

OCCURRENCE OF CHLORINATED NAPHTHALENE IN INDOOR AIR OF SCHOOLS AND  
KINDERGARTEN

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Volatile organic chemicals (VOC's) can be found in indoor air at high concentrations due to offgassing from furniture, building materials etc.. Especially log-homes and buildings with particle board elements have caused concern due to release of the wood preservative pentachlorophenol (PCP) and formaldehyde. Following complaints about bad odour and health problems in two schools we studied the indoor air quality in these and similar buildings. 1-chloronaphthalene and dichloronaphthalenes (CN) were identified as major indoor air contaminants.

#### METHODS

Standard methods were used for sampling chemical substances in air. Briefly VOC's were collected on activated charcoal (Draeger), desorbed with carbondisulfide and analyzed by means of GC-FID (Perkin-Elmer 8500, column: 30m DB624) (fig. 1). Further analysis of signals with retention time > 40 minutes by GC-MS (Finnigan ITD 700) identified monochloro- and dichloronaphthalenes (fig. 2, 3), this was confirmed by means of a reference material for monochloronaphthalene (Fluka).

#### RESULTS and DISCUSSION

Concentrations of VOC's were in the range commonly found in indoor air (Seifert et al., 1986), however the occurrence of chloronaphthalenes is a new and so far unexpected finding, they are not listed as typical indoor air contaminants (Berglund et al., 1984). This obvious discrepancy between the lack of data on CN's in indoor air and the encountered concentrations was the reason to investigate the phenomenon in more detail. Indoor air analysis of similar and different constructed buildings revealed CN as a significant contaminant only in one type prefab-building with walls, floors and ceilings made from particle board (table 1) built in the seventies. In brick and concrete buildings and one prefab-school built before 1969 no CN was detected.

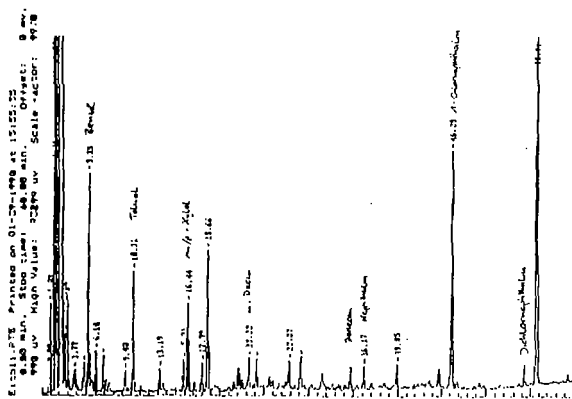


Fig. 1: GC-FID chromatogram of indoor air from a classroom, school A, depicting monochloronaphthalene at :46.29 min.

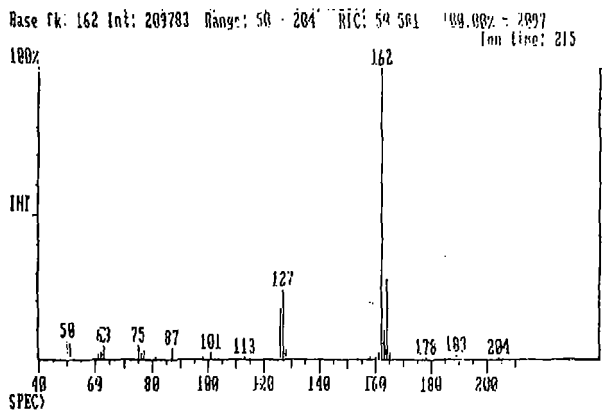


Fig. 2: ITD mass spectrum of monochloronaphthalene from indoor air.

Comment: LUFTPR. NUFARB. DAMM, 49-249, 1111-A, 1500V, 2UG  
 Scan Range: 1201 - 1800 Scan: 1800 Int = 3917 @ 34:01 RIC: 100% = 37746

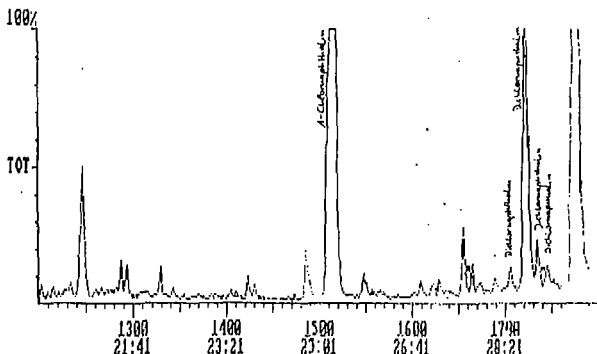


Fig. 3 : GC-ITD chromatogram, full scan

Table 1: Naphthalene and Cl-Naphthalene in indoor air ( $\mu\text{g}/\text{cbm}$ ).

Building	Naphthalene	1-Cl-Naphthalene
School A entrance	-	12.5
classroom	2.7	26.3
classroom, 14 °C	1.0	14.4
, 28 °C	4.9	45.5
School B classroom	1.0	23.3
classroom	-	9.0
School C classroom	2.1	33.7
School D classroom	-	2.1
classroom	-	3.6
Kinderdergarten	-	5.8

Air sampling, if not indicated at room temperature 21 °C.

Analysis of building materials (GC-MS following soxhlet extraction) from one school revealed that CN was present at concentrations between 20 and 30 mg/kg in particle board used for construction of walls and ceilings. Only traces were found in timber posts and other construction material, most likely due to diffusion and adsorption from the impregnated particle board. The indoor air concentration of CN is mainly influenced by ventilation rate and temperature, as another confounding factor humidity of the particle board might be of importance with higher volatility from wet and decomposed material.

Inquiries revealed that a wood preservative containing CN was added during fabrication of the particle board for protection against fungal attack (rot). According to Ullmann (Encycl. d. Techn.Chemie) monochloronaphthalene was an ingredient of several products. One of them, Basileum SP 70 was an BGA approved oily, organic solvent type wood preservative for particle board and plywood protection and in use from 1970 to 1980. Approx. 1% to dry chips and 8 kg/cbm of finished plywood were recommended. Technical monochloronaphthalene contains impurities of naphthalene (N) and higher chlorinated CN's (N 5%, I-CN 78%, Di-CN 15,7%, Tri-CN 0.3%). Many prefab-buildings for public and private purposes were buildt in the sixties and seventies when there was a shortage of schools, kindergartens and housing, because they were rapidly buildt and inexpensive compared to conventional houses. At present it is not known how many buildings and-if any-private homes are affected, however CN has since been found by others in similar day-nurseries in quantities of >100 µg/cbm (sum CN's) (Stauff, pers.communication).

Chloronaphthalene has a typical mouldy odour, which was perceivable even at the low concentrations encountered. It is noteworthy, that in the past the bad smell in the schools was attributed to water damage and mould. The parents reported that they could smell the typical school-odour when the children returned from classes. Health problems reported by some of the exposed children were nasal and ocular manifestations like nasal irritation, itching and burning of the mucous membranes of the eyes, headache and alleged irritation and allergy of the skin. At present it is not possible to attribute all the symptoms solely to CN's, since in the most affected buildings there were also problems with water damage and mould. No serious health problems have been presented so far.

Limited evidence is available on the chronic inhalation toxicity of the lower chlorinated compounds. Mono-/Dichloronaphthalenes are considered to have low toxicity and do not accumulate in biological systems. The higher chlorinated congeners (PCN's) especially the Penta-/Hepta combinations resemble in their toxicity the polychlorinated biphenyls (PCB's) and dibenzodioxins (PCDD's) according to an EPA report(1982), causing damage of the liver and chloracne. In conclusion we wish to point out chloronaphthalene as a possible indoor air contaminant associated with impregnated particle board. Maximum CN concentrations found in indoor air are in the upper range of reported values for other aromatic contaminants. The encountered concentrations might be associated with health complaints and are regarded as undesirable.

#### REFERENCES

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