Distribution of PCBs in Environmental Media around Industrial Complex, Korea

Park Un[1]

[1]National Institute Of Environmental Research

Introduction

As it is increasing in population and industrial activity is getting various and complex, a number of chemicals had been used in human life and some of them were prohibited in production and usage due to their toxicity and harmful effects to environment. PCBs are one of those compounds, which are of great concern worldwide, especially in international conventions such as Basel and Stockholm Convention.

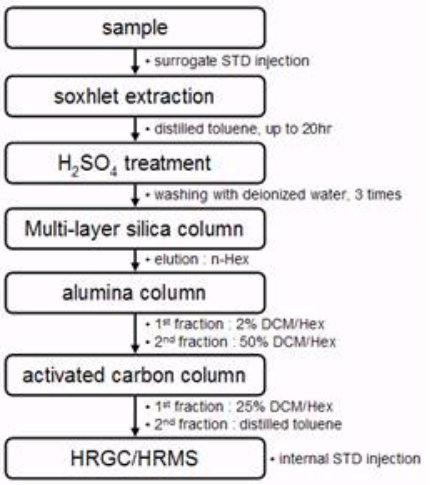
Although PCBs are having been issued in the world from earlier, in Korea it is regarded that PCBs wastes are not well-managed and disposed completely. Furthermore, concentration in environmental media as well as emission amounts is not grasped clearly.

Therefore, in this study, we determined the whole PCBs congeners in environmental media around industrial complex to investigate the concentration distribution and compare distribution patterns between environmental media.

Materials and Methods

Sample collection and analytical method

Eight soil samples and six air samples were collected in industrial area using pre-cleaned core-sampler made of stainless steel and high volume air sampler. Sampling method was based on *Analytical Methods of Endocrine Disrupting Chemicals* (NIER, 2002). After pretreatment such as drying, sieving and etc, each sample was extracted by soxhlet extraction apparatus with distilled toluene for more than 20hr. And then extracts were treated with H_2SO_4, followed by multilayer silica gel column, alumina column and activated carbon column. The sampling sites and the analytical flowchart of this study are depicted in Fig. 1 and Fig. 2, respectively.



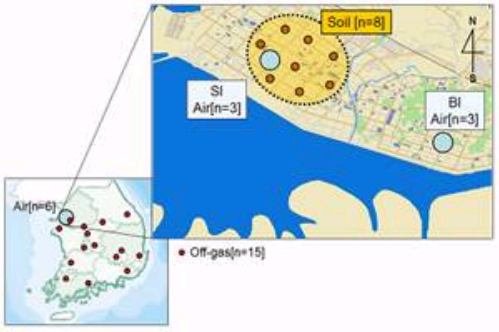


Fig. 1. Sampling sites Fig. 2. Analytical flowchart

Instrumental analysis

Total 209 congeners of PCBs were analyzed with HRGC (HP6890)/HRMS (Finnigan MAT 95X). DB-5MS column was used and isotope dilution method was used in quantification. More detailed information of instrumental condition is described in Table 1.

Table 1. Analytical condition and parameters of HRGC/HRMS

Instrument	HP 6890 Series

GC	Injector	Splitless
	Front inlet	270℃
	Interface	260℃
	Carrier gas	He, 1mL/min
	Injected sample volume	1
	Column	DB-5MS
	Temp. program	75℃(hold 1 min) - 40℃/min - 190℃(hold 0 min) - 1℃/min - 240℃(hold 0 min) - 10℃/min - 275℃(hold 6 min)
MS	Instrument	MAT95XP, Thermo Finnigan
	Ionization mode	Electron impact(EI) positive
	Detection mode	Selected Ion Monitoring(SIM)
	Ionization voltage	35eV,
	Ionization current	380uA
	Ionization temp.	250℃
	Acceleration voltage	4770V
	Resolution	>10000 (5% valley)

Results and Discussion

Concentration in environmental media

Concentration of air and soil samples was ranged from 2077.886~5817.746 pg/m^3, 2.432~273.989 ng/g dw, respectively. In TEQ value, air sample was ranged from 0.069~1.014 pg WHO-TEQ/m^3 and soil sample was from 0.116~60.509 pg WHO-TEQ/g dw. Ratio of coplanar PCBs to total PCBs was highest in soil-3 whose TEQ concentration was the highest. The analytical results are described in Table 2.

Table 2 Concentration of PCBs air and soil samples

Soil	HS-1	HS-2	HS-8	HS-12	HS-14	HS-17	HS-20	HS-5
total PCBs	3.971	5.930	273.989	3.764	209.105	2.432	36.230	6.440
1~3CB	3.253	4.016	5.446	2.841	47.188	1.384	10.511	2.175
co-PCBs	0.080	0.270	91.340	0.118	34.663	0.194	6.563	1.087
co-PCBs /total PCBs	2%	5%	33%	3%	17%	8%	18%	17%
WHO-TEQ	0.141	0.439	60.509	0.116	18.702	0.188	6.856	0.964

Air	SI-2	SI-3	SI-6	BI-2	BI-3	BI-6
total PCBs	2077.886	2707.174	3539.416	5817.746	2821.922	2585.276
1~3CB	1674.457	1404.965	2675.077	2907.233	1629.453	1305.796

co-PCBs	12.106	50.690	176.260	99.460	120.110	56.582
co-PCBs /total PCBs	1%	2%	5%	2%	4%	2%
WHO-TEQ	0.069	0.432	0.194	0.877	1.014	0.409

[1] Unit; air is pg/m^3, soil is ng/g dw.

[2] WHO-TEQ; air is pg WHO-TEQ/m^3, soil is pg WHO-TEQ/g dw.

[3] Total PCBs is sum of 1~10CB and 1~3CB was excluded in factor analysis.

Comparison of distribution patterns

Generally low-chlorinated PCBs (1~4CB) were dominant than high-chlorinated PCBs (5~10CB). In both air and soil, homologue distributions differed from sample to sample, but isomer distribution was very similar with each other in same environmental medium.

The factor score plot of air, soil and off-gas samples is showed in Fig. 3. In factor analysis, 1~3CB were excluded due to their uncertainty from low recovery rate and factor analysis was carried out using SPSS 10.0. In the factor score plot, off-gas samples were spread out relatively. It may be because off-gas samples were collected from numerous kinds of incineration facilities. Especially, F15 sample showed unique distribution pattern than other 14 off-gas samples.

Air and soil sample group were placed in a short distance. Actually, isomer distributions in each homologue of air and soil samples were similar with each other to some extent, although there was a little bit of difference. It could be caused because the sampling sites of air and soils were very near and regarded air and soil samples were affected by almost same sources of PCBs.

Additionally, it is considered that further investigation about sources of PCBs is necessary to make sure the relationship between environmental media and sources in Sihwa and Banwol industrial area.

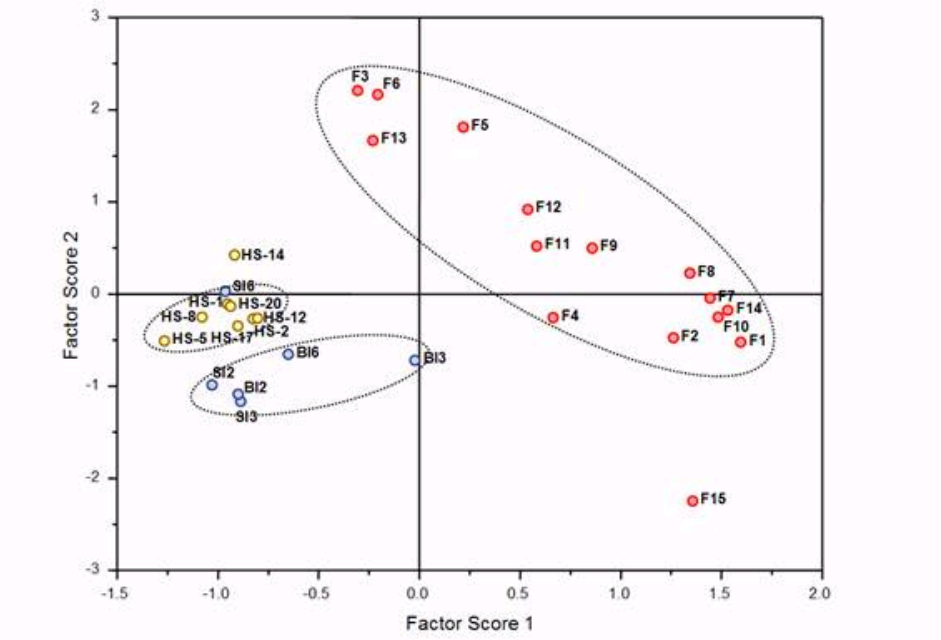


Fig. 3. Factor score plot of environmental media

References

1. Analytical Methods of Endocrine Disrupting Chemicals, National Institute of Environmental Research, 2005.

2. K. S. Kim, Shigeki Masunaga, Source apportionment of PCBs in urban ambient air, Japan. Organohalogen Compounds, Volume 66, 2004.

3. KyoungSoo Kim , Yusuke Hirai , Mika Kato , KouheiUrano and Shigeki Masunaga, Detailed PCB congener patterns in incinerator flue gas and commercial PCB formulations (Kanechlor), Chemosphere, Volume 55, Issue 4, Pages 539-553, April 2004.