Monitoring of PCDDs and PCDFs in Soil around Various Incinerator, Korea

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Introduction

Today solid waste management is faced with a difficult problem in Korea, due to insufficient land to dump solid waste, and Nimby Syndrome. High growth of economy also results in an increase in the volume of wastes, which causes a problem for disposal. Hence, many countries choose incineration to dispose of solid waste. In Korea, the incineration ratio of municipal waste and specific waste was 14% and 22%, respectively. The utilization of incineration will be significantly grown in the future.

A major concern regarding the operation of incinerators is the problem of air pollution. Incinerators are known as source of PCDD/Fs. PCDD/Fs emitted from source is distributed among various environmental media. Human health can be affected through food web, inhalation and contact with soil.

Soil was selected as the monitors of PCDD/Fs due to very slow degradation and change of PCDD/Fs in soil compare with others media. To investigate level of PCDD/Fs and assess the potential impact to the environment, about 300 soil samples around a twelve incinerator were collected.

Materials and Methods

Sampling

A total of 304 soil samples were taken from July 2002 to December 2004 around twelve incinerator; five paper mill incinerators, four general industrial waste incinerators, and three specific industrial waste incinerators. Soil samples were collected at about 25 sites around each incinerator. Sampling points were selected considering results a Gaussian plume model (Industrial Source Complex, ISC 3).

Determination of the PCDD and PCDF concentration

The samples were air-dried and manually ground before ASE (Accelerated Solvent Extractor) extraction (1500psi, 150°C, distilled toluene, 2 times for 7 min). The extracts were subjected to clean-up procedures as follows; H_2SO_4 treatment, silicagel column, alumina column and activated carbon column. The finally concentrated samples were spiked with 13C-labeled recovery standard for HRGC/HRMS analysis. Purified PCDD/Fs extracts were analyzed by a DB-5 column (60 m x 0.25 mm ID, 0.25 µm) and SP-2331 column (60 m x 0.25 mm ID, 0.25 µm) in order to identify 2,3,7,8-substituted PCDD/Fs. The average recovery of internal standard compounds ranged from 60% to 110%.

Water contents were determined by drying at 105 ~ 110°C for 2hr. Ignition loss, a measure of organic matter contents, was determined by heating at 600°C for 1hr after drying.

Results and Discussion

Concentration of PCDD/Fs in soils and flue gases

The concentrations of PCDD/Fs in soil samples according to the different distances form the stack are given in Table 1. The highest mean concentration in soil was found at 250m from stack. The tendency of degradation of concentration according to distance is easily founded in all of incinerators. The toxic equivalent (TEQ) calculated

based on the international toxic equivalent factor (I-TEF) ranged from 167 to 0.1 pg I-TEQ/g (d.w.) with an average concentration of 7.53 pg I-TEQ/g (d.w.). The ranges of PCDD/Fs in soils in the vicinity of incinerator were presented in Fig. 1 with other literatures. The level of PCDD/Fs in this study is lower than other countries.

Table 1. Average concentration of PCDD/Fs in soil samples collected according to the distances from incinerator (pg I-TEQ/g, dry weight basis)

	250m	500m	1km	2km	overall	Flue gas*
SIWI –A	9.87	7.48	5.51	5.68	7.73	1.90
PMI-A**	2.3	3.15	1.24	1.41	2.02	73.5
PMI-B	11.53	1.12	0.26	1.99	3.97	0.02
GIWI-A	5.14	2.64	3.66	3.68	3.78	3.75
PMI-C	0.12	0.12	0.05	0.07	0.10	0.09
GIWI-B**	0.56	1.41	0.19	0.06	0.69	71.4
PMI-D	1.24	0.51	0.96	1.47	0.94	1.51
SIWI-B	31.6	37.29	2.67	1.11	19.27	0.33
GIWI-C	70.85	8.91	3.04	1.26	29.19	21.5
GIWI-D	7.41	3.98	4.94	5.37	5.29	2.66
PMI-E	13.43	24.45	21.36	8.18	16.51	1.55
SIWI-C	1.59	0.98	0.75	0.04	0.83	0.37

GIWI means the general industrial waste incinerator

PMI means the paper mill incinerator

SIWI means the specific industrial waste incinerator

* ng I-TEQ/Sm^3, ** refer to report (obligatory measurement data of the past)

The concentration of PCDD/Fs emitted from stack were corrected by an O_2 compensation factor according to the following formula (Kim et al., 2004).

$$PCDD/Fs\ concentraton\ (ng/Sm^3) \times \left[\frac{(21-12)}{(21 - measured\ O_2\ concentraton)} \right]$$
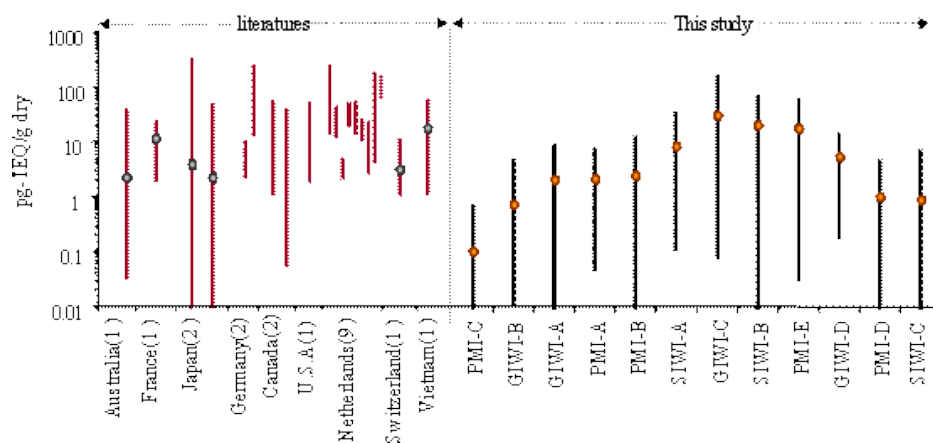

Fig. 1. PCDD/F levels in soils collected in the vicinity of various incinerators.

Congener profiles of PCDD/Fs in various stack emission gases and soils

The results of PCDD/Fs emitted by the various plants are shown in Fig. 2. The congener profiles of soil were not shown for want of space. The predominant congeners emitted by the incinerator were hepta- and octachlorinated PCDD/Fs (Fig. 2). The fingerprint profiles were dominated by the higher chlorinated PCDD/F congeners including 1,2,3,4,6,7,8-HpCDF, OCDF and OCDD as well as low chlorinated furans. The PCDD/Fs are bound primarily to aerosols or absorbed to particulate in ambient air and can settle on soil.

The OCDD is the predominant congener in soil around incinerator. Moreover the 1,2,3,4,6,7,8-HpCDF and OCDF were dominated as a whole. On the other hand, no relevant differences in PCDD/Fs congener profiles were found in soils around incinerators according to the wind direction.

In order to estimate influence of incinerator, the cluster analysis and principal component analysis were conducted using information of PCDD/F congener profiles. As a result of statistical analysis, we can divide soil samples into several groups and estimate influence of incinerator using comparison congener profiles of incinerator with that of each soil group. But it is necessary to obtain further information of congener in order to estimate influence of incinerator and others potential sources of PCDD/Fs such as heavy traffic and industrial complex.
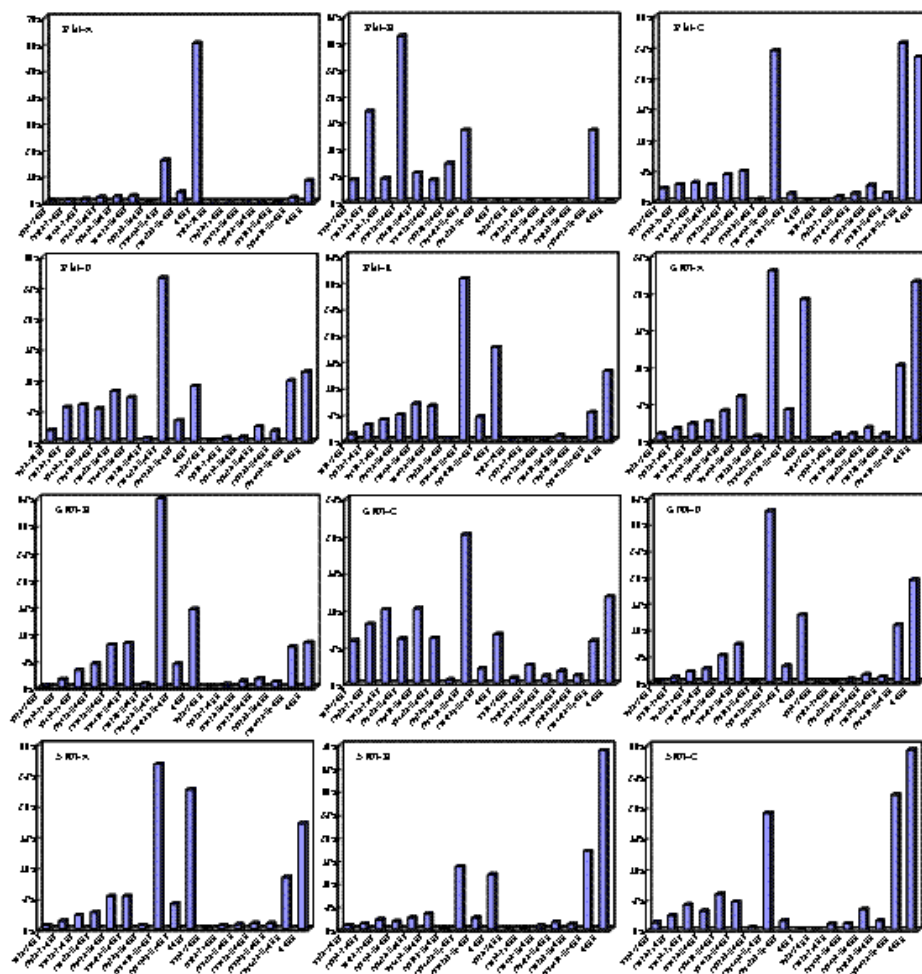
GIWI, PMI and SIWI means general industrial waste incinerator, paper mill incinerator, and specific industrial waste incinerator, respectively

Fig. 2. Congener profiles of PCDD/Fs emitted by various incinerators.

Acknowledgements

References

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