

Levels of PCDDs/DFs in soil in the vicinity of an industrial waste incinerator, Korea

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Introduction

In recent years, sources of PCDDs/DFs have been well characterized based on various researches. There are mainly combustion processes and reservoirs. Soil and sediment are known to be the main reservoirs of PCDDs/DFs. Masunaga et al (2001)¹ recently reported that some agrochemicals such as PCP and CNP used in the past also contained certain amount of PCDDs/DFs as impurities. In this study, PCDDs/DFs were measured in soil collected around the vicinity of an industrial waste incinerator (IWI). This study was aimed to estimate relation to above sources using information of congener patterns of PCDDs/DFs in soil samples.

Methods and Materials

Sample collection and analysis

The soil samples were collected from 20 stations around an IWI during December 2002 and April 2003. The locations of the sampling stations are shown in Figure 1. The samples were air-dried and manually ground and then Soxhlet extraction was performed for 20hr with distilled toluene. The ¹³C-labeled internal standards were added before Soxhlet extraction. The crude extracts were subjected to clean-up procedures as follows; H₂SO₄ treatment, silicagel column, alumina column and activated carbon column. The final concentrated samples were spiked with ¹³C-labeled recovery standard for HRGC/HRMS analysis. Purified PCDDs/DFs extracts were analyzed using a DB-5 column (60 m × 0.25 mm ID, 0.25 μm). The blank concentration during the analysis was found to be negligible.

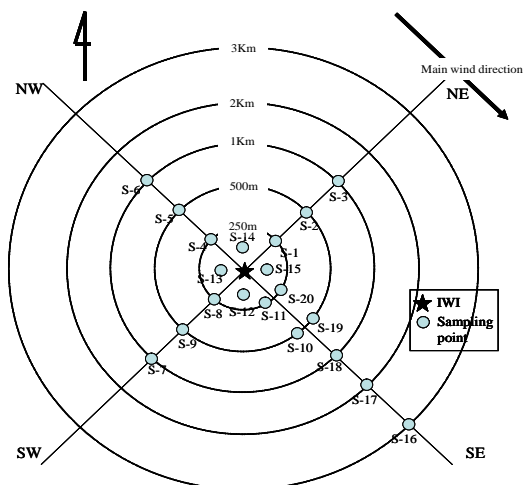


Figure 1. Sampling site around IWI

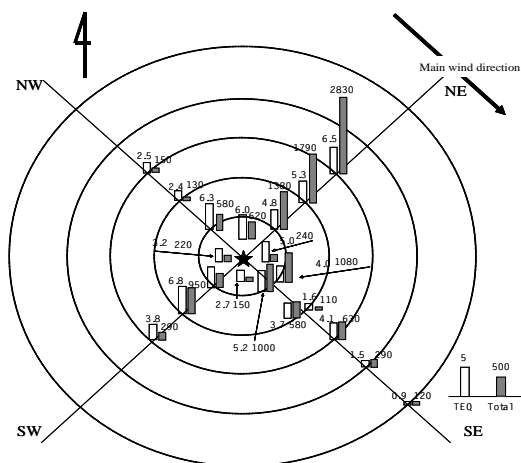


Figure 2. Total concentration and TEQ concentration in soil around IWI

Results and Discussion

Total concentration and TEQ concentration in soil samples

The concentrations of PCDDs/DFs in soil are shown in Figure 2. TEQ concentrations were calculated using WHO-TEFs. The concentration of total PCDDs/DFs (sum of from 4Cl to 8Cl homologue) and TEQ values were ranged between 108 and 2830pg/g and between 0.90 and 6.8pg-TEQ/g, respectively. The highest concentrations were detected at location of NE direction regardless of main wind direction (S-1, S-2 and S-3 site). These locations may be due to the influence of other factors. The level of PCDDs/DFs was decreased with increase in distance from IWI for the locations at NW and SE direction.

Classification of soil samples by cluster analysis

The congener profiles could be used to estimate relationship between environmental media and source of PCDDs/DFs. A receptor has characteristic of source because these compounds are not easy to be resolved in environment. Cluster analysis was performed in order to classify many soil samples according to the congener pattern. The concentration ratios of each congener against concentration of PCDDs/DFs were used as input variables in the cluster analysis. The result of cluster analysis was shown Figure 3. Figure 3 indicates that soil samples were separated into two big groups according to the congener pattern. Group 1 consist of S-1, S-6, S-2, S-9, S-5, S-14, S-12, S-15 and S-13 samples. And other samples were belonged to Group 2.

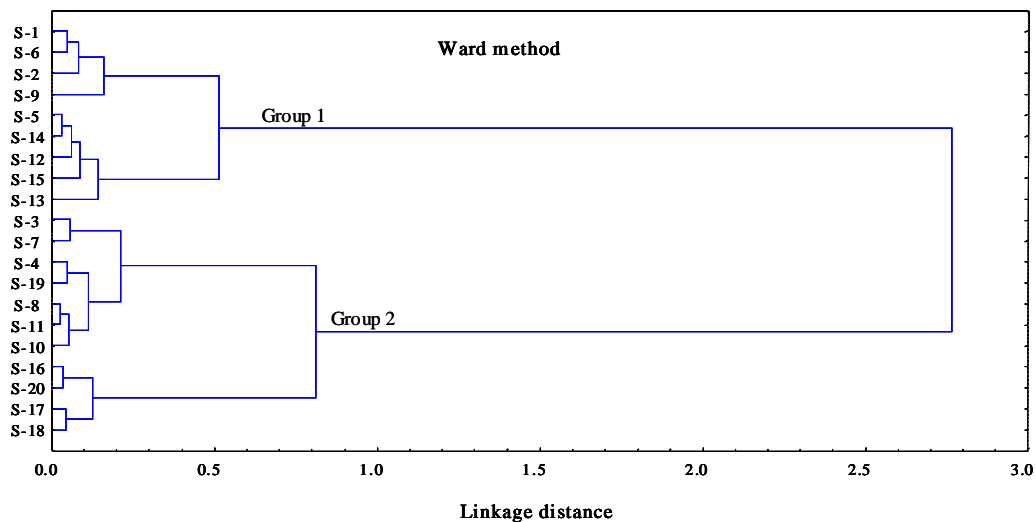


Figure 3. The classification of soil samples by a cluster analysis

Comparison between each group of soil samples and source in terms of congener pattern

The pattern of 2,3,7,8-substituted congeners in soil samples and source samples were shown in Figure 4. The profile of PCP ($n=4$) and CNP ($n=5$) was the reported data of Masunaga et al (2001) and showed average pattern. The IWI samples ($n=2$) measured 2001 and 2002 year that were analogous in terms of congener patterns. The congener profiles of group 1 samples were similar to those of IWI samples, which were contained higher concentrations of 1,2,3,4,6,7,8-HpCDF, OCDF, 1,2,3,4,6,7,8-HpCDD and OCDD. Moreover, the congeners of lower chlorinated furan were dominant than those of PCP, CNP and group 2. It is assumed that sites of group are mainly influenced by the IWI than PCP and CNP.

OCDD showed significantly higher proportions than other homologues in group 2 samples (about 67%). The ratios of HpCDD concentration divided by OCDD concentration in group 2 samples ranged from 0.04 to 0.20, while the this ratios in group 1 samples ranged from 0.2 to 0.6. Also, lower chlorinated congeners were detected in group 2 samples. It is observed that the locations mentioned in group 2 are influenced by IWI and PCP. However, no locations around the IWI are influenced by CNP.

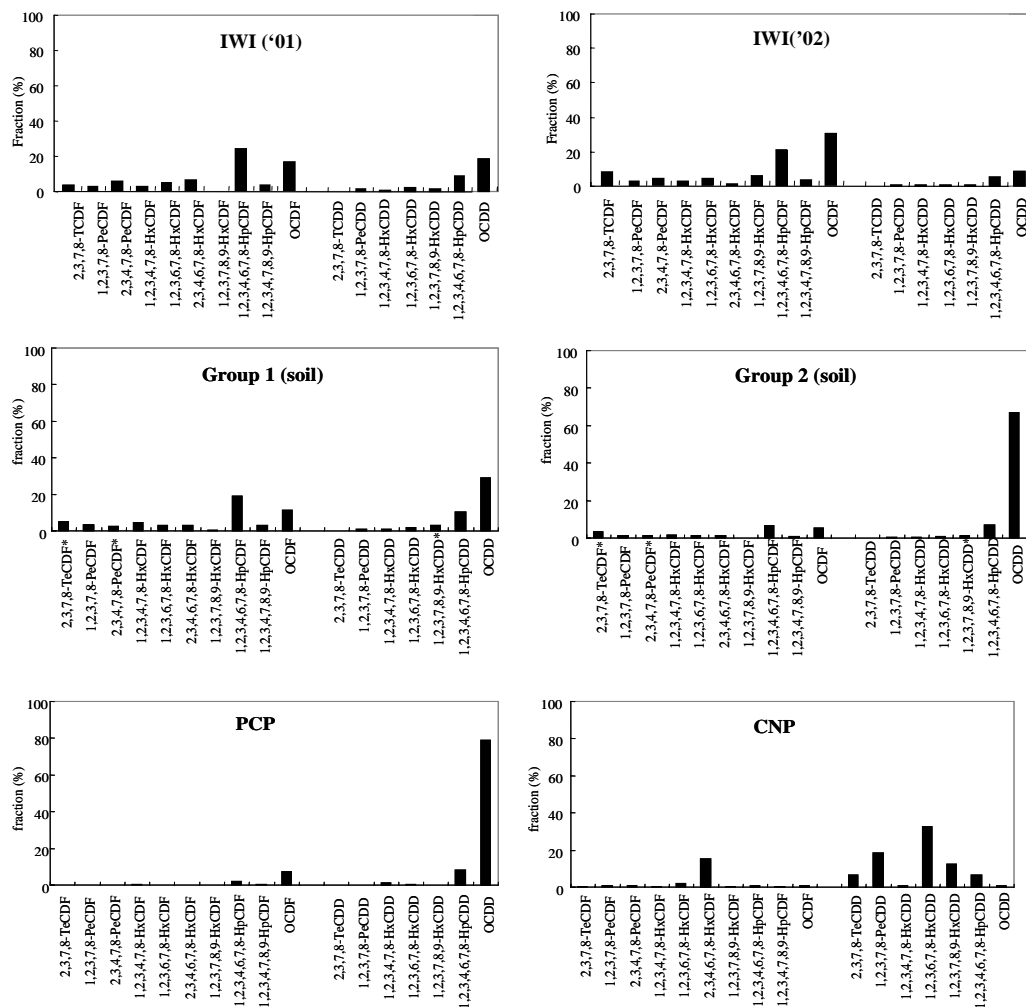


Figure 4. Congener patterns of two soil group, IWI, PCP and CNP

Acknowledgement

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References

1. Masunaga S, Takasuga T, Nakanishi J. (2001) Chemosphere 44, 873-88