# The evaluation of PCDDs/DFs contamination levels by multi-points simultaneous sampling within small area

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## Introduction

Persistent organic pollutants (POPs) such as polychlorinated dibenzo-ρ-dioxins and dibenzofurans (PCDDs/DFs) are toxic compounds that affect both human and environment. For that reason, many countries have focused on proper treatment and emission reduction of these compounds. The emission routes of PCDDs/DFs could be generally classified into three groups; air, water and soil. Especially, PCDDs/DFs emitted to ambient air from the various combustion & incineration processes could contaminate surrounding soil or water.

**Table 1. The summary of sampling locations and potential PCDDs/DFs emission sources**

| Sample label | Location Characterisitcs | Local PCDDs/DFs emission sources | Year/Sampling frequency |
|---|---|---|---|
| A | Industrial area | Industrial complex and small scale factories | 2002 / 2 times<br>(spring/fall)<br>2003 / 2 times<br>(spring/fall)<br>2004 / 1 time<br>(fall) |
| B | Industrial area | A number of large scale factories | |
| C | Industrial/ Residential area | Industrial complex and small scale factories | |
| D | Commercial/ Residential area | Commercial/residential boilers, transport etc. | |
| E | Rural area | none | |

Many researchers have investigated that the concentration of PCDDs/DFs in ambient air depends on the temperature, humidity, wind velocity, wind direction and etc. Recently, Mithat et al (2005) reported that PCDDs/DFs concentrations in surface soils ranged between 0.4 and 4.27 pg I-TEQ/g in industrial area, while those in ambient air were between 0.023-0.563 pg/m$^3$. In Korea, many researchers and government carried out lots of investigations about the characteristics of PCDDs/DFs in ambient air and soil.[1, 2, 3]

In this study, we set the small area within a radius of about 5 km and sampled simultaneously both ambient air and soils at 5 points 5 times from 2002 to 2004. From the results, we could evaluate and compare the contamination level of each sampling point within the small area and, moreover, present the method of selecting location affected directly from PCDDs/DFs emission sources.

## Materials and Methods

### 1. Sampling sites

There are various PCDDs/DFs emission sources to air in the selected area which had a lot of industrial facilities such as paper manufacturing factory, petrochemical industry, metal assembly plant and so on. We could see that there was no significant difference in PCDDs/DFs emission sources within the selected area for 3 years. As shown in , sampling locations A, B, C were industrial complex or nearby, D was commercial and residential area and E was a typical rural area without any local emission source. Additionally, soil sampling had been done close to the air sampling location during the period of ambient air sampling.The summary and information of sampling location for ambient air and soils is given in Table 1.

**Table 2: TEQ concentration of each sampling location**.

| Sampling Location | Ambient air (pg-TEQ/Nm3) | | | | | Soil (pg-TEQ/g d.w.) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2002 S | 2002 F | 2003 S | 2003 F | 2004 F | 2002 S | 2002 F | 2003 S | 2003 F | 2004 F |
| A | 0.288 | 0.199 | 0.035 | 0.228 | 0.234 | 0.082 | 0.687 | 10.025 | 0.187 | 4.703 |
| B | 0.267 | 0.271 | 0.022 | 0.257 | 0.853 | 0.019 | 0.010 | 0.013 | 0.009 | 0.597 |
| C | 0.084 | 0.064 | 0.019 | 0.196 | 0.157 | nd | nd | 0.282 | nd | 0.172 |
| D | 0.054 | 0.102 | 0.012 | 0.112 | 0.071 | 0.042 | 0.050 | 0.026 | 0.036 | 0.029 |
| E | 0.054 | 0.071 | 0.022 | 0.126 | 0.080 | nd | 0.006 | 0.007 | 0.009 | 0.246 |

S= Spring, F=Fall

### 2. Sample collection and PCDDs/DFs analysis

Air samples in each site were concurrently collected using high volume air sampler (HVAS, Sibata HV-1000F) for 24 hrs allowing for the sampling of 1,000m$^3$,or more.

A glass fiber filter (GFF) and polyurethane foam (PUF) were used for collection both gaseous and particulate PCDDs/DFs. In addition, meteorological data (temperature, relative humidity, wind direction and etc.) were recorded during the sampling period using portable equipment (RainWise Inc. WS-2000, USA). At the same time, soil samples in each site were collected by “measurement method for EDCs (National Institute of Environmental Research, Korea)“.

PCDDs/DFs analysis was conducted by HRGC/HRMS (HP 6890/Autospec Ultima) according to Korean Standard Method and USEPA method 1613. TEQ concentration was calculated using the international toxicity equivalency factors (I-TEFs).

## Results and Discussion

### 1. Comparison of PCDDs/DFs levels in ambient air and soils according to each sampling location

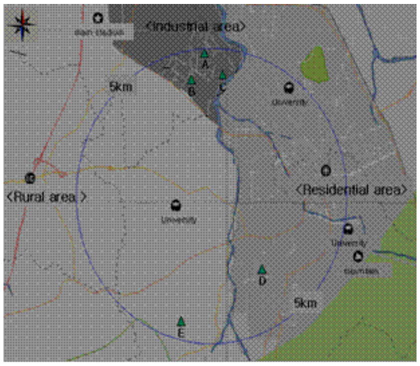

Fig. 1. The sampling locations of this study

As shown in , we could distinguish whether the location was contaminated directly or indirectly with the measurement of PCDDs/DFs concentration in ambient air at the same locations 5 times for 3 years. PCDDs/DFs concentration of location A and B was relatively higher than that of others. Therefore, the locations where PCDDs/DFs were detected high level, could be selected for concentrated monitoring area.

While on the other, the concentration of PCDDs/DFsin soils, with the exception of location A at spring 2003 and fall 2004, ranged N.D – 0.597 pg-TEQ/g d.w. every sampling location. As shown in , It would be presumed that location A can be contaminated directly, but, for the other locations, it might be unreasonable to find out the tendency of direct contamination from emission sources using these data.

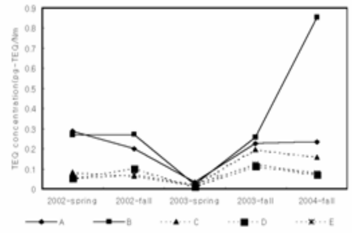

Fig. 2. Variation of PCDDs/DFs TEQ concentration in ambient air at different sampling points by sampling periods

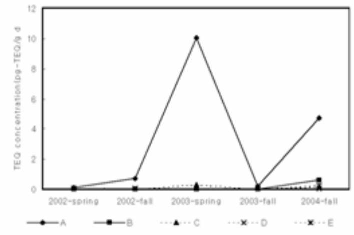

Fig. 3. Variation of PCDDs/DFs TEQ concentration in soils at different sampling points by sampling periods

With these results of measurement of ambient air and soils, we could estimate that sampling points A and B (industrial area) have been affected directly from PCDDs/DFs emission sources comparing with other points.

### 2. The comparison of PCDDs/DFs congener profiles in ambient air and soils

2,3,7,8-substituted PCDDs/DFs congener profiles in each sampling location were evaluated using the results measured for 3 years. As shown in , for ambient air samples, similar congener pattern was acquired without regarding to detected contamination level and distance from emission sources at each sampling location. These results showed that PCDDs/DFs in ambient air within small area (a radius of about 5 km) were affected mainly by the factors such as diffusion, convection and dilution.

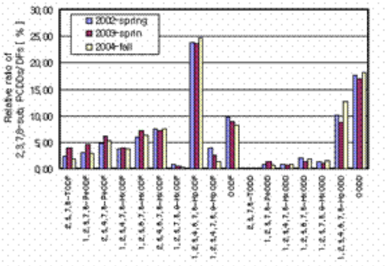

**Fig. 4. The comparison of 2,3,7,8-substituted congener profiles between each ambient air sample**

showed the relative ratio of PCDDs/DFs congeners in soils by the sampling locations. As shown in this figure, we could separate PCDDs/DFs profiles into two groups; one showed the profile on which OCDD be dominant, the other showed that the low chlorinated congeners had been detected to somewhat high level. From these results, location A and B would be latter group that determined to be contaminated directly from PCDDs/DF emission sources.

As a consequence, using the method of the comparison both TEQ concentration and congener profile, multi-point simultaneous sampling method in ambient air and soils could be recommended to find out the contaminated locations among many sampling points.

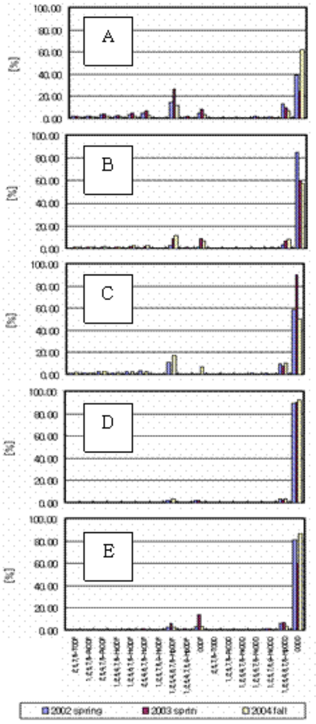

**Fig. 5. The comparison of 2,3,7,8-substituted congener profiles in each soil sample**

## References

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