CONTAMINATION WITH POLYCHLORINATED BIPHENYLS AND NAPHTHALENES FROM ELECTRONIC EQUIPMENT

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ABSTRACT

Electronic equipment in the laboratory was found to emit polychlorinated biphenyls (PCBs) and naphthalenes (PCNs). The chromatographic pattern of PCBs was similar to Clophen A40 and Clophen A50 and that of PCNs was similar to Halowax 1014. The source of the contaminats was located to capacitors and wire coatings.

INTRODUCTION

Polychlorinated bipheyls (PCBs) have been used in many different products (i.e. plastics, paints, hydraulic oils, electronic equipments). Due to their favourable electrical properties, they are still used in transformers and capacitors, which are considered to be closed systems. Polychlorinated naphthalens (PCNs) have physical and chemical properties similar to PCBs and they have been used for similar applications[1]. PCBs are well-known pollutants which are commonly found in our environment and humans. Their ubiquitous occurrence is partly explained by the atmospheric distribution and fallout[2-5]. However, only a few reports describe the indoor contamination. Caulking material used on buildings may contain PCBs[6] and indoor contamination due to caulking material between concrete panels covering a building has been reported[7]. In another investigation defective fluorescent light ballasts were identified as a source of indoor contamination with PCBs[8].

PCNs have not been used to the same extent as PCBs. However, they have been found in environmental samples[9-10], indicating pollution from unknown sources. The present study[11] shows that commonly used electronic equipment may contaminate the indoor environment with PCBs and PCNs.

MATERIALS

Gas chromatography-mass spectrometry (GC/MS)

GC/MS analyses were performed using a VG 7070E mass spectrometer with VG 11-250 data system. The accelerating voltage was 6 kV and the ionization was made by electron impact at 49 eV. The resolution at m/z

293 was 8000-9000. The technique of selected ion recording was used in the determinations. Two ions of the molecular cluster were monitored. Helium was used as carrier gas. The gas chromatographic separations were made on an SE-54 fused silica column (25m x 0.32mm, Quadrex Co., New Haven, CT, USA). An all-glass falling-needle injector was used at a temperature of 250-260°C. The column temperature was kept at 190°C for 8 min and then programmed at 5°C per min to 270°.

Gas chromatography (GC)

The GC analyses were performed using an electron capture detector and the SE-54 fused silica column as described above. The temperature was 190°C for 15 min and then programmed at 2°C per min to 240°C.

Solvents and standards

All solvents were of analytical reagent grade and were redistilled. The PCB products Clophen A30, Clophen A40 and Clophen A50 and the PCN product Nibren D88 were from Bayer AG, Leverkusen, Germany. The PCN product, Halowax 1014, was from Koppers Co., Pittsburgh, PA, USA. The compounds were dissolved in hexane and used as standards for comparisons.

EXPERIMENTAL AND RESULTS

During analyses of organochlorine compounds in biological samples PCBs and PCNs were suddenly detected in the blank samples. The air in the laboratory was suspected to be polluted. In order to locate the source, clean glass dishes were placed in different rooms close to the laboratory for 2-4 days. The dishes were rinsed with hexane and the rinse was analysed by GC/MS. The deposit of PCBs and PCNs was highest on the dish placed in the control unit of an old mass spectrometer, stored in the corridor next to the laboratory while waiting for transport to be discarded.

Different parts of the equipment were monitored. The capacitors were first rinsed with hexane in order to avoid contaminants transported via air or by direct contact with other parts of the equipment. Then part of the capacitor was soaked in hexane for 2 min. and the extract was purified with conc. sulphuric acid. Electric wires with coatings were treated similarly. The upper part of a small transformer was rinsed twice, the second rinse was cleaned-up with sulphuric acid. The purified extracts were analysed by GC and GC/MS. The gas chromatographic analyses of the extracts from old capacitors and wires showed a complex peak pattern. Analysis by GC/MS confirmed that the patterns of the compounds found in the electronics, Figs 1 and 2, were similar to those found from the deposit on the dishes and corresponded to PCBs and PCNs. Parts of the old equipment (from 1969-1975) and recently purchased (1991) capacitors and wires were monitored. PCBs and PCNs were also found from one of the new capacitors. In contrast, the new wire did not emit these compounds.

DISCUSSION

The application of PCBs and PCNs in e.g. fireproofing agents, electronic equipment and wire coatings was designed for products used at workplaces as well as in homes. It may be assumed that components

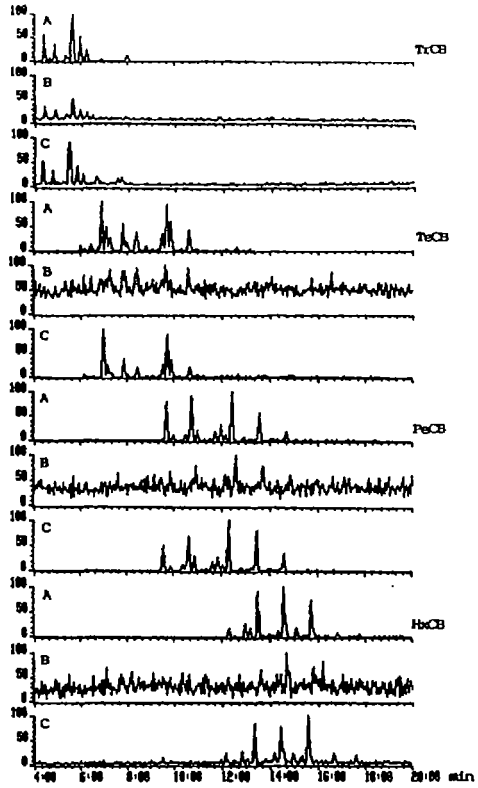

Fig. 1. Selected ion chromatograms of PCBs containing 3-6 chlorine atoms ($[M+2]^+$) obtained from the hexane wash of an old capacitor (A), a new capacitor (B) and 100 pg Clophen A50 (C).

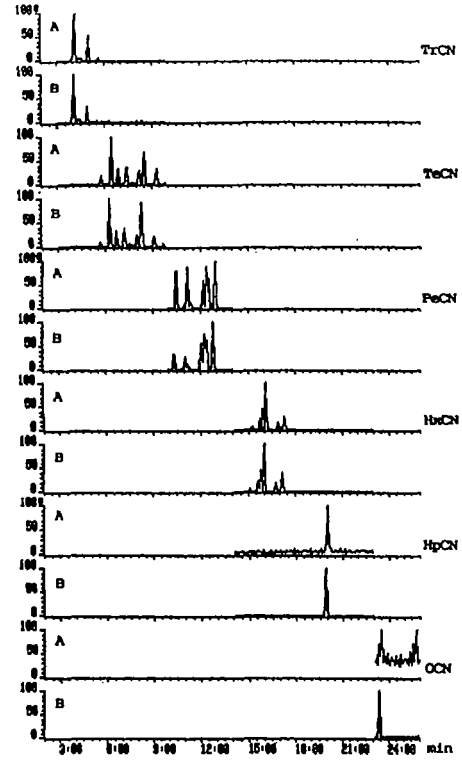

Fig. 2. Selected ion chromatograms of PCNs containing 3-8 chlorine atoms ($[M+2]^+$) obtained from the hexane wash of an old capacitor (A) and 100 pg Halowax 1014 (B).

such as capacitors and wires from the 1970s are still in use, and the fact that the substances were also found in recently purchased products indicate that the migration of PCBs and PCNs from electronic equipment may be considerable. The contamination of the indoor environment from such sources has been poorly investigated. It can also be noted that much attention has been paid to PCBs during the last decades while relatively few investigations of PCNs have been published. Certain congeners of PCBs and PCNs are inducers of enzymes which is considered an evidence for toxic activies of high potency[12-13]. The extent of occurrence of such compounds in indoor environment is therefore of great interest.

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