THE INFLUENCE OF AGEING AND AIR CHANGE ON THE EMISSION RATE OF GASES AND VAPOURS FROM SOME BUILDING MATERIALS

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Introduction

Results from earlier experiments have shown that the indoor air often contains a large number of organic gases, vapours and odours.

Moreover, it has been proved that the organic gases and vapours in the indoor air are almost the same, which are released from building materials. Consequently, it could be assumed that the building materials may be an important source of the indoor air pollution of the nature mentioned above.

The emission from building materials as a function of time has been examined, and also the effect of the air change on the emission rate is determined.

Materials and experimental equipment

Based on a study on emission from 42 different building materials (1), five materials with low, medium and high emission rates were chosen for the present experiment. The five materials were floor coverings of linoleum, of polyvinylchloride (PVC), a carpet of nylon, a glue product and a gypsum plasterboard.

The emission from the building materials were measured in five stainless steel test boxes - one for each material. The volume of each box was 225 l. It was possible to regulate the temperature, the air humidity and the air change in the boxes, but during the experiments they were kept constant at 23°C, 45% RH and 0.25 h^{-1}.

The air samples absorped on charcoal were analysed on a computerized gaschromatograph and a massspectrometer (GC-MS). The content of total amount of hydrocarbon (THC) in the air was analyzed by a flame ionization detector (FID) too.

Odour judges (6 persons) evaluated the smell from the boxes. The judges used 4 different methods of evaluation:

Dynamic butanol reference scale, dynamic triangle olfactometer, verbal description of the smell (Harper), and an estimate of the nuisances by completing a questionnaire.

The concentration of organic gases and vapours was measured with 3 different areas of each material in the box, but at the same air change of 0.25 h^{-1}.

Table 1. Areas of material and air supply

Experiment no.	Specific air change h^{-1}	Area of material m^2	Area/vol $m^2 \cdot m^{-3}$	Fresh air $l \cdot m^{-2}$ material
1	0.21	2.69	12.0	89
2	0.25	2.26	10.1	106
3	1.06	0.50	2.2	480

The areas of the materials correspond to the fact that the air change in an ordinary room in a flat, the children's room for instance, would be 0.21, 0.25 and 1.06 in experiment no. 1, no. 2 and 3, respectively.

Measurements of each of the 5 materials were made in order to determine the influence of time on the emission rate. The measurements were made with intervals during a period of up to 9 months. During the entire period the air change in the boxes was 0.25 h^{-1}. The measurements of the emission rates in each experiment continued until the equilibrium concentration was achieved.

Results

29 different chemical substances were identified from the 5 materials. For 4 materials the weight quantity of the identified substances was higher than 80%. For the fifth material (gypsom plasterboard) the weight quantity of the identified substances was less than 6% (~ many substances, but in so small concentrations that they were under the limit of identification). Toluene was identified as emission from all 5 materials, and it was also the substance which had the highest concentration. Table 2 shows the distribution of the substances in chemical groups.

Table 2. The distribution of the 29 identified substances in 4 chemical groups

Group	Number	Weight %
Aromatic hydrocarbons	16	55
Alifatic hydrocarbons	3	10
Terpines	4	14
Miscellaneous (5 alcohols)	6	21

The absolute concentrations of substances in the air are given in Table 3.

The detection limits of the method for one particular substance was normally appr. 100 $\mu g/m^3$.

Table 3. Weight of substances in the air found by the initial measurements

Material	Weight in mg/m^3 by initial measurement
linoleum floor covering	19.6
polyvinylchloride (PVC)	2.2
nylon carpet	0.16
a glue product	814
gypsom plasterboard	0.65

The influence of the specific air change

Fig. 1. The influence of the specific air change on the average equilibrium concentration. The abscissa is the reciprocal value of the specific air change (hours), the ordinate is relative concentration expressed as the percentage of the first measurement. Each coloumn shows average and distribution for the 5 materials examined. The results are based on the total number of measurements.

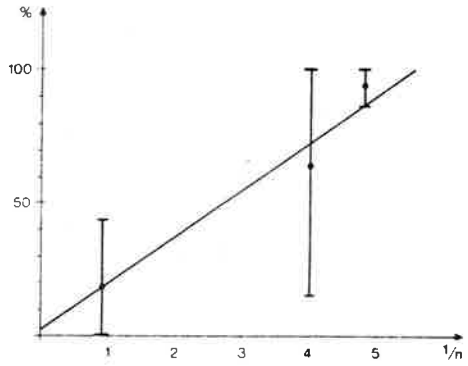
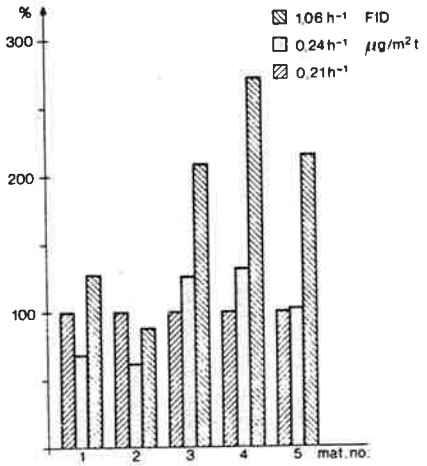


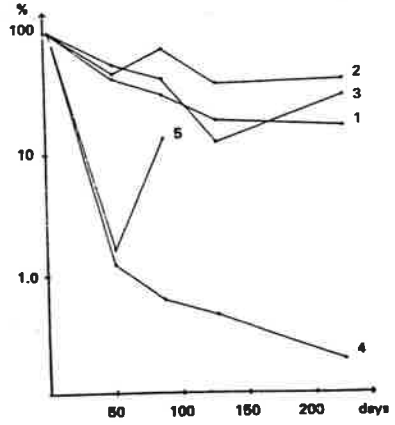
Fig. 2. The influence of the specific air change on the emission concentrations. The ordinate is the emission concentration expressed as the percentage of the value measured at an air change of 0.21 h^{-1}.



The evaluation by the odour judges showed that, if the four evaluation methods are taken together, more acceptable odour levels were found with increased specific air change.

The influence of ageing

Fig. 3. The influence of ageing (time) on the relative concentration of substances. The concentration is given as a percentage of the highest concentration of each material at the first measurement. The last measurement was made about 240 days after the first one. During the whole period an air change of 0.25 h^{-1} was maintained in the test box as described above.



The evaluations of the odour judges showed that a decrease in the odour levels was found in all the four methods used during the experimental period.

Discussion and conclusion

The influence of the air change

If it is assumed that the materials used in the experiment represent an average of those used as building materials, the anticipated equilibrium concentration of substances as a function of the air change can be calculated.

Fig. 4 shows the influence of the anticipated equilibrium concentration of substances emitted from new building materials.

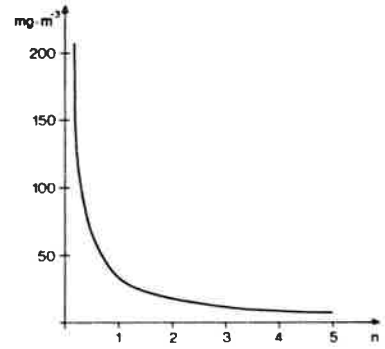


Fig. 4 also illustrates that increasing the air change with the aim of preventing problems caused by emissions from building materials or furniture has only a small effect in a leaky house (air change higher than 1 • h^{-1}. Moreover, the Fig. shows that a reduction of the air change in a reasonbly tight house (air change less than 1 • h^{-1} - 0.5 h^{-1}) may result in a considerable increase in the concentration of gases in the room air.

The influence of ageing

The total concentrations decreased with time for all five materials. For four of the materials - the floor coverings and gypsum plasterboard - the initial half-value period was about 40 days. The emission from these materials slowed down considerably after about 100 days. Concerning the glue product the concentration decreased to appr. 1% of the initial level

in the course of the first 51 days. Then the emission rate went down to a half-value period of 80 days. However, after 51 days the concentration was still higher than the initial concentration of the other materials.

The experiments indicate that very high emission rates can be expected during a period of about 100 days after the building has been finished. During this period a high air change must be maintained in order to avoid high concentrations of substances emitted by the building materials.

Acknowledgement

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References

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SUMMARY

P.A. Nielsen: The influence of ageing and ventilation on the emission rate of gases and vapours from building materials. The present paper describes a study of the influence of the air change and the ageing on the emission from 5 different building materials. The paper concludes that, with the aim of preventing problems caused by emissions from building materials, it is of practically no importance to increase the air change in a rather leaky house. It is also assumed that a reduction of the air change in a tight house may result in a considerable increase in the concentration of substances in the room air. For all 5 materials the emission rate decreases with time. The experiments indicate that, especially during the first 3 months after the building is finished, very large concentrations of emission products from the newly manufactured building materials will be present in the room air.

RESUME

P.A. Nielsen: L'influence de l'âge et de la ventilation sur l'emission des gaz et des vapeurs émanant des matériaux de construction. Cette communication décrit une recherche scientifique sur l'influence de la ventilation et de l'âge sur l'emission de cinq differents matériaux de construction. On est arrivé à la conclusion que, en vu de lutter des problèmes causés par les agents émis des matériaux de construction, il est inutile d'augmenter la ventilation dans un bâtiment d'un étanchéité faible. Egalement il est conclu qu'une réduction de la ventialtion dans un bâtiment étanche peut résulter en une augmentation de la concentration des gaz dans l'immeuble. Pour tous les cinq matériaux une réduction de l'emission au cours de l'age etait constaté. Cela indique que, surtout pendent les premiers 3 mois après la finition d'une constructions nouvelle, il sera des grandes concentrations des produits de gaz dans l'immeuble émanant les frais matériaux de construction.

KURZFASSUNG

P.A. Nielsen: Der Einfluss des Alterns und Luftwechsels auf die Entgasungsgeschwindigkeit der Gase und Dämpfe von Baumaterialien. Dieses Papier beschreibt eine Untersuchung über den Einfluss des Luftwechsels und des Alterns auf die Entgasung von 5 verschiedenen Baumaterialien. Im Papier ergibt es die Folgerungen, dass es nur von geringer Bedeutung ist, das Luftwechsel in einem undichten Haus zu erhöhen, um Probleme zu bekämpfen, die von Stoffen von Baumaterialien abgegeben verursacht sind, so wie es konkludiert ist, dass eine Reduktion des Luftwechels in einem schon dichten Haus eine kräftige Erhöhung in der Konzentration der Stoffen in der Raumluft verursachen kann. Was alle 5 Materialien betrifft, nimmt die Entgasung mit der Zeit ab. Die Untersuchung deutet darauf hin, dass besonders den drei ersten Monate nach der Endfertigung eines Neugebäudes besonders grosse Konzentration von Entgasungsprodukten in der Luft sein werden, die von den neuhergestellten Baumaterialen herrühren.