# LEVELS OF PCBS, PCDDS AND PCDFS IN SOIL SAMPLES FROM INCINERATION SITES FOR METAL RECLAMATION

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## ABSTRACT

Surface soil samples from six incineration sites of waste electric wires and/or magnetic cards for the metal reclamation in Taiwan, Republic of China, were analysed for PCBs, PCDDs and PCDFs. The samples from the combustion sites of waste electric wire were heavily polluted by these chlorinated chemicals.

## INTRODUCTION

Hryhorczuk et al.(1982) and Marklund et al. (1986) detected PCDDs and PCDFs in furnace ash, fly ash or flue gas from electric wire scrap incinerator for the recovery of metals. The chlorinated compounds were considered to generate thermochemically from plastics covering wire. In Taiwan, Republic of China, waste electric wires and/or magnetic cards have been incinerated directly on the ground for the reclamation of metals, especially copper, silver and gold. Therefore, an aim of this study is to examine the pollution of PCBs, PCDDs and PCDFs in soils on the incineration sites in Taiwan.

## EXPERIMENTAL

### Sampling

Surface soil samples were collected in 1989 from six combustion sites for metal reclamation from waste electric wires and magnetic cards. The soils were air dried and shattered to small pieces.

Analytical procedure

The powderded soil sample (200g) was extracted with 700 ml of acetone-benzene (1:6) for 5 hours under refluxing. The extract was washed twice with 200 ml of water and dried over anhydrous sodium sulfate. A tenth aliquot of the extract was cleaned-up on a multi-layer column according to our previous method (Miyata et al., 1987). The n-hexane eluate from the column was concentrated and chromatographed into two fractions on an alumina column (20g, Merck, Art No. 1077, 1.5 cm i.d.) with successive eluants of 350 ml of 1% methylene chloride in n-hexane and 200 ml of 50% methylene chloride in n-hexane. The first fraction was concentrated and then determined for PCBs on a OV-1 capillary column (10 m x 0.53 mm) by a Hewlett.Packard 5890A GC with $^{63}$Ni-ECD. The second eluate was also reduced to about 0.5 ml and the 2 ul aliquot was analysed for PCDDs and PCDFs on a Supelco 2331 (30 m x 0.25 mm, 0.20 um) and a SE-54 (30 m x 0.31 mm, 0.17 um) capillary columns in an EI-SIM mode at a resolution of 7000 by GC-MS (Hewlett.Packard 5890J GC-JEOL SX-102 MS).

## RESULTS AND DISCUSSION

There was observed a distinct difference in the color and ordor of surface soil samples from six combustion sites (Table 1). Sample No. 1, No. 2 and No. 4 had a oil smell, but others did very weak oil smell or non-oil smell. The color was in a wide range of dark grey through ocher. These are considered to be attributed to the kind of scrap material, the fuel used for incineration and the color of original soil.

As shown in Table 2, soil No. 1, No. 2 and No. 4 were all heavily polluted by PCBs at levels of 47, 77 and 36 ppm, respectively. However, the levels of other samples were much lower, with a range of 0.45 through 4.8 ppm. On the other hand, the high contaminations of PCDDs and PCDFs were found in soil No. 1 and No. 2 from combustion sites of waste electric wires. However, all other

Table 1. Character soil samples from combustion sites for metal reclamation in Republic of China

| Sample No. | Scrap material | Color | Odor |
|---|---|---|---|
| 1 | electric wire | ocher | oil smell |
| 2 | electric wire | grey Yellow | oil smell |
| 3 | magnetic card*, electric wire** | dark grey | non-oil smell |
| 4 | magnetic card*, electric wire** | dark grey | oil smell |
| 5 | magnetic card*, electric wire** | ocher | weak oil smell |
| 6 | magnetic card*, electric wire** | dark grey yelow | non-oil smell |

*: major **: minor

Table 2. Levels of PCBs, PCDDs and PCDFs in various samples

| Sample | PCBs (ppm) | PCDDs (ppb) | PCDFs (ppb) | PCDDs/PCBs ($10^{-3}$) | PCDFs/PCBs ($10^{-3}$) |
|---|---|---|---|---|---|
| Soil No. 1 | 47 | 120 | 310 | 2.6 | 6.6 |
| Soil No. 2 | 77 | 540 | 50 | 7.0 | 0.65 |
| Soil No. 3 | 4.8 | 1.5 | 4.3 | 0.31 | 0.83 |
| Soil No. 4 | 36 | n.d. | 12 | - | 0.33 |
| Soil No. 5 | 0.45 | 2.1 | 13 | 4.7 | 29 |
| Soil No. 6 | 2.1 | 0.13 | 1.8 | 0.062 | 0.86 |
| River sediment* | 1.6 | 9.8 | 7.8 | 6.1 | 4.9 |
| Bottom ash** | - | 29 | 22 | - | - |

*: Eight samples from the River Neya and the Second Neya in Osaka in Japan (Miyata et al., 1988b) **: Twenty four samples from three urban municipal waste solid incinerators in Japan (Miyata et al., 1988a)

samples from locations, at where waste magnetic cards had been mainly incinerated, were contaminated with lower levels of PCDDs and PCDFs. Especially, the levels of PCDDs and PCDFs in soil No. 4 were negligible (<0.01 ppb) and 12 ppb, respectively, in spite of the high PCB level. This indicates that PCDDs and PCDFs generate more largely in the case of waste electric wires incineration than in waste magnetic cards, that is, the formations of these compounds are surmised to be significantly influenced by the kind of plastic included in the scrap. In all samples, the level of PCDDs or PCDFs was much lower than that of PCBs (Table 2). When compared with the results of sediments from the River Neya and the Second Neya in Osaka in Japan, which were heavily polluted by PCBs, PCDDs and PCDFs among Japanese river sediments (Miyata et al., 1988b), soil No. 1 and No. 2 respectively contained 29 and 48 times higher of PCBs, 12 and 55 times of PCDDs, and 40 and 6.4 times of PCDFs. In addition the two samples were more largely contaminated with 4.1 and 19 times of PCDDs and 14 and 2.3 times of PCDFs in comparison with average those of 24 samples of bottom ash from three urban municipal solid waste (MSW) incinerators with large combustion capacities of MSW, 450-600 tons/day.

As shown in Table 3, a remarkable variation of PCDD congener ratio was observed among analysed samples. The congener profile of No. 1 was roughly similar to that of Japanese MSW incinerator fly ash, showing H6CDD through O8CDD to be present as a major component. However, sample No. 2 contained distinguishably large amount of H6CDD, with 55.2% of the total PCDDs. Meanwhile, in soil No. 6, T4CDD through H7CDD were the main constituents. A significant difference in the congener profile was also seen in the case of PCDFs. All Taiwanese samples had remarkably lower ratios of H7CDF than did Japanese MSW incineratior fly ashes, bottom ashes or river sediments. In both of soil No. 1 and No. 2 containing the high level of PCDFs, the congener

Table 3. Congener ratios (%) of PCDDs and PCDFs in various samples

| Sample | PCDDs | | | | | PCDFs | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 4Cl | 5Cl | 6Cl | 7Cl | 8Cl | 4Cl | 5Cl | 6Cl | 7Cl | 8Cl |
| Soil No. 1 | 3.1 | 7.5 | 20.4 | 37.1 | 31.8 | 9.5 | 15.8 | 22.9 | 24.1 | 27.7 |
| Soil No. 2 | 9.6 | 20.0 | 55.2 | 14.3 | 0.9 | 19.0 | 19.4 | 21.3 | 23.1 | 17.1 |
| Soil No. 3 | 2.0 | 2.8 | 11.4 | 35.4 | 48.3 | 31.3 | 15.6 | 16.4 | 21.6 | 15.2 |
| Soil No. 4 | - | - | - | - | - | 71.9 | 22.6 | 5.1 | 0.5 | 0.1 |
| Soil No. 5 | 8.4 | 13.8 | 35.8 | 29.4 | 12.7 | 26.2 | 28.4 | 26.1 | 17.1 | 2.2 |
| Soil No. 6 | 21.5 | 15.7 | 25.5 | 17.8 | 19.6 | 48.5 | 25.0 | 17.8 | 9.0 | 1.1 |
| River sediment | 6.1 | 3.2 | 11.2 | 20.4 | 56.1 | 11.2 | 11.8 | 19.2 | 41.0 | 17.9 |
| Bottom ash | 7.5 | 14.9 | 14.9 | 25.0 | 37.3 | 14.4 | 14.3 | 12.7 | 42.4 | 14.7 |
| Fly ash* | 6.5 | 12.7 | 19.9 | 31.2 | 27.9 | 7.4 | 15.7 | 17.4 | 46.5 | 13.9 |

*: Thirty two samples from four urban municipal waste solid incinerators in Japan (Miyata et al., 1988a)

From above results, it was revealed that incineration for the recovery of metals from waste electric wires and magnetic cards, especially the former, generated substantial amounts of PCBs, PCDDs and PCDFs. Hereafter, in view of risk to humans and animals, it is necessary to examine hazardous chlorinated compounds in gas emitted at metal reclamation sites.

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