AMBIENT AIR MONITORING OF PCDD/Fs FOR ASSESSING THE EFFECT OF EMISSION SOURCES TO THE ENVIRONMENT

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Introduction

Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/Fs) are extremely hazardous chemicals and they are known to be formed during combustion processes as well as natural processes. PCDD/Fs produced from incinerators are emitted into the atmosphere and then transported great distances before being deposited in other environmental compartments.

The identification of the source of contamination in an area is necessary to reduce the emissions and proceed with remediation of the impacted areas. The determination of characteristic homologue patterns in representative environmental samples is essential to evaluate the relationship among sources and impacted areas. Therefore, to trace the source, a comparison among PCDD/F homologue patterns in environmental samples and those in source emissions are made either by a simple direct comparison or by using statistical methods such as principal component analysis (PCA). (1,2)

In this study, the PCDD/Fs levels and homologue patterns were investigated in various incinerator emissions according to waste types and air samples collected near incinerators in Korea. Using a principal component analysis, we compared patterns of various incinerators and air samples, which became quite helpful in determining the relationships between incinerators and environments. In addition, we attempted to characterize the homologue patterns according to incinerator types.

Materials and Methods

Sampling ; Stack gas samples of eleven municipal solid waste incinerators (MSWIs), three small size incinerators (SIs), three industrial waste incinerator (IWIs), one hazardous waste incinerator (HWI) and sintering plant were collected following the Korean Standard Method which is a modified US EPA method 23. Ambient air samples were collected using a high volume air sampler (DHA-1000S, SIBATA). Twenty-one air samples were taken seasonally from August 1999 to March 2001 at four locations in Korea. Their specific locations are as follows, (a) site A; incineration area within 300 m distance of municipal solid waste incinerator. This site also has highways, a power plant and various kinds of factories. (B) site B; industrial complex of chemical and oil refinery industries. This heavy industrial complex was created in 1967 and one of the biggest industrial complex in Korea. (c) site C and D; located in the industrial areas neighboring the iron and steel foundries. Site A is located in the city but the other sites are located in suburban or rural area. The distance of site B and C is about 15 km.

Sample preparation was done according to the US EPA method 1613. PCDD/Fs were analyzed by high-resolution gas chromatography / high-resolution mass spectrometry (Hewlett-Packard Model 6890 series Ⅱ / JMS 700T) with a DB-5MS column (60m, 0.25 mm i.d. 0.25 um film thickness). As one of multivariate statistical techniques, principal component analysis (PCA) was used to

evaluate similarities or differences of PCDD/Fs homologue patterns in each environmental sample.

Results and Discussion

PCDD/Fs Levels; The PCDD/Fs concentration and the waste types in various incinerators are given in Table 1. The highest PCDD/Fs levels were observed in industrial waste incinerators which were mainly burning waste plastic. The PCDD/Fs concentrations in ambient air were 0.043 ~ 0.994 pg-TEQ/m^3 (2.17 ~ 65.6 pg/m^3) with an average of 0.304 pg-TEQ/m^3 (16.12 pg/m^3) in this study. Compared to previous reports (3), the PCDD/Fs concentration at incineration area (site A) was above that of urban/industrial areas and the PCDD/Fs concentration of other sites were similar to that of rural areas.

Table 1. PCDD/Fs concentration and waste types in various incinerators.

Incinerator	Waste type	PCDD/Fs conc	
		ng-TEQ/m^3	ng/m^3
MSWIs	food, paper, plastic, textile	6.57	390.2
SIs	paper, plastic, textile	15.41	654.4
I1	waste plastic	28.46	1471.4
I2	waste plastic,waste rubber, waste oil	6.65	363.4
I3	waste plastic, waste organic solvent, waste oil	31.38	3602.1
H1	waste oil, waste organic solvent	0.025	1.5
Sintering plant	lime, raw ore	1.67	74.4

Table 2. Total and TEQ-value of PCDD/Fs in ambient air samples.

site	Summer	Fall	Winter	Spring
incinerator area A	0.5255	0.9935	0.7645	0.561
	(32.51)	(65.6)	(27.19)	(27.79)
industrial area B	-	0.113	0.172	0.079
	-	(2.17)	(7.01)	(3.95)
steel industry area C	-	0.130	0.071	0.08
	-	(11.80)	(2.17)	(4.23)
steel industry area D	0.043	-	0.12	-
	(2.41)	-	(6.59)	-

unit ; pg I-TEQ/m^3 (total ; pg/m^3)

Homologue patterns according to sample types; We attempted to characterize PCDD/Fs homologue patterns of various incinerator groups using PCA and presented the results in Figure 1. MSWIs, SIs and a Sintering plant were clustered in one group, displayed homologue patterns dominant with low chlorinated furans (tetra, penta, hexa furans). Many studies have reported that the PCDD/Fs homologue patterns are similar for all thermal processes and more PCDFs than PCDDs are found in the flue gas (4). Therefore, PCDD/Fs homologue patterns in Group 1 was in

accordance with previous reports.
Group 2 was clustered with industrial incinerators burning waste plastic and homologue patterns for these facilities displayed high chlorinated furans (hexa, hepta furans). Group 3 included hazardous waste incinerators combusting waste organic solvent as well as one industrial waste incinerator. Their homologue patterns revealed that low chlorinated dioxin/furans were dominant. From these results, the characteristic homologue pattern was observed according to waste types.
All of the air samples, except A3, belong to one group regardless of sampling sites and 84.5% of variance is accounted for by the first principal component (Figure 2) and PC1 is mainly affected by tetra, penta, and hexa-CDFs. Tetra, penta, and hexa-CDFs are predominant in these air samples and this pattern is similar to that found in most of the stack gas samples (MSWIs, SIs, Sintering plant). From this result, the most of Korean air samples have a similar homologue patterns and might be influenced by the thermal sources like Group 1.

References

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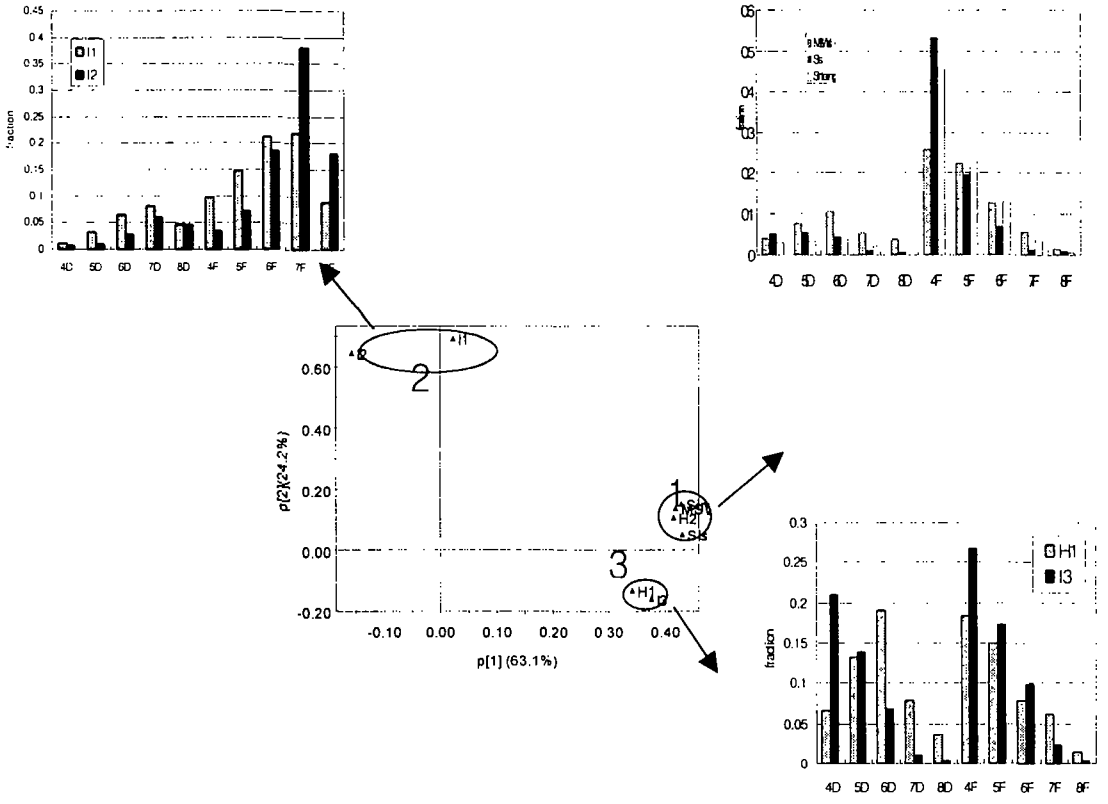

Figure 1. PCA results of PCDD/Fs homologue patterns in various incinerators

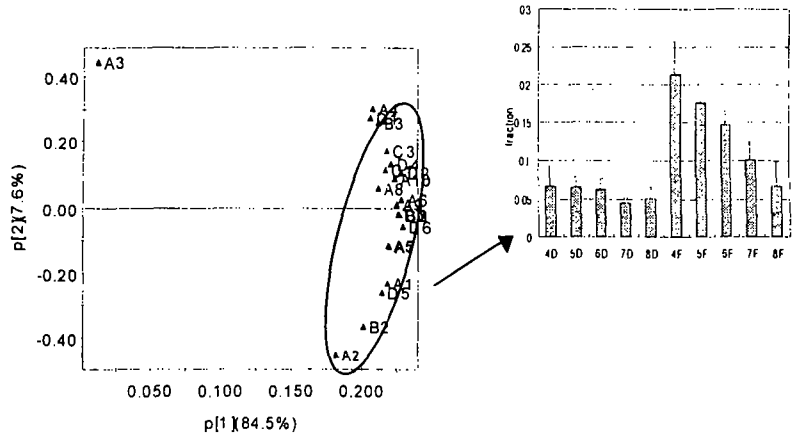

Figure 2. PCA result of PCDD/Fs homologue patterns in ambient air samples