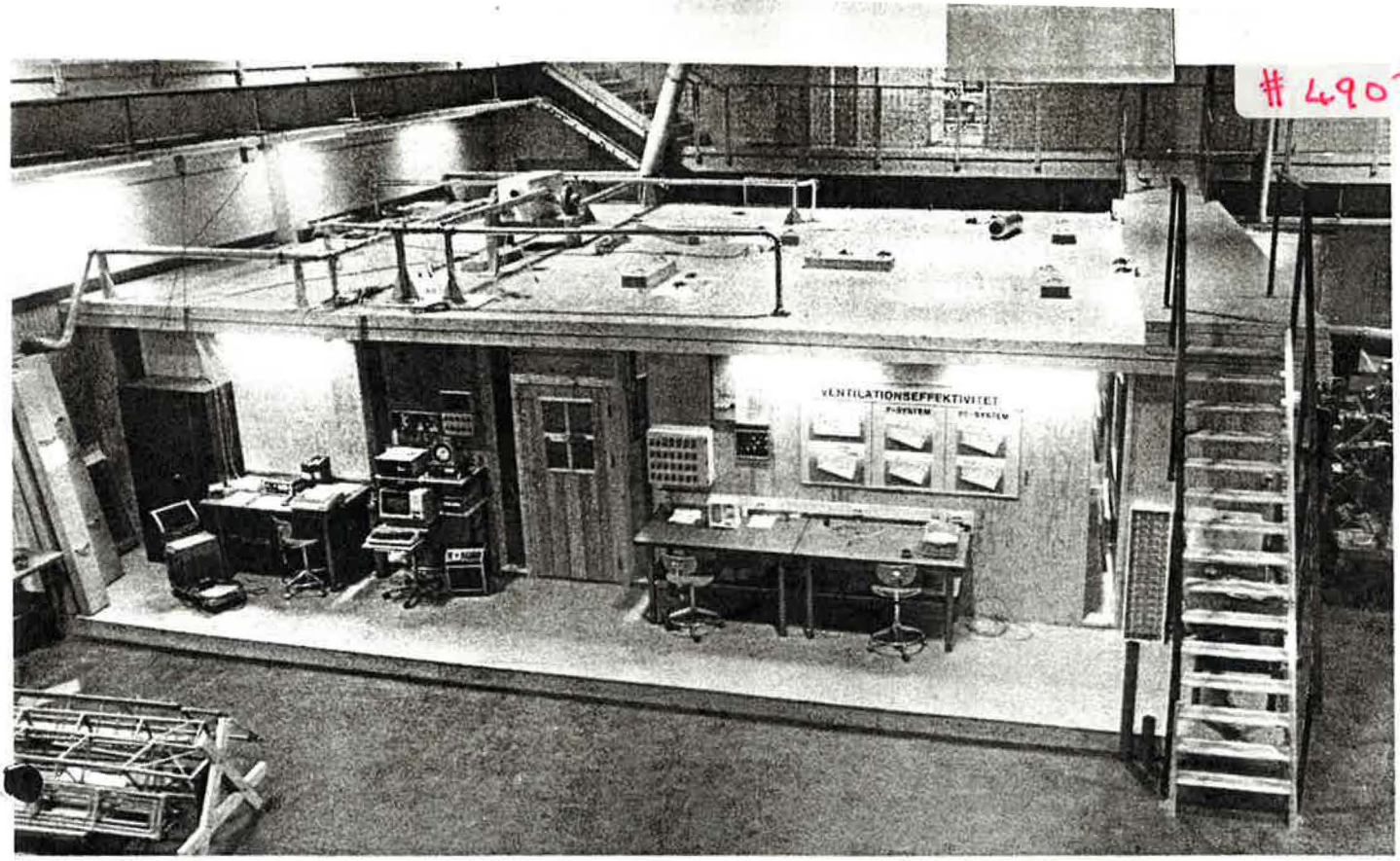

An Indoor Test House

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Introduction

The test house is located in the Institute's laboratory hall. This new facility (see above) will mainly be used for the study of alternative ventilation strategies in tight houses. However it will also be used for basic air infiltration research.

The main reason for building the house indoors, is to obtain a controlled environment both with regard to the ambient temperature and the flow rate of outdoor air supplied. Therefore the house is well suited for use in connection with the development of different measuring methods and in particular the determination of their accuracy (the accuracy of methods for measuring the infiltration rate is more or less unknown at present).

Technical description

The house has five 'rooms' (see figure 1) and a total volume of 176 m^3 while the total floor area is 70 m^2. One wall of the house consists of the existing south facade of the laboratory hall. In the wall on the opposite side there is a cooling chamber. The air temperature in this chamber can be reduced to –25°C. The house is heated by electrical radiators or by heating the supplied ventilation air, and can alternatively be ventilated by forced or natural ventilation. Natural ventilation is simulated by heating the house to a higher temperature than the ambient air. To increase the stack effect the house is equipped with a 'ventilation' stack (not shown above) connected to outdoors.

Both above and below each internal door there are adjustable gaps. The air movement in the doorways is shown by releasing smoke (see figure 2). To enable inspection from outside there are several strips of glass in the building envelope. The following quantities are normally monitored in each room:

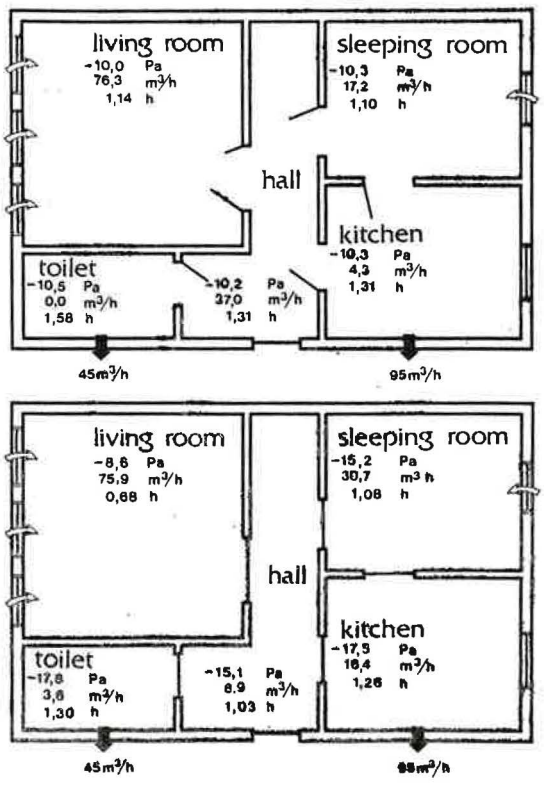

Figure 1

- temperature
- pressure
- tracer gas concentration (N_2O)
- CO_2 concentration.

The whole measuring sequence is controlled by a computer which also starts and stops the mixing fans.

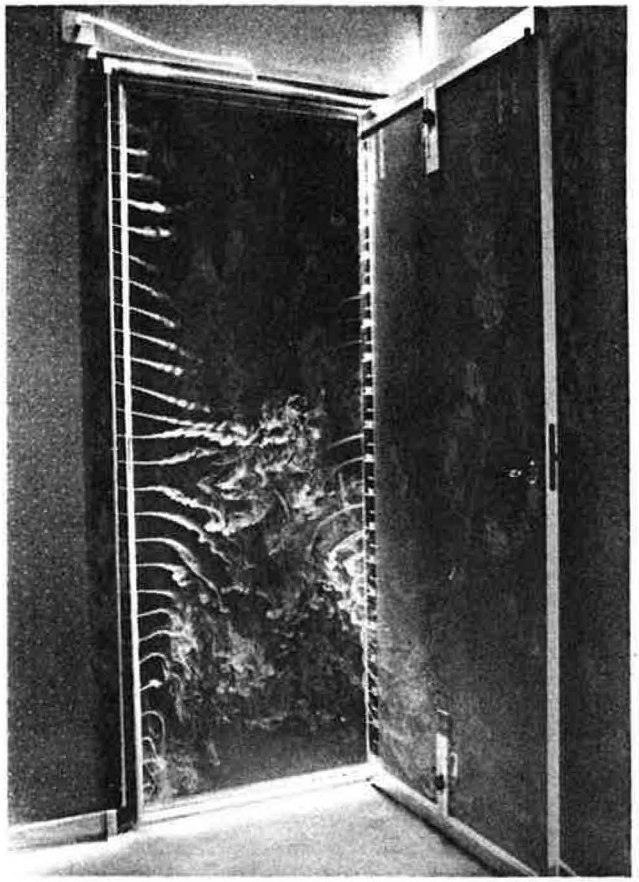

Figure 2

Ventilation efficiency studies

When the performance of different ventilation schemes are evaluated, the measuring sequence in each room is normally as follows:

- temperature
- pressure
- flow rate of outdoor air
- mean age of air
- a repeat measurement of temperature and pressure.

The total flow rate of outdoor air to each room is measured by the constant concentration tracer-gas method. An example of results obtained with a mechanical extract system in operation is shown in figure 2.

In the first case all internal doors were open and in the second they were closed. The slot ventilators in the living and the sleeping rooms were open and the air was extracted from the kitchen and the toilet. The total flow rate of outdoor air amounted to 140 m^3/h which corresponds to a nominal time constant (the total volume divided by the total flow rate of air) equal to 1.25 h. In figure 1, the pressure (reference is the laboratory hall), the predicted flow rate of outdoor air and finally the mean age of the air is given for each room. When the doors are closed the mean-age of the air in the whole house drops from 1.28 h to 1.03 h. This implies that the air present in the house is replaced (exchanged) by new air more rapidly when the internal doors are closed.

Methods for determining the infiltration rate

The accuracy of different tracer gas methods is being explored as a part of the main project. Determination of the total infiltration rate by the decay method is based on the assumption that complete mixing is achieved in the whole ventilated space. When this is so the mean-age of the air at every point in the room is equal to the nominal time constant. Tests carried out with two mixing fans in the living room and one fan in the other rooms show that the variations of the mean-age of the air between the rooms lie in the range 10–30%. However the slope of the decay curve reflects a mean-value and therefore the variations of the slopes are less (5–20%).

The advantages of the more expensive constant concentration method are claimed to be as follows:

- the prediction of the total flow rate with a high degree of accuracy
- the prediction of the amount of air entering each separate room
- the prediction of the time dependent infiltration rate.

The results shown in figure 1 indicate that the total flow rate is predicted with an accuracy between 3–5%. However, when it comes to the second point above, i.e. the distribution of the air entering the house, the accuracy seems to be much lower.

It is difficult to understand why the total infiltration rate to the hall should be much greater when the doors are open compared with when all internal doors are closed. However it should be stressed that these results are very preliminary.

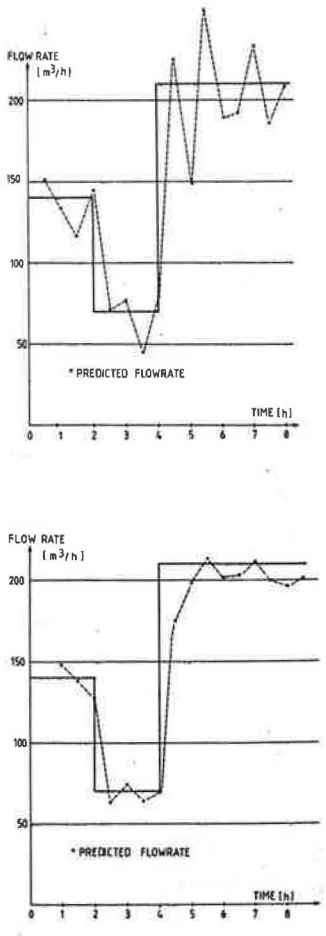

Figure 3

An example of the constant concentration method's ability to predict a time varying total infiltration rate is shown in figure 3. The response to a step change in total infiltration rate is shown. The predicted value constitutes an average over a time period of half an hour. In the first figure a control algorithm with a proportional and integration part has been adopted. In the other figure a derivation term has been added in the former control algorithm.