Sanitation of a PCB-Contaminated Building

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Introduction

Polychlorinated biphenyls (PCB) are — in despite of prohibited use in european countries — still major contaminants in the food chain. Most of the daily intake of 0.1 µg/kg b.w./day is ingested orally. However indoor air contamination, as recently reported due to Thiokol sealants used in prefabricated concrete buildings, with concentrations in the 1 - 10 µg/m^3 range contributes as a significant additional exposure. We wish to report on the progress of procedures taken for sanitation of an office building with indoor air PCB-contamination between 1 and 3 µg/m^3 [1)], with emphasis on difficulties removing secondary contamination and use of a new adsorbent wall paper.

Material & Methods

Building: The fifteen-storey "Mercator-House" in Kiel was built in 1969 with prefabricated concrete elements and joints sealed with a sulfide polymer (Thiokol®) containing 30 % Clophen A 40. Following the discovery of significant indoor air contamination (1 - 3 µg/m^3) the building was evacuated and several steps for sanitation were pursued during the last 12 months. Noteworthy are secondary contaminations of the room-walls and ceilings (50 - 100 mg PCB/m^2). The sanitation process and each step to reduce the contamination was followed closely by means of standardized indoor air measurements.

Indoor Air: Samples were taken during daytime in the unoccupied room with closed windows and tape sealed doors by means of a NI-calibrated Desaga GS 312 gas sampling pump with an air flow of 2.5 l/min and a total volume of 1 - 2 m^3, the air was passed through a glass tube (12 mm x 180 mm) filled with 8 g of Florisil® and wads of glass wool. Room temperature, outdoor temperature - because of the observed relationship between temperature and PCB-indoor air concentration - and atmospheric pressure were measured. For comparability the room temperatures were kept between 20 and 24 °C.

Analytical methods: The glass wool and the florisil bed were transferred into a chromatography column (Ø 15 mm), filled with 20 ml n-hexane. The column was eluted with 40 ml of n-hexane followed by 20 ml of n-hexane/dichloromethane (80:20 v:v). After evaporation of the solvent to a final volume of ~2 ml in a rotary evaporator and further concentration under a gentle stream of nitrogen the residue was redissolved in a defined volume of n-hexane (1 - 5 ml). GC-ECD was performed on a Varian-GC 3400 equipped with a 30 m DB5 capillary column. Detection limit for single PCB-congeners was 0.1 ng/m^3. According to a recommendation of the German Federal Health Office (bga)[2)] 6 indicator congeners (Ballschmiter/IUPAC No: 28, 52, 101, 138, 153, 180) were quantified by means of single standards (Promochem Corp.) and total PCB-concentration was calculated as 5 times the sum of the congeners No: 28, 52, 101, 138, 153, 180 ($5 \times \Sigma 6$)[3)].

Sanitation: Several different procedures of sanitation (A - F) were undertaken to reach a longterm indoor air PCB-concentration below 300 ng/m^3. The course of the indoor air PCB-concentration was followed by close air-monitoring (at least once per fortnight)

A: Sealing of the Thiokol® rubber containing gaps with a tight bitumen-aluminium tape of 20 cm width.

B: Extirpation of the Thiokol® rubber with a sharp knife, sealing of the gaps with a PCB-free sealant, exchange of the PVC-floor with new linoleum-floor and repainting.

C: Extirpation of the Thiokol® rubber with a sharp knife, sealing of the gaps with a PCB-free sealant, exchange of the PVC-floor with new linoleum-floor, aluminium-foil equipped wallpaper only at the single primary contaminated wall (window-side) and repainting.

D: Extirpation of the Thiokol® rubber with a sharp knife, sealing of the gaps with a PCB-free sealant, exchange of the PVC-floor with new linoleum-floor, aluminium-foil equipped wallpaper on every wall and repainting.

E: Extirpation of the Thiokol® rubber with a sharp knife, sealing of the gaps with a PCB-free sealant, removing of the wall paint by caustics (Molto paint remover "spezial", Molto GmbH, Löhnberg/Lahn, Germany), exchange of the PVC-floor with new linoleum-floor, repainting.

F: Extirpation of the Thiokol® rubber with a sharp knife, sealing of the gaps with a PCB-free sealant, exchange of the PVC-floor with new linoleum-floor, use of a special adsorbent wallpaper TaP 12 (Blücher Corp., Erkrath, Germany) (fig. 1) on the walls and the ceiling and repainting.

Results and Discussion

Sanitation procedures A - D had only interim effects on the PCB-indoor air concentration. Concentrations decreased immediately after the renovation but returned to longterm-levels well above 300 ng/m^3 within 3 - 4 months (fig. 2).
The off scraping of the wall paint with a commercial paint remover (procedure E) resulted shortly after the procedure in indoor air concentrations in the range of 600 ng/m^3. Application of an airtight aluminium-foil which sealed the total wall (procedure D) achieved indoor air concentrations with a mean below 300 ng/m^3, lower long term results were obtained with the adsorbent wallpaper (procedure F) (fig. 3). The wallpaper contains 200 g activated carbon per m^2 and was developed especially for decontamination purposes (fig. 1).

In the meantime several buildings with Thiokol® related indoor air contamination have been identified and caused great concern especially in schools. The problem was discussed intensively and a working party was set up by the German building (ARGE Bau) and health authorities (ABLMB, uba, bga). In september 1994 the PCB-guidelines were introduced and have since been implemented into federal states legislation[4)].

The guideline sets as a limit value 3000 ng/m^3/24 h occupancy, derived as 100 % of the present ADI of 1 µg/kg b.w./day. The recommended sanitation level is one tenth of the level of concern: 300 ng/m^3. The latter value is comparable to the proposed NIOSH risk assessment[5)] with 500 ng/m^3.

Previous steps of sanitation were unsatisfactory if only primary contamination and not secondary contamination was regarded. The lesson learned from sanitation procedures B - D is the importance of secondary contamination, especially from walls, ceilings and floors. Elsewere the wall-plaster has been removed by labour and energy intense and costly measures (e.g. liquid nitrogen freezing and removal of the brittled concrete and plaster). At first only aluminium-foil equipped wall-paper seemed to solve the problem of secondary contamination (procedure D). However covering of the walls and ceilings with air tight aluminium-foil equipped wallpaper has negative impact on indoor air climate and might cause a tight building syndrome in occupants. The recently developed adsorbent wall paper TaP 12 by the Blücher Company is an alternative and elegant solution to reach the aim of an indoor air concentration below 300 ng/m^3 and offers the opportunity of later decontamination when the process of adsorption is in equilibrium. The adsorbent wall paper can then be removed together with the PCB-containing activated carbon[6)]. The binding capacity of 200 g activated carbon is well above the maximum measured contamination of 73 mg PCB/m^2 painted plaster and should not be limited due to competition by other volatile indoor air contaminants.

We will further follow closely the time course of PCB-indoor air contamination, at present the use of adsorbent wallpaper seems to be a promising method of sanitation for PCB and other semivolatile contaminated buildings.

References

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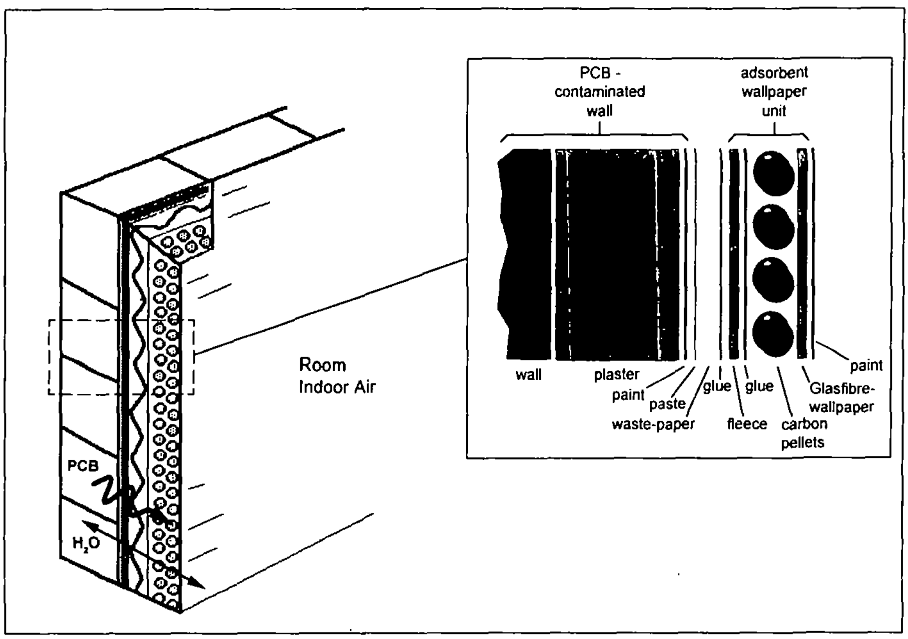

Figure 1. Layers of the PCB-contaminated and wallpaper TaP12 equipped wall

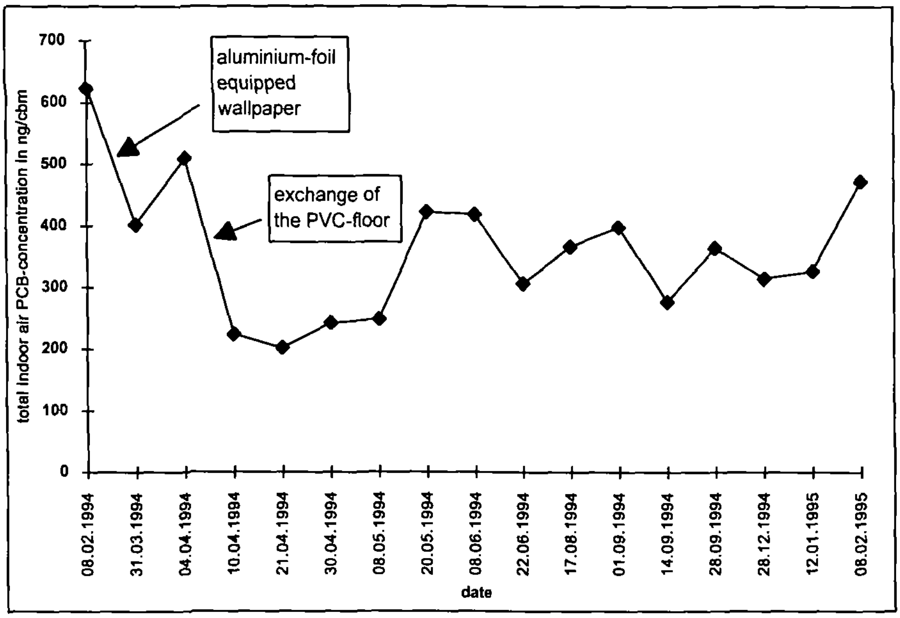

Figure 2. Total indoor air PCB-concentration of sanitation procedure C

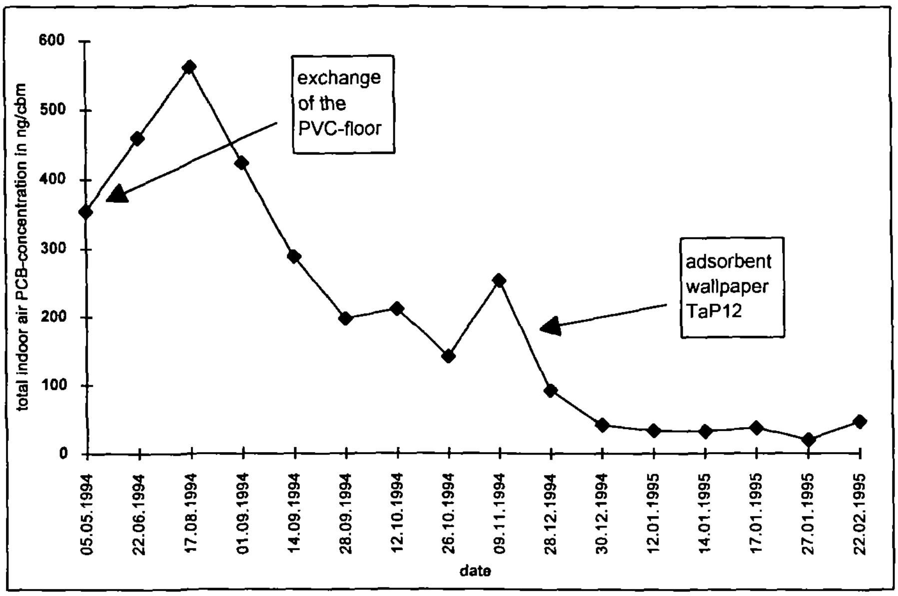

Figure 3. Total indoor air PCB-concentration of sanitation procedure F (use of the special adsorbent wallpaper TaP12)