PCB IN SEALANT IS INFLUENCING THE LEVELS IN INDOOR AIR

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Introduction

PCBs were used in different kinds of building material in many countries during the fifties to the early seventies. In Sweden this occurred during the period 1956 - 1972. The most important of these building materials were presumably sealants used between concrete blocks and around windows and doors on the outside of the building. The total amount of PCB that has been used for this purpose in Sweden has been estimated to 70-190 tons[1]. The PCB concentration in such sealants has today been found to be from a few percent up to around thirty percent but considerably lower concentrations have also been found, probably as a result of contamination. The original PCB content in the current sealants is however unknown. It was anticipated that the PCB would stay in the sealant and in the buildings as long as the sealant was not removed. However, later investigations have shown that PCB could escape from the buildings into the environment and that it also could be found in indoor air[2-5].

Different measures have since long been taken in order to decrease the leakage of PCB into the environment, mainly from different kinds of electrical equipment. These measures have resulted in decreasing PCB levels in biota, including man, in most of the industrialised world.

In order to remove the remaining PCB in Swedish buildings, the Eco-cycle Council of the Building Sector has launched a programme that comprises inventories, development of environmentally sound methods and removal and destruction of the current sealants. Therefore they have published instructions on the screening procedure (which buildings should be investigated, how should sampling be performed etc.) in order to get reliable information for the further efforts. So far the screening procedure has included chemical analyses to be able to decide whether dismounting should be performed or not. If the sealants are found to contain more than 500 ppm of PCB dismounting is recommended. Certain equipment has been developed for this process and routines have been worked out in order to achieve a sound work environment and to reduce the emission of PCB into the environment during the dismounting process. The sealant and other PCB-contaminated material generated during the process will eventually be destroyed at a hazardous waste incineration plant. The dismounting process has caused some harassment among the people living in the current buildings, as it has not been possible to answer the entitled question: "Have we been living in a poisonous building?" This study has been performed in order to generate information that would facilitate the possibilities to answer that question.

Material and Methods

A residential area, built in the early seventies, was identified in Solna, north of Stockholm, Sweden. The area was chosen as contained buildings with as well as without PCB containing sealants, thereby suitable for comparative studies. Data from this area, both "study" and "control", will be referred to as "Series 1". The buildings in the area are materially identical and so is the social structure. The primary use of PCB containing sealant in the current area was for tightening between balconies and outer wall. As a number of these balconies later had been furnished with windows, the balcony doors had been kept open during part of the year, which led to that these sealants materially often became a part of the indoor environment.

Recording of PCB in indoor air was performed with 17 (10 study and 7 control) samplers in 13 (9 study and 4 control) different flats in the area. Sampling was performed with semipermeable membrane devices (SPMDs) set out in the different flats for two weeks. The sampling equipment was developed by the Institute of Environmental Chemistry, Umeå University, and is described by Strandberg[6]. All samplers were set out in bedrooms or living rooms. In one flat two samplers were set out in different rooms. For further details see table 1.

One of the advantages with this type of passive sampler is that it does not prevent people from living in the flat during the sampling period. There are also some limitations as the method primary reflects substances present in gaseous face and that it will not give a direct measure of the concentration of the current substances but the amount sampled during the sampling period. This implies that the results will be relative rather than absolute. To be able to convert the relative recordings into more absolute concentration levels, another set of five samplers were set out together with active electrostatic samplers in a second area where PCB containing sealants previously had been identified. Three of these samplers were set in empty flats and the remaining two on open balconies of the same flats. Result from these recordings will be referred to as "Series 2".

The analyses were performed at the Institute of Environmental Chemistry, Umeå University, as described by Strandberg[6]. In total, some 20 PCBs were determined in each sample, which required a higher resolution than commonly used. The reason for applying this high resolution was to gain information on as many congeners as possible in order to be able to compare the different congener patterns.

The results of the different recordings were studied with principal component analysis, PCA, a multivariate method suitable for extraction of systematic variation in complex matrices. For this purpose we used the software package SIMCA P 8.0 (from UMETRICS, Umeå, Sweden). With multivariate methods, it is possible to investigate the relations between all variables in a single context. The software also makes it possible to display these relationships as plots.

Result and Discussion

In Table 1 the preliminary results are given as ng/sampler. The primary results have been corrected considering the length of each sampling period, result from the blank samplers. These corrected results are given as averages and standard deviation in Table 2.

When comparing the total PCB concentration in flats with PCB sealants, as given by series 1 and 2, no materially differences could be detected. Similarly, no real differences could be detected between the outdoor recordings in series 2 and the indoor recordings in series 1 from flats without PCB-sealants. On the other hand it could be noticed that the patterns of all samples analysed in series 2 showed profound similarities independent of if the samples were taken indoors or outdoors in spite of the fact that the total amounts differ with almost two orders of magnitude. These relationships are illustrated in Figure1.

Table 1: Recorded amounts of PCB in each sampler, total and expressed according to degree of chlorination (ng/sampler).

Code	PCB seal-ant	Σ Tri	Σ Tetra	Σ Penta	Σ Hexa	Σ Hepta	Σ Octa	Σ Tri-Octa
P1	Yes	1800	930	62	6.4	1.3	0.066	2800
P2	Yes	3200	1700	91	11	4.3	0.051	5000
P3	Yes	3000	1500	86	16	10	0.14	4600
P4	Yes	4600	2800	170	14	2.4	0.081	7600
P5	Yes	2700	1100	55	4.8	1.1	-	3900
P6	Yes	3200	1500	67	5.1	1.3	-	4800
P7	Yes	2200	1500	110	7	1.1	-	3800
P8	Yes	6500	4300	230	14	2.1	-	11000
P9	Yes	8500	5200	470	22	3.4	0.087	14000
P10 (=P9)	Yes	6000	3300	200	15	2.6	-	9500
K1	No	40	47	18	6.7	1.3	-	110
K2	No	38	30	6.2	3.8	1.1	-	79
K3	No	34	33	11	9.5	4.6	0.093	92
K4	No	36	42	14	13	7.4	0.14	110
K5 (=K4)	No	140	84	20	8.5	1.7	-	250
K6	No	120	69	17	7.2	1.7	-	210
K7 (=K6)	No	18	16	6	4.3	1.2	-	46
S1	Yes	2500	4700	970	1100	230	0.89	9500
S2	Yes	1700	3100	640	830	190	0.69	6500
S3	Yes	1900	3200	820	1200	340	1.5	7500
S4 (balcony)	-	28	51	11	8.8	2.9	-	100
S5 (balcony)	-	28	51	12	8.2	2.4	-	100
Blank 1	-	2	2	-	-	-	-	4
Blank 2	-	2	2.1	-	-	-	-	4.1

Table 2: Calculated PCB concentration in air in flats with and without PCB-containing sealants, and in outdoor air. Standard deviation is given in parentheses.

Sample type	Preliminary calculated PCB-concentration ng/m^3
Flats with PCB-containing sealants (Series 1+2)	366 (158)
Flats without PCB-containing sealants	6 (3,4)
Ambient air, buildings with PCB-sealants	5 (0,06)

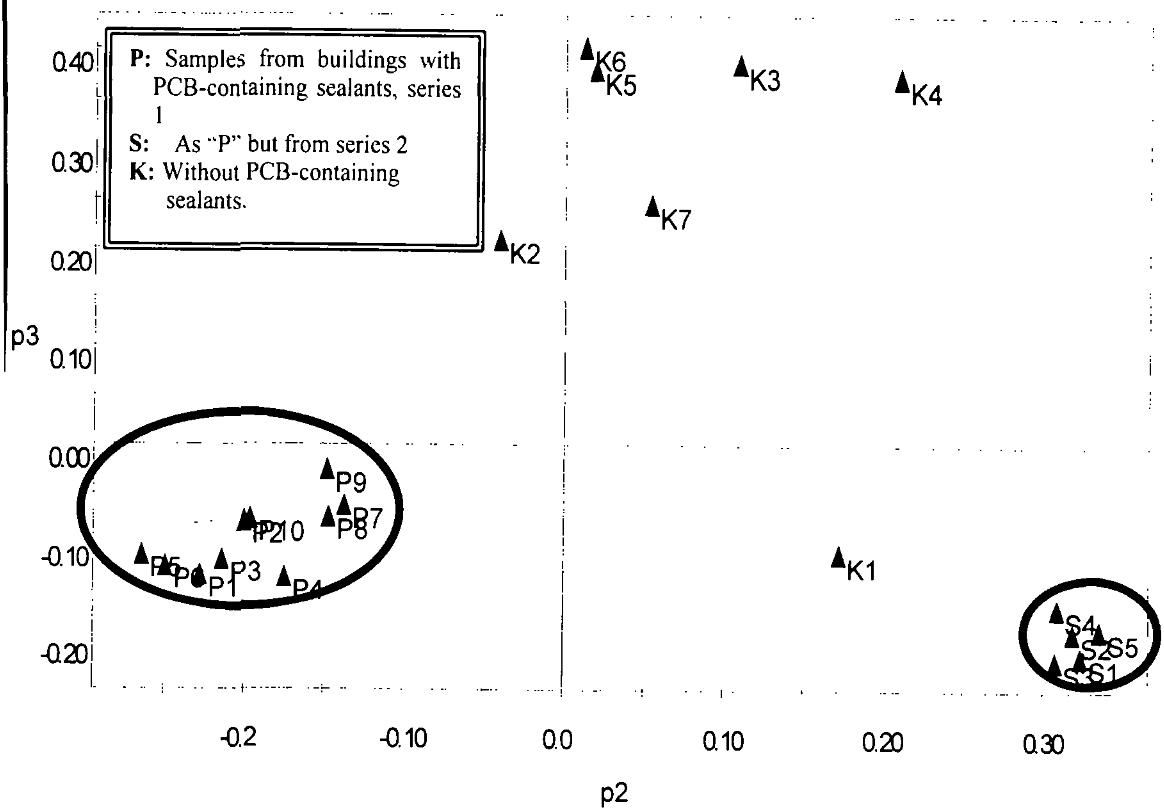

Figure 1: Loading plot of the second (p2) and third (p3) principal components proceeding analysis of the 22 samples (objects) with reference to 20 different PCB-congeners. The plot shows how the objects relate to each other. Object close to each other carry similar information, while those far apart show great difference with respect to the information they contain.

The PCA of the entire data set resulted in many interesting results. The analysis generated six significant (cross validation, 95%) components. The first component is based upon almost 85 % of the total systematic variation and can be almost exclusively related to simple co-variation between the different congeners. That is, if one congener is high, the other congeners are also elevated and this co-variation is obviously very strong. The consecutive principal components (no. 2 and 3) represents further 10 % of the total systematic variation. When these two, pattern related components are plotted versus each other, the plot shown in figure 1 is generated. Object belonging to series 2 are closely grouped in the lower right corner. These samples are closely correlated to the presence of PCB 52, plotted to the same area in the corresponding "score plot" based on second and third principal components. One group of objects from series 1 are plotted in the lower left hand corner. They are correlated to low relative concentrations of PCB 52 but relatively high levels of a number of high-chlorinated congeners. The remaining samples from series 1, representing buildings without PCB sealants, show less concordance compared to the other groups. They distribute over a considerable central area, indicating a lower degree of contribution from these objects to PCA components 2 and 3. However, a number of low chlorinated congeners, but also high-chlorinated congeners as 138 and 153 are plotted in the same area in the score plot mentioned above.

Conclusions

The indoor air concentration of PCB in buildings containing PCB sealants can be up to two orders of magnitude higher compared to similar buildings without such sealants. The toxicological significance of this finding is uncertain. Tentative calculations indicate that such exposure via indoor air could contribute significantly to the general exposure via food. A follow up study of PCB levels in blood in persons that have been living in the current buildings is under way.

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