AMBIENT AIR LEVELS OF POLYCHLORINATED BIPHENYLS AT DIFFERENT SITES IN HESSEN, GERMANY

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Introduction

Since the end of 1989 the GfA have been conducting an ambient air measurement program in Hessen (Germany) assigned by the HLfU to get a general view of the actual impact by polychlorinated aromatic compounds[1-4]. This paper presents the ambient air levels of polychlorinated biphenyls (PCB) measured at nine different sites in the period from 1990 to 1992. A special attention is drawn to the annual trend of the PCB concentrations as well as to the portion of the so-called DIN congeners.

Materials and Methods

For sampling, a modified LIB sampler was used in accordance to the draft of the VDI-Guideline 3498, part 2. Behind the particle filter an adsorption unit consisting of three polyurethane foams was arranged in series to collect the gaseous portion of the PCB. Per year 21 samples each representing a measuring time of 72 h and an air volume of approx. 1000 m^3 were taken at the individual sampling sites.
After sampling the glass fiber filters and the corresponding PU-foams were Soxhlet extracted with toluene for 20 h. A portion of 15 % of these extracts was treated with several $^{13}C_{12}$-labelled PCB standards and cleaned-up according to the German DIN 51527, part 1, employing commercially available cartridges containing benzenesulfonic acid and silica. Additionally, silica impregnated with sulfuric acid was used. The consecutive analysis was carried out by capillary-column gas chromatography and mass spectrometry using selected ion monitoring.

Results and Discussion

The annual means of the total PCB concentrations (total is standing for the sum of all congeners belonging to the tri- to decachlorinated homolog groups) are summarized in Table 1 for all sites.

Table 1: Annual means of the total PCB concentrations resulting from measurements from 1990 to 1992 at nine sampling locations in Hessen

Sampling Locations		Concentrations of Total PCB (ng/m^3)		
		1990	1991	1992
ID Codes	Name	Annual Means	Annual Means	Annual Means
A	Biebesheim	0.66	a	a
B	Crumstadt	0.42	0.35	0.37
C	Frankfurt (F)	9.55	a	a
D	F-Griesheim	1.08	0.94	1.35
E	Hanau	1.01	0.78	0.72
F	Kassel	a	1.02	1.03
G	Kirberg	0.62	0.51	0.54
H	Offenbach	a	0.51[b]	
I	Stadtallendorf	1.63[c]		a

ID codes = Identification codes
a No measurements were performed in this year
b This annual mean represents the period from 03/91 to 02/92
c This annual mean represents the period from 07/90 to 07/91

Neglecting the comparatively high PCB concentration at location C in 1990, the annual means obtained from 1990 to 1992 at the different sampling sites are in the range between 0.35 and 1.63 ng/m^3. It is noteworthy that the lowest concentrations were not observed at the supposed background station G, which is located in a rural area without particular emission influences, but at sampling site B, which is also located in a rural area but additionally in lee of an industrial area with potential emission sources. The highest concentrations were found in urban areas characterized by industry and/or heavy traffic.

At four locations the PCB measurements were performed during the whole period of three years. As it can be seen from Table 1, there is a general decrease of the PCB concentrations from 1990 to 1991 in the range of 13 to 23 %. From 1991 to 1992 the PCB level remains nearly constant at three sites, whereas an increase of about 44 % can be observed for location D located in a highly industrialized area in the conurbation of the Untermain district.

Due to the traffic and building density at location C in the center of Frankfurt the sampling device was installed on the flat roof of a public building. The results

obtained at this sampling site in 1990 are presented graphically in Figure 1. Compared to the PCB burden at all other locations the level in Frankfurt was rather high, especially resulting from extremly high concentrations (up to 24.3 ng/m^3) in the summer months. Subsequent investigations showed that the exceptional concentrations were obviously caused by evaporation of PCB from materials used as sealants for the prefabricated concrete elements of the building on which the sampling device was placed.

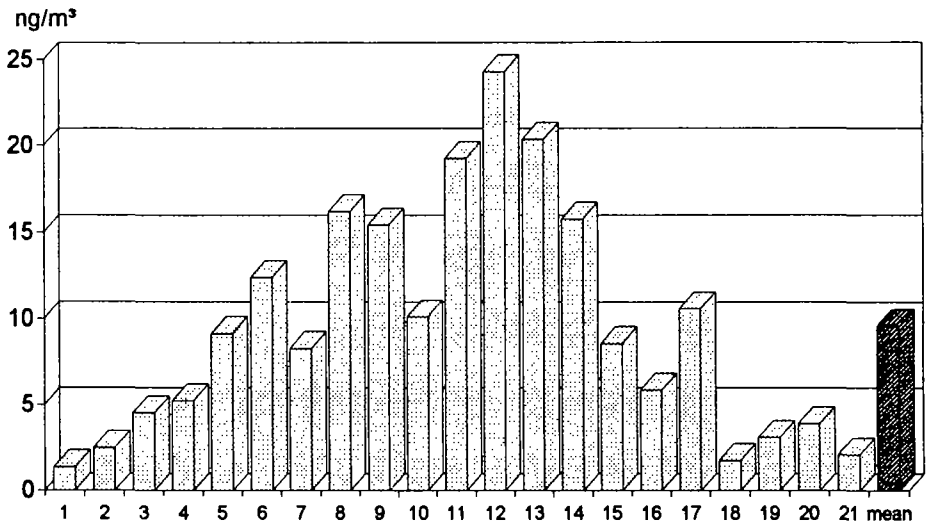

Figure 1: PCB concentrations for all measurements performed at location C in the center of Frankfurt in 1990

Regarding the seasonal fluctuations of the PCB concentrations at the other locations it becomes obvious that, predominantly, the levels are higher in the summer months, but no sampling site showed an annual trend as evident as location C in Frankfurt. Although several different patterns of seasonal fluctuations could be observed, no contrary trend with a low level in the summer and increasing concentrations towards the winter months was found. This indicates that, in contrast to substances like polychlorinated dibenzofurans and dibenzo(p)dioxins or polycyclic aromatic hydrocarbons, which are preferably generated by combustion processes, evaporation from different materials is the major source for PCB in ambient air.

In Germany PCB measurements in ambient air usually include the analytical determination of six congeners (IUPAC No. 28, 52, 101, 153, 138, 180) according to the German DIN 51527, part 1. Usually a factor of 5 is used to calculate the total PCB concentration (LAGA recommendation). However, hardly a factor is mentioned to find out the total PCB concentration as defined above. In order to

get an idea of this factor, the concentrations of the so-called DIN-congeners were deter-mined additionally for all samples investigated. The factors obtained by dividing the total PCB concentrations by the sum of the DIN-congeners vary between 2.9 and 13.0 resulting in an over-all mean of 4.3. The frequency distribution of this factor is shown in Figure 2. The most frequent factor calculated from a total of 373 samples is approximately 4.

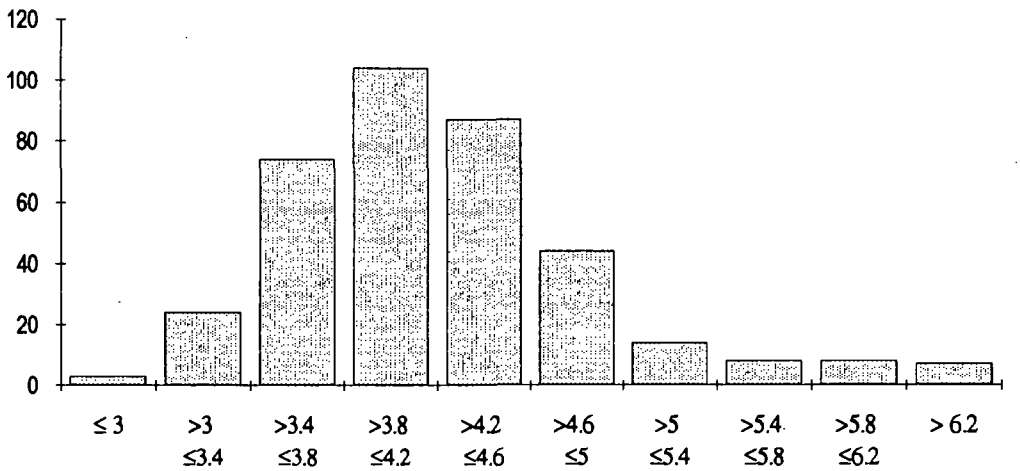

Figure 2: Frequency distribution of the factors obtained for all individual samples by dividing the total PCB concentrations by the corresponding sums of the DIN-congeners

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