DIOXIN DEPOSITION AROUND A DANISH MUNICIPAL INCINERATOR

Arne Oxbøl[1], Ole Schleicher[1], Karsten Fuglsang[1], Allan A. Jensen[1], Karsten Borg Jensen[2] and Bernd Schilling[3]

[1]dk-TEKNIK ENERGY & ENVIRONMENT, Gladsaxe Møllevej 15, DK-2860 Søborg, Denmark
[2]Århus Amt, Natur og Miljø, Lyseng Allé 1, DK-8270 Højbjerg, Denmark
[3]ERGO Forschungsgesellschaft GmbH, Geierstrasse 1, 22305 Hamburg, Germany

Introduction

Very few investigations of the deposition of PCDD/F (dioxins and furans) have been carried out in Denmark. The county of Århus initiated in 2000 a series of measurements of the deposition of PCDD/F in the county. The objective of the measurements was to investigate whether the deposition could be related to the emission from the local municipal solid waste incineration plant (MSWI). This paper presents the results of the deposition of dioxins (PCDD) and furans (PCDF) in three stations in the distance of 750 metres, 800 metres and 14,000 metres from the MSWI plant. Congener patterns for the deposition samples and emission samples from the MSWI plant is compared to clarify whether the deposition could be related to the emission from the MSWI plant.

Methods and Materials

Deposition sampling were performed with five glass vessels in a Bergerhoff sampling apparatus according to VDI 2119/2, in a height of 1,5 metres above the ground on each of three positions. The vessels were changed after two months and the sampling continued for another two months.

The obtained samples were analysed according to VDI 2090 part 1. Quantitative determinations of PCDD/PCDF in various samples according to the isotope dilution method were carried out by means of 2,3,7,8-PCDD/PCDF substituted ^{13}C-UL internal standards. The five samples from each site and sampling period were combined to one bulk sample. The vessels were emptied and rinsed with acetone and toluene and internal standards were added to the liquid. The liquid was filtered and the filter was treated with hot aqueous acid, and afterwards dried with acetone. From each bulk sample, the liquid was extracted with toluene, and the filter was soxhlet extracted by toluene. Cleanup was done on multicolumn systems involving various kind of treated silica gel, aluminium oxide, carbon-on-fibre or carbon-on-celite. The final extract was reduced to dryness and dissolved in syringe standard. Determination was carried out by using an HRGC/HRMS combination with HP 5890 series II / VG-AutoSpec on DB 5 and SP2331 capillary columns. For each substance, two isotope masses were measured.

Site Description

The MSWI plant is situated in the countryside with small villages and smaller industrial areas. No heavy industries and no severe dioxin polluters are found in the near surroundings. The MSWI plant has a combustion capacity of 23 ton/h wastes in tree lines. The plant has not yet a special flue gas cleaning system for dioxin reduction, and the dioxin emission has been measured to be between 1 and 1.5 ng I-TEQ/m³ at standard condition, dry gas and 11% O_2[2].

With the Danish Operational Meteorological Dispersion Model, it was calculated that the highest immission concentrations could be expected in the distances between 600 metres and 1,000 metres

from the plant, and in the directions of 30°, 110°, 230° and 320°. Based on this, two sampling positions where chosen.

Position 1 was in a field with alfalfa, and the location was approx. 800 metres from the source in the direction of 35°. The field is situated in a low forest (2-5 metres height).

Position 2 was in an open grass field approx. 750 metres in the direction of 228°.

A third position, a reference position, was chosen 14,000 metres from the plant in the direction of 165°, in a residential area without industry.

Table 1. Sampling sites

Site	Distance from the plant	Direction from the plant
Position 1	800 metres	35°
Position 2	750 metres	228°
Position 3 (Reference)	14,000 metres	165°

Meteorological data on wind speed and direction was obtained from the Danish Meteorological Institute, which has a meteorological station app. 10 km from the MSWI plant.

Results and Discussion

Because of the wind fluctuations, it has been estimated, that the emission from the MSWI plant could influence the sampling point, if the wind direction deviate up to 30° to both sides, from the direction to the sampling position.

The wind directions in the sampling periods were not optimal for the investigation with wind towards Position 2 in only 2 % and 1,5 % of the time in the two periods. The position is consequently more similar to a reference station. Towards Position 1 considerably more wind has blown, respectively 12,7 % and 22,5 % of the time in the two periods. The selected angular section at 60° represents app. 17 % of the circle, and the period is considered to have a representative wind distribution. The results in table 2 are given as the sum of congeners in picogram I-TEQ/m2/day. For period 1 the samples had a severe interference for OCDD and consequently this congener could not be analysed. However, in period 2 the OCDD did only contribute with up to 1,3 % of the total I-TEQ concentration, and assuming the same relationship for period 1, the error by not including OCDD in period 1 is negligible.

Table 2. Deposition in pg I-TEQ/m³/day

Position	Distance from MSWI metres	Period 1 3rd July – 7th Sept. pg I-TEQ/m²/day	Period 2 7th Sept. – 14th Nov. pg I-TEQ/m²/day	Average pg I-TEQ/m²/day
1	800	0.6 – 1.1	3.6 – 3.9	2.1 – 2.5
2	750	0.6 – 1	1.8 – 3.4	1.2 – 2.2
3	14,000	0.6 – 0.8	1.9 – 2.3	1.2 – 1.6

The interval represents values without congeners below the detection limit, and values including the detection limits.

For period 1 there are almost no differences between the three sampling positions, while in period 2 the value for position 1 seems to be higher compared to position 2 and 3, but only for the value excluding the detection limits. This could indicate, that for all samples the true concentrations for congeners quantified below the detection limits are only slightly below the detection limits, and consequently the high value in the interval could be the most correct value for the deposition.

Period 2 shows a considerably higher deposition of dioxins, roughly a three times increase, compared to period 1. It seems unlikely that the emission from the MSWI plant could be responsible for the increased deposition in period 2, when the wind directions in the two periods is taken into consideration. It seems more likely that the reason is a combination of the start of the heating season, with an expected higher dioxin emission from heating systems etc., in combination with much more winds from southeast, and less wind from northwest. Wind from southeast may bring more dioxins from the larges city Århus towards position 1 and 2. Position 3 is situated in a small residential area south of Århus, and hardly any wind has blown in that direction from Århus.

The rainfalls were 145 mm in period 1 and 173 mm in period 2. The greater rainfall in period 2 will also cause an increased down wash of dioxins, especially if the concentration in the air is higher, but it cannot alone explain the higher deposition in period 2.

The results show much lower deposition than reported in a previous investigation from Belgium, Fré *et al*.[3], where the PCDD/F deposition in two stations approximately 600 metres from a waste incineration plant was measured to 108 and 1025 pg I-TEQ/m^2/day, respectively.

Dioxin congener pattern for the deposition samples and for emission samples from the plant[2] has been examined, to additional evaluate whether the plant has contributed directly to the higher deposition in period 2. The congener pattern was calculated in weight percent, after OCDD has been omitted from all samples, to make it possible to compare all the different patterns. The pattern for the deposition samples is showed in figure 1, and the pattern for the emissions samples from the MSWI plant is showed in figure 2.

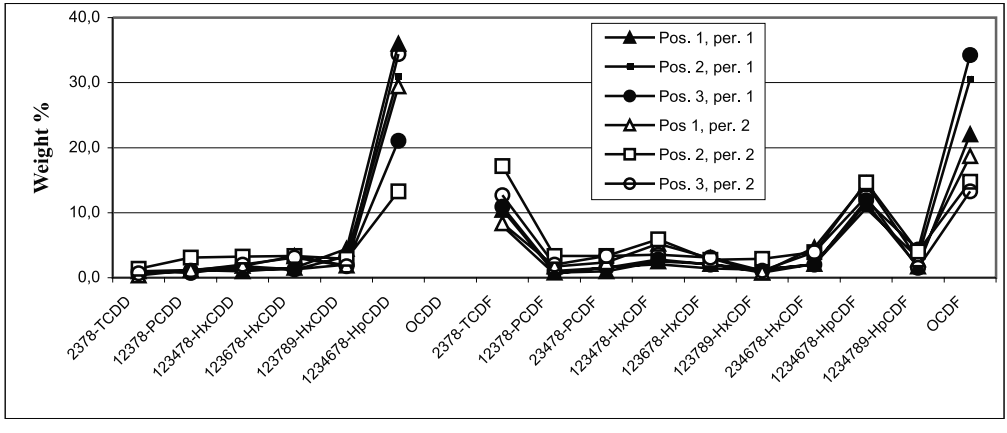

Figure 1. Dioxin congener pattern for deposition samples in both sampling periods
The patterns for all the deposition samples show a very high degree of similarity.

LEVELS IN ABIOTIC COMPARTMENTS

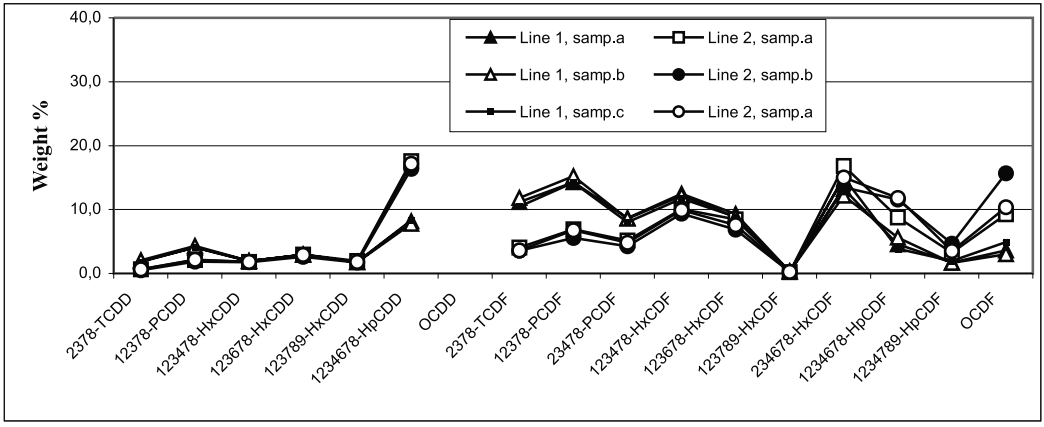

Figure 2. Dioxin congener pattern for emission from two lines at the MSWI plant
The patterns for the MSWI plant consist of three samples from each of two lines. They show a high degree of similarity within the samples from each line. The difference in the pattern for the two lines is most likely caused by differences in combustion conditions.

It is obvious that the emission from the MSWI plant has not clearly affected the deposition, when comparing the patterns.

Conclusion

No effect from the MSWI plant could be found in the deposition samples. The sampling positions have not been very suitable for detecting deposition from the MSWI plant, because of the actual wind directions in the sampling periods. The deposition samples should consequently be seen as normal background samples.

Reconsidering the choice of sampling points, they should have been chosen based on the most prevailing wind direction or based on a calculation of the highest average immission concentrations around the plant, rather than based on a calculation of where the highest immission concentration could be expected.

References

1. Oxbøl, A, Fuglsang, K: Århus Amt, Måling af dioxiner i støvnedfald, Juli-November 2000. Rapport til Århus Amt fra dk-TEKNIK ENERGI & MILJØ.
2. Degn, C.: Dioxinmålinger, Ovn 1 og Ovn 3, Århus Nord Forbrændingsanlæg, November 1998. Rapport til Århus Amt fra dk-TEKNIK ENERGI & MILJØ.
3. De Fré R, Wevers M. Van Cleuvenbergen R, Schoeters J.: Measurement of deposition of dioxins in Flanders, Belgium. Organo Halogen Compounds, 1994;20:9-14.