USERS INFLUENCE ON THE AIR INFILTRATION

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Summary

To measure actual air infiltration in dwellings due to the house and the inhabitants it is necessary to measure continuosly for several days. This can be done by the constant concentration measuring method.
The measurements show that in houses with a reasonably low AIR ($0,2-0,5h^{-1}$) the inhabitant has the major impact (up to 50-75%) on the total AIR.
This must be taken into consideration when designing mechanical and natural ventilation systems.

Introduction

The aim of this part of the project is to see if it is possible to measure the influence on the AIR (Air Infiltration Rate) from the behaviour of the inhabitants, and to estimate the necessary area of ventilation openings to allocate the fresh air to the rooms wanted.

Measuring Equipment

The measuring equipment has been designed to measure the air infiltration rate continuously in up to 10 rooms. The equipment is controlled by a computer and the measuring - that normally lasts a week - is automatic. The measuring data are gathered on a diskette during the measurement. The measuring principle is tracer gas according to the "constant-concentration-method". During the measurement the equipment will keep up a constant concentration of tracer gas in the room, and the air change rate is then determined on the basis of the quantity of tracer gas that it is necessary to supply to the room to keep up the concentration.

Our analyses of possible measuring errors and our control of the measuring equipment as compared with reliable references show that the measuring method is very accurate. When measuring small to moderate air infiltration rates the inaccurancy is $\pm$ 5%.

It appears that the measuring equipment may also be applied to other purposes; it has thus been applied for quantiying the short circuit in case of mechanical ventilation between injection and exhaust.

Measurement of air infiltration rate in dwellings at Galgebakken

Measurements of natural air infiltation rates in dwellings due to the behaviour of the inhabitants, and to ventilation openings.

Summary

The AIR - when the dwellings are used by the inhabitants (called UAIR) - has been measured in 7 houses during a period totalling 61 days from October 1983 - April 1982. The UAIR has been measured for every single room.

The condensed results are shown in table 1.

The variations in the UAIR shown in fig. 1, 2, 3, 4, 5 and 6 are typical for the 7 houses, and the influence of the inhabitant's behaviour on the UAIR.

Fig. 1 and 2 show the difference in the same house during the school holidays (fig. 1) and during school days (fig. 2). In this house the UAIR varies from UAIR = $0,7h^{-1}$ in fig. 1 and to UAIR $\simeq$ $0,3h^{-1}$ in fig. 2.

Fig. 3 and 4 show the normal pattern of ventilaton due to excessive use of windows.

The Figures (1, 2, 3 and 4) show that the UAIR exceeds the basic AIR with closed doors and windows by a factor of 2 - 5.

Conclusion

1. The behaviour of the inhabitants has, by far, the major influence on the total air infiltation rate in a house with natural ventilation.
2. The influence of the behaviour will give a UAIR of nearly 1 - 5 time the basic AIR with windows and doors closed.
3. In reasonably thight houses with a basic AIR of the magnitude of $0,2h^{-1}$ it is necessary to install ventilation openings to ensure a proper and good ventilation.
4. To ensure a reasonable AIR it is necessary to install ventilation openings of the magnitude of 100 - 200 cm^2 in each room, totalling 500 - 1000 cm^2 for the houses measured.
5. The ventilation openings must not be placed in the same height and in the neutral pressure zone in the wall (due to thermal convections).
6. It is reasonable to assume that properly designed and placed ventilation openings will be used constantly and in agreement with needs.
   The need for using the windows as ventilation openings will then be reduced, thereby reducing the UAIR.

Table 1

House No.	1	2	3	4	5	6	7	3a	Average House 1-7
Terrace house, 2 storeys	x	x			x	x	x		
Atrium house, 1 storey			x	x				x	
Area m^2	75	51	113	113	130	75	51	113	72
Volume m^3	184	130	261	261	299	184	130	261	190
Number of rooms	3	1	5	5	4	3	1	5	3
Number of inhabitants	3	2	4	4	4	1	2	4	3
Month (of measuring)	10	12	12	1	2	2-4	2	4	10-4
Outdoor temperature °C	6	1	-5	-8	-1	2	0	6	-1
Outdoor humidity % RH	90	87	94	90	91	82	89	73	89
Wind velocity m/sec.	4	6	4	4	5	5	6	4	5
Room temperature °C		21	22	22	22	21	23	21	22
Indoor humidity % RH		47	42	47	42	44	45	54	45
Air change n/h	0,52	0,43	0,67	0,43	0,38	0,46	0,54	0,8	0,49
Air change m^3/h	95	56	175	112	114	84	70	208	101
Basic air change n/h	0,12	0,22	0,22	0,27	0,22	0,20	0,25	0,10	0,21
Basic air change m^3/h	22	29	57	70	66	37	33	26	45
m^3 fresh air per person/h	32	28	44	28	29	84	35	52	40

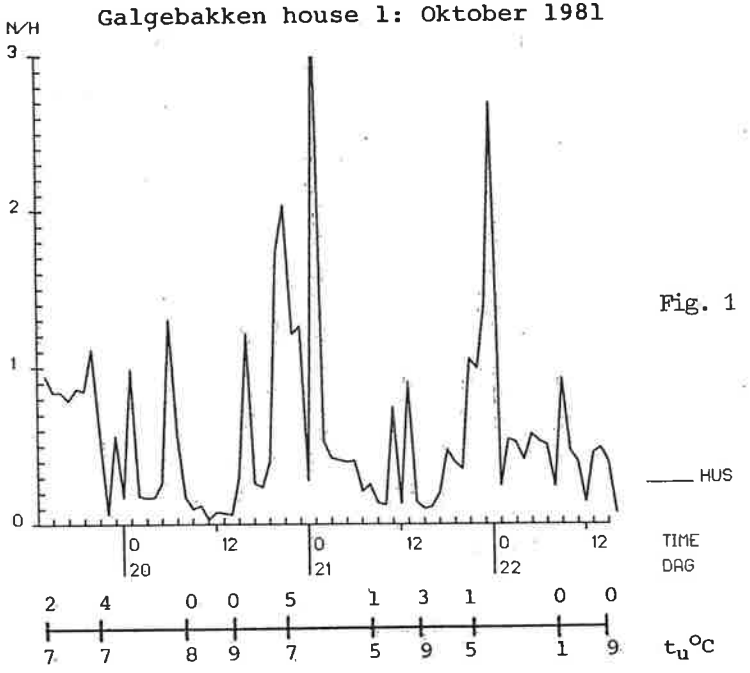

Fig. 1

Note! The autumn holidays of the school are from October 19 - 22.

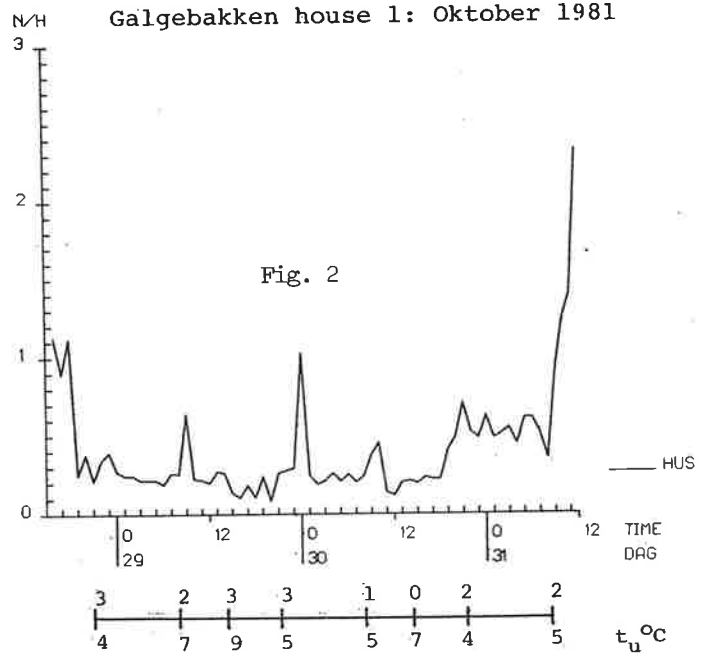

Fig. 2

Galgebakken house 2: November 1981

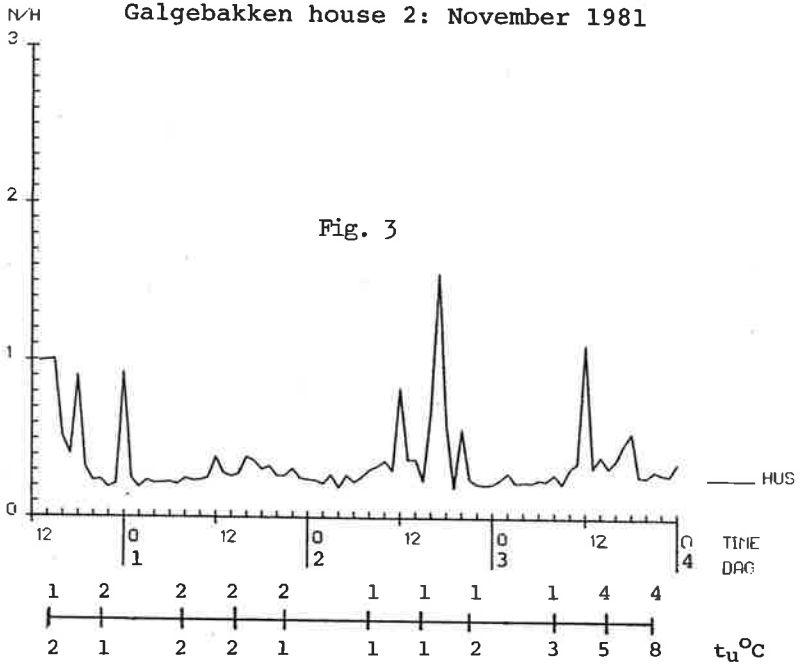

Fig. 3

Galgebakken house 2: November 1981

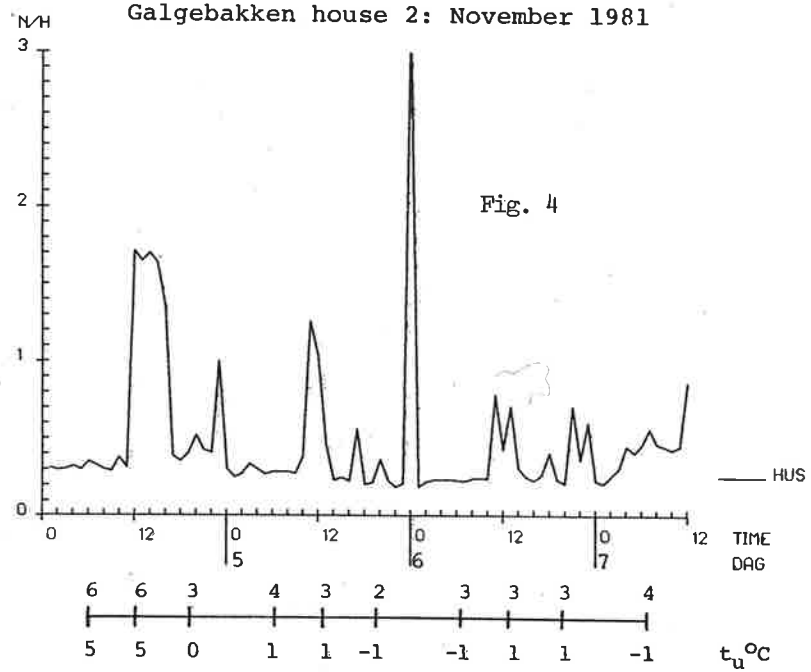

Fig. 4

Galgebakken house 5: Februar 1982

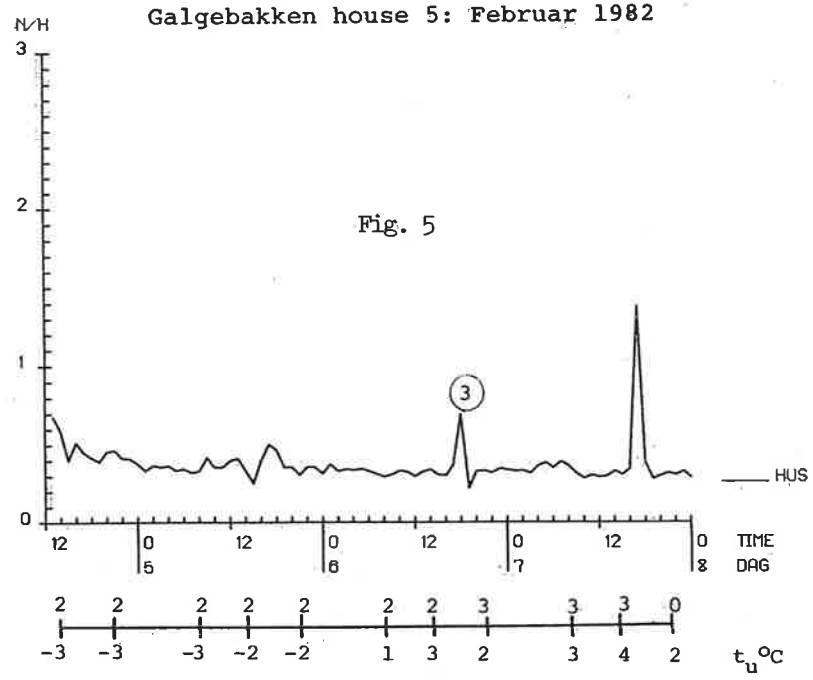

Fig. 5

③ Ventilation of room, approx. 15 min.

Galgebakken house 5: Februar 1982

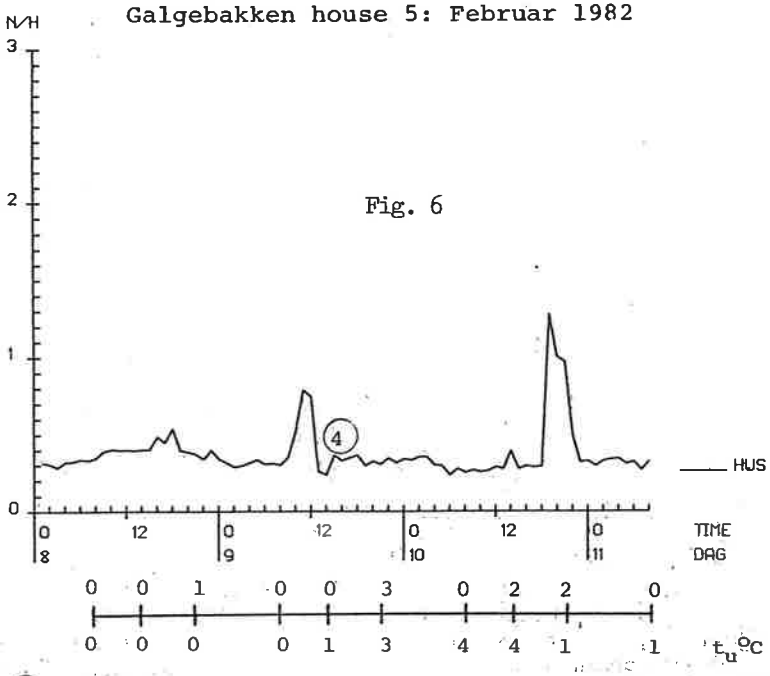

Fig. 6

④ From 12 - 2 p.m. metal ventilation openings closed, at 2 p.m. ventilation openings open.