Environmental Levels (Air and Soil) of Other Organohalogens and Dioxins P282

Monitoring PCDD/Fs in the Vicinity of an Old Municipal Waste Incinerator, 1996-1998. Part I: Soil Monitoring

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Introduction

Incineration of municipal solid waste results in the emission of heavy metals, polychlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs), polycyclic aromatics, acids and other compounds (1). Consequently, environmental contamination from municipal solid waste incinerators (MSWI), as well as safe ash disposal are subjects of great concern. Among the pollutants emitted in trace amounts from MSWI, PCDD/Fs are of especial interest. After discovery in 1977 of PCDD/Fs in flue gas and fly ash of MSWI (2), many studies have been performed to investigate its function and removal during incineration processes.

In recent years, the emissions of PCDD/Fs have become one of the most controversial issues in relation with incineration of MSW. Once emitted into the atmosphere, PCDD/Fs are dispersed throughout the environment, and because of their semivolatile and hydrophobic properties, they accumulate in organic rich media such as soils, sediments, and biota (3,4). Atmposheric deposition is the main mean of supplying PCDD/Fs to surface soils. However, under natural conditions PCDD/Fs are highly persistent in soils and their degradation in this medium is slow or even nonexistent. Therefore, a decline in atmospheric PCDD/F emissions can not result in a direct and observable decrease in the PCDD/F burden for some time (5).

To assess the temporal variation in PCDD/F concentrations in soil and vegetation near to an old MSWI, in 1996 and again in 1997, soil and herbage samples were collected in 24 sampling points in the vicinity of the plant and the levels of PCDD/Fs were determined. In the present survey, soil and herbage samples were again taken at the same sampling points and analyzed for the levels of PCDD/Fs. This paper shows the results in soils and a companion paper (6) presents the results in vegetation samples.

Materials and Methods

In October 1998, one and two years respectively after the first and second soil and vegetation sampling, 24 soil samples were taken at 100, 250, 500, 750, 1000, 1500, 2000 and 3000 m from the stack in each of the three main directions of the wind in the area (NE, NW, S). The MSWI is placed in a residential area of Montcada (Barcelona, Spain) with an important industrial activity. It began operating in 1975 and has a capacity of approximately 45000 tons/year.

The extraction and clean-up procedures, as well as the analytical determination of PCDD/Fs were carried out as previously reported (7,8). PCDD/Fs were determined by GC/MS. Kruskal-Wallis test and Principal Component Analysis (PCA) were used for data comparison.

Results and Discussion

In the current study, PCDD/F concentrations in soil samples ranged between 0.06 and 127.00 ng I-TEQ/kg (dry matter), with median and mean values of 4.80 and 9.95 ng I-TEQ/kg (dry matter), respectively. In the 1996 survey, PCDD/F concentrations ranged from 0.30 to 44.26 ng I-TEQ/kg (dry matter), with median and mean values of 3.52 and 6.91 ng I-TEQ/kg (dry matter), respectively. In turn, in the 1997 study the levels of PCDD/Fs ranged between 0.15 and 29.27 ng I-TEQ/kg (dry matter), with median and mean values of 2.56 and 4.47 ng I-TEQ/kg (dry matter).

The PCDD/F concentrations (median, quartile, and extreme I-TEQ values) in soil samples for the three collections are presented in Figure 1. When the current levels of PCDD/Fs were compared with those of the previous survey (1997), it could be observed that median (I-TEQ) values increased in a percentage of 87%. By contrast, a 27% of decrease was observed in the period 1996-1997 (8). However, the analysis of the differences did not reach the level of statistical significance in both periods: 1996-1997 and 1997-1998.

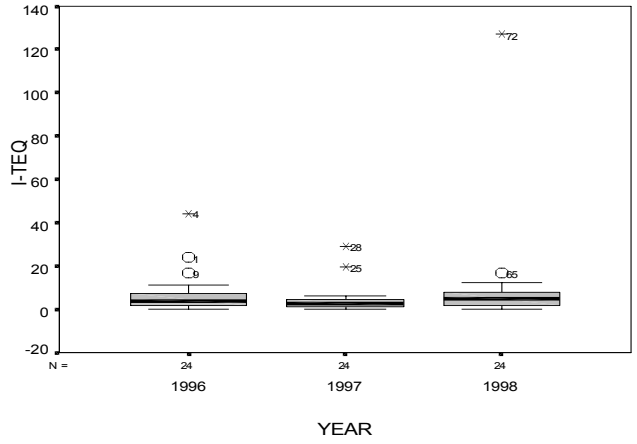

Fig. 1. PCDD/F levels in soil samples collected near an old MSWI in 1996, 1997 and 1998.

Figure 2 shows the levels of PCDD/Fs in soil samples according to increasing distances from the MSWI. During the period 1997-1998, the concentrations of PCDD/Fs increased at all distances. During the previous period (1996-1997), PCDD/F levels also increased at all distances with the exception of samples taken at the largest distances from the stack (2000-3000 m). Anyhow, the differences did not reach the level of statistical significance ($p < 0.05$). On the other hand, Figure 3 shows the concentrations of PCDD/Fs in soils according to the three main wind directions for the 1996, 1997 and 1998 surveys. During the last year, PCDD/F concentrations increased to the three directions: 115%, 82% and 45% to the NE, NW and S, respectively. In the previous period (1996-1997), median PCDD/F concentrations decreased to the NW (38%) and to the S (50%) directions, whereas they increased to the NE direction (22%). However, these variations did not reach the level of statistical significance ($p < 0.05$).

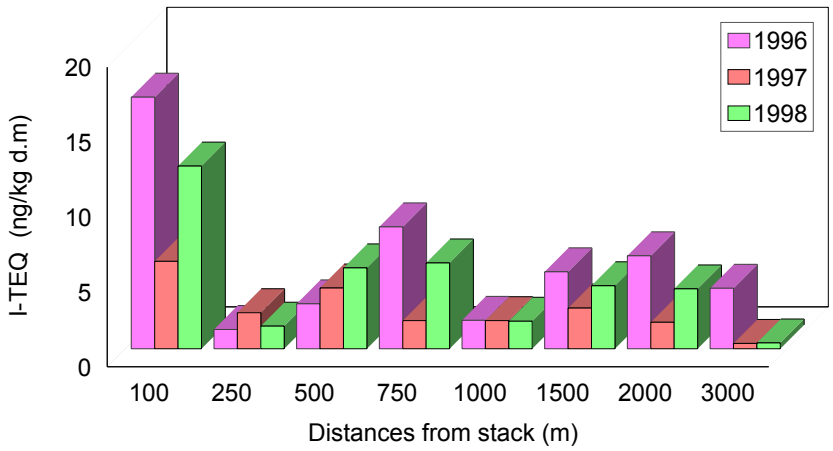

Fig. 2. Concentrations of PCDD/Fs in soils collected at increasing distances from an old MSWI.

When PCA was applied to the 72 samples corresponding to the three surveys, this analysis provided a single two-dimensional model which would explain 91.2 % of the variance in the data. The first main PC (which would explain 68.9 % of the variance) is highly and positively correlated with the lower substituted PCDD/Fs, while the second PC (29.34 % of the variance) is positively correlated with the higher substituted PCDD/Fs (HpCDD, OCDD, OCDF). Although a main cluster could be identified, a number of samples appeared as outliers (Fig. 4).

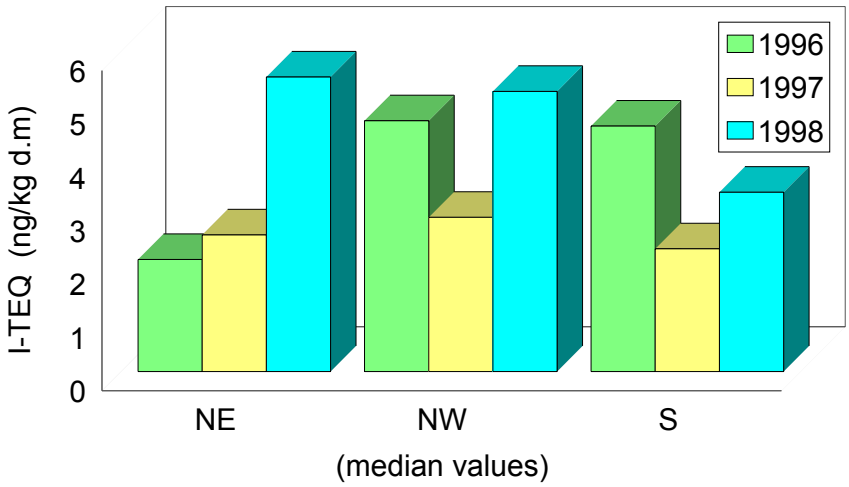

Fig. 3. PCDD/F levels in soils collected in the vicinity of an old MSWI according to the main directions of the wind in the area.

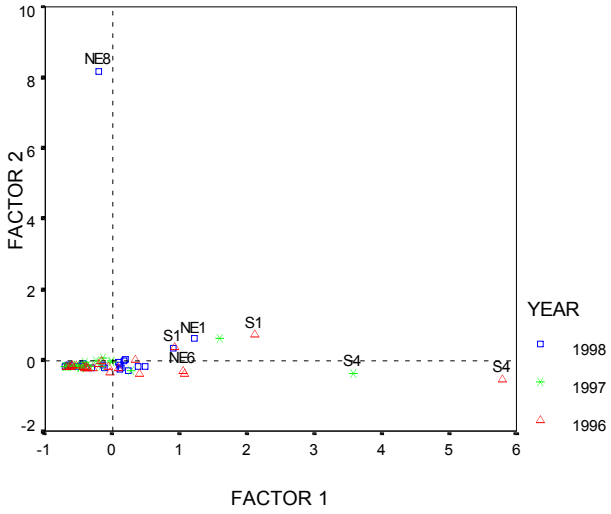

Fig. 4. Principal component analysis: plot for soil samples collected near an old MSWI in 1996, 1997 and 1998.

The results of this study show that the levels of PCDD/Fs in soil samples collected in the vicinity of the MSWI did not increase significantly between 1996 and 1998. Although the technical characteristics of the MSWI, as well as the total amount of MSW incinerated during this period remained basically unchanged, the potential PCDD/F acummulation in soils in the vicinity of the plant could be counteracted by a decrease in the atmospheric levels of PCDD/Fs from other emission sources located in the same area.

References

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