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Average concentrations of compounds in Air rooms

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Abstract: Carpet is used in many countries a room and its fixation with adhesive resulting in an increase of the concentration of volatile organic compounds (VOC) in the air, while carpeting is the source of 4-phenylcyclohexene, which is responsible for the typical carpect odour, and of styrene and 2- ethylhexanol, the use of adhesives introduction generally aromatic hydrocarbons. The levels of these VOC are judged to be sufficiently high to explain complaints like those associated with the sick building syndrome.
Keywords: Volatile organic compounds, 4- pheny1cyclohexene, 2- ethylhexanol polymer.

INTRODUCTION

In Iran, about 30% of all carpeting is made of polyamide with a backing of either fabric or foam of synthetic latex. Emissions from such carpeting include a large number of volatile organic compounds (VOC)[1,2,3], among them one odoriferous substance, 4-pheny1cyclohexene. This compound of one of the reaction products formed during the manufacturing process of the backing, which is mostly a styrene/butadiene polymer[4].

Complaints about perception of bad odour, headache and irritation of mucous membranes in buildings where using snch carpets, we investigated VOC emissions from the carpeting both under test chamber and filed conditions. This paper deals with the results of these investigations, which also includes head-space experiments to determine the emissions from adhesives and related products used to fix the carpeting.

EXPERIMENTAL

VOC were collected by both active and passive sampling. For active sampling commercial charcoal tubes were used with flow-rates of 10 and 100 1/h, respectively. Passive sampling was done using samplers. Also for active sampting with home- made tubes. VOC collected on charcoal tubes and passive samplers were desorbed with carbon disulphide and analysed in a dual – column system as described elsewhere[5]. Recovery experiments were carried out for 3 important compounds for which no respective date were available from earlierstudies: 4-phenylchclohexene (PCH), 2-ethylhexanol and styrene. Active and passive samplers were spiked with standard solutions, the substances were desorbed after 24 h and analysed as usual. For PCH and 2-ethylhexanol recoveries of about 100% and 60% respectively, were observed[6]. At a total load of the sampler of about 20/ug, recovery was about 60% for styrene in the case of passive samplers; with charcoal tubes no styrene could be detected. Thus, charcoal tubes were not analysed quantitatively for styrene. All concentrations given in the following were corrected according to the results of the recovery experiments.

Confidence limits of the results are estimated to vary the sampling procedure.

The emissions from polyamide carpeting with a laminated fabric backing and from adhesives and ancillary products were studied using a dynamic and a static head – space procedure, respectively. The dynamic procedure was used in combination with a 100 – ml glass flask and a 1-m^3 test chamber. For the experiments with the small glass flask, six pieces of the carpeting with 10 cm^2 each were placed in the flask held at about either 25 or 50 °C. the flask was purged with a stream of putified nitrogen at several liters/h. the gas steam leaving the flask was conducted through either tenax/carbosieve or charcoal cartridges for various time intervals. In another part of the experiments, a piece of carpeting (70 cm ×80 cm) was placed in a 1-m^3 chamber. At a ventilation rate of 0.7$h^{-1,}$ air samples were taken at different times between day 1 and day 60 after the start of the experiment.

Head – space analyses of five different products used to fix the carpeting were carried out ambient temperature. The sample of 0.1 m1 was taken directly from the head-space of each commercial container. Passive samplers were exposed in 12 rooms (n= 6) were investigated starting on day 3 after installation the new carpeting, for group II rooms (n=3) about one month had elapsed since the respective wotks. Rooms of qroup III (n=3) served as a control, no carpeting having been layed. The samplers were exposed for 2 weeks in the centre of each room at about 1.20 m height. Occupants were asked to maintain their usual ventilation habits[6]. In addition to passive sampling, active sampling was carried out ewith charcoal tubes over periods of 60 minutes: two consecutive samples were taken in one of the group I rooms and one sample was collected in one room of each, group II and III.

3.RESULTS

The dynamic head- space analyses of the carpeting revealed that PCH was the main componet emitted into the gas phase. The nature of the also indicates the relative compostion of the gas phase. Compounds No. 6 and 9 could not be identified definitely even using the mass spectrometer. However, there are indications that they belong to the class of polyglylycols.

From additional experiments with the 100 – ml flask, in which charcoal tubes were used, an emission rate of about 40 and 150/ug/m^2.h at 24 and 55°C, respectively, was calculated. These figures, however, cannot easily be converted into concentrations since for practical reasons the ratio of cut edges to total surface area was much higher than would ever be encountered in practice.

Limited information on the composition of two of the three adhesives as well as on two additional products used in lying the carpet could be obtained from the manufacturer.

As the percentages given relate only to the total VOC content of the gas phase above the product, the results do not reflect the composition of the product, but rather indicate the likelihood of finding the respective VOC in the room air. Also, since no check for the reproducibility was made, the confidence range of the figures given in table 1 may be relatively large; especially for compounds with a content blow 7% the results may vary by a factor of up to 2. The results obtained in the field study for the 5 most abundant VOC are summarized in table1, the data show that besides toluene and xylenes which were the main solvents in the adhesives and other products sued, three substances emitted from the carpeting namely PCH, styrene and 2-ethylhexanol, exhibited the highest concentration levels in the air of the offices. Obviously, the decay rate of toluene was much higher than that of the other VOC, potential reasons being the higher volytility of toluene or its initially higher concentration level.

TABLE*1*: Average concentrations (and ranges) of 5 major VOC in the air of group I,II and III rooms.

Compound	Concentration(/ug/m3)		
	3 days after laying of carpeting (Group I)	4 weeks after laying of carpeting (Grolup II)	Control (Group III)
4- PCH	43 (29 – 45)	17 (12-17)	<1 (<1)
Styrene	27(16– 30)	10(5-13)	3 (2-5)
2- Ethylhexanol	44 (24-72)	19 (11-26)	<1 <1 to 1)
Toluene	2028(1200- 2400)	312 (190-400)	21 (13-27)
m/p-Xylene	26 (18-29)	18 (10-27)	6 (6-7)

4. CONCLUSIONS

Equipping rooms with wall – to – wall carpeting introduces a number of voc into the air of these, some of which being odoriferous, others being irritants. The typical carpet odors is caused by 4-phenylcyclohexene, the concentration of which may reach the order of some 52/ug/ m^3. Among other VOC observed in indoor air after new carpeting was layed out were styrene and 2-ethylhexanol. Bath substances are formed during the manufacturing process of the carper backing and are known to be irritants. In the offices studied here, their initial concentration level was about 10 times higher than was the 90 percentile obtained from a randomized study of indoor air. Even after a period of 3 weeks, much higher concentrations than in the air of control offices were observed.

The levels of toluene, which is frequently used as a solvent in adhesives used to fix the carpet, were high and reached 2 mg/m3 on average even 3 days after the carpeting had been installed. Such elevated levels of toluene may be – either by the substance itself or its combined presence with smelling PCH and / or other voc – at the origin of complaints of the occupants and be in part responsible for effects like the sick building syndrome. It must be emphasized that the level of 2 mg/m3 measured here can easily be emphasized that the level of 2 mg/ m3 measured here water – based adhesives are used. In an earlier study(2) , an initial concentration of about 30 mg/m3 of toluene had been observed after a room had been equipped with new carpeting, which was fixed with an adhesive containing twice the amount of toluene than the adhesives used here. Unfortunately, no attention had been payed to PCH at the time of that study. Carpeting with foam backing may give rise to a greater variety of voc in indoor air than was observed here. As an exmple, head – space experiments conducted with foam – backed carpeting, which could not be described here, revealed the presence of a larger number of voc among others amines and butanoic and maleic acid esters. Like PCH, these classes of compounds are likely to add to the perception of assessment of toxic heavy metal pollution in urban atmosphere in Tehran.

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