IMPACT OF EMISSIONS OF MODERN MUNICIPAL WASTE INCINERATORS ON ATMOSPHERIC CONCENTRATIONS OF PCDD AND PCDF

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1. INTRODUCTION

Although there are provisional regulations for older facilities, new municipal waste incineration plants in Germany have to meet the emission limits regulated by the 17. BImSchV (17th ordinance implementing the federal immission control act). The emission limits fixed in this ordinance result from the values attainable by treatment of waste incineration flue gas with the best technology available in 1991. But the discussion about municipal solid waste incineration is controversial and MSWI-plants are still not commonly accepted in Germany. One major point of the ongoing discussion is the environmental impact of these plants.

To adress the continuing public concern the Bavarian State Ministery for State Development and Environmental Affairs launched a long term study to monitor the environmental impact of emissions from two modern waste incineration plants in Bavaria. The primary aim of the study was the monitoring of the atmospheric environment before and after begin of operation and the evaluation of the effects of the waste combustion emissions on the contaminant levels in the surrounding area.

The local air pollution situation has been monitored approximately one year during the construction of the plants and continues for 18 months after starting of operation. For sampling samplers were installed at 5 locations in Burgkirchen and 7 locations in Augsburg. Continuous sampling of dust particles and adsorbable gaseous substances was performed. The samples were analyzed for 23 elements (mainly heavy metals), polychlorinated benzenes (PCBz), polychlorinated phenols (PCPh), polychlorinated biphenyls (PCB), polychlorinated naphthalenes (PCN), polychlorinated dibenzodioxins (PCDD), polychlorinated dibenzofuranes (PCDF) and polycyclic aromatic hydrocarbons (PAH).

Dispersion model calculations predict low additional input of micropollutants due to waste incineration emissions. To determine the possible additional input, the emission pattern of the waste incineration flue gas and the emission patterns from other sources such as traffic and domestic heating are being determined. Input from long distance transport of micropollutants is monitored by background sampling stations situated 20 km off each incineration plant. Additionally, directional samplers are used for the identification and characterization of sources[1,2]. Differentiation of the contributions to the total air pollution from the different sources should be possible by chemometric methods like Principal Component Analysis and Factor Analysis[3,4], thereby allowing determination of even low impacts from waste incineration.

2. EXPERIMENTAL SET-UP

Two plants located in different regions of Bavaria have been chosen for the study. The first plant is the MSWI in Augsburg, which is located in an urban area, the second is the MSWI in Burgkirchen, which is located in a rural area. In the vicinity of the MSWI Burgkirchen however there are some chemical plants present (1-20 km off). The locations of the samplers have been determined by applying the dispersion model AUSTAL[5] and considering the local topography and local conditions (see fig. 1), trying to avoid local features which might interfere with the measurements.

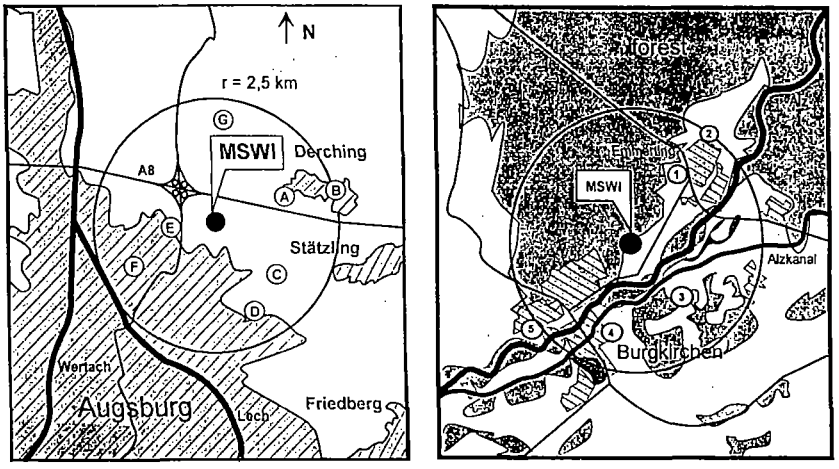

Figure 1: Sampling net in Augsburg (Station A-F) and Burgkirchen (Station 1-5)

The samplers were based on an earlier development[6,7] and were modified and further developed with respect to avoidance of interferences, ease of handling and robustness[8] (patents pending). Figure 2 shows details of a sampling device for organic compounds.

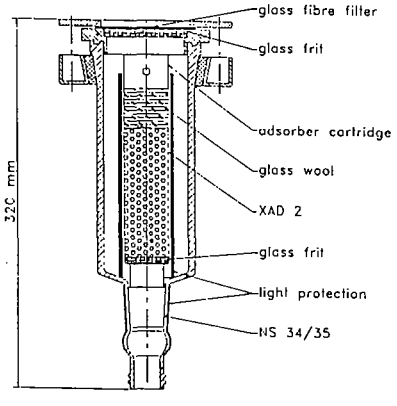

Figure 2: Sampling device for organic compounds

The device for sampling of dust for determination of heavy metals and other elements uses a quartz fibre filter and omits the adsorbent cartridge. The filters were changed every two weeks (sampling volume approximately 700 Nm^3), the adsorber cartridges were changed every six weeks corresponding to approximately 2000 Nm^3 sampled.

For detailed source apportionment studies a system for directional sampling of gaseous and particulate compounds has been developed and used. The sampling system consists of a sampling unit with a temperature sensor and the sampling heads, a mast (7m) with sensors for wind speed and direction and a box that contains the pump, the mass flow meter, the switching valves for the sampling heads, the electronics and, as the control and registration device, a computer. Details are given elsewhere[1,2].

Sampling and analysis were subject to a comprehensive quality assurance/quality control programme before and during the monitoring because the errors of sampling and determination limit the magnitude of detectable impact. For the determination of heavy metals the quartz fibre filters were analyzed by GFAAS and ICP-OES after microwave assisted acid digestion. For the determination of semivolatile organics and their particulate/vapour phase distribution filters and cartridges were extracted separately and analyzed by HPLC, GC and GC-MS after selective clean-up.

3. Results

The detailed results of the monitoring before the start of operation of the MSWI in the Augsburg area have already been published[9,10,11]. In the course of the one-year study spatial differences and pronounced seasonal fluctuations in contaminant concentrations have been determined. For example the PCDD/PCDF and the PAH concentrations raise by a factor of five to ten during the winter season, while PCB concentrations are higher by a factor of 4 in summer. The PCDD/PCDF concentrations were about two times higher at the sampling points on the edge of the city than that at the remote location. This was attributed to PCDD/PCDF and PAH emissions from local and regional sources, with seasonal (winter) sources contributing the vast majority of the emission fluxes whereas PCB origin from diffuse sources. At higher temperatures release from temporary sinks by evaporation becomes possible and transportation is preferred.

In fig. 3 the PCDD/PCDF concentrations during the construction of the plant in Augsburg and after starting of operation are shown. There are no differences in the overall concentrations and the spatial distribution.

Monitoring in the Burgkirchen area showed lower overall concentrations, the sum of PCDD/PCDF ranged between 200 and 3000 fg/Nm^3 respectively 7,5 and 51 fg/Nm^3 I-TEQ (fig. 4). This is approximately half the concentrations observed during the premonitoring in the Augsburg area. The time course of PCDD/PCDF concentrations is dominated by the same seasonal fluctuations as in the Augsburg area.

Neither before nor after start of the operation of the MSWI Burgkirchen significant differences in the spatial distribution of the total PCDD/PCDF concentrations could be observed. Also the profile of chloro-homologues remained the same, being more uniform than in the Augsburg area. The even spatial distribution and the uniform homolog composition can be attributed to the fact that the primary input is still due to diffuse sources like household heating, traffic and long distance transport. So far no influence of the emissions of the MSWI could be determined regarding PCDD/PCDF.

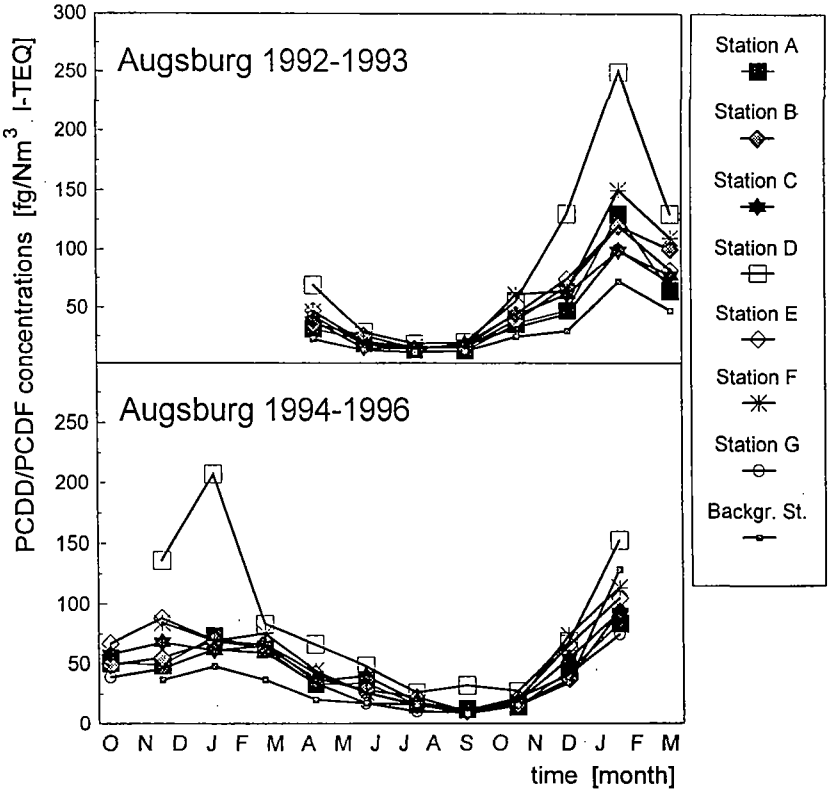

Figure 3: Total PCDD/PCDF concentrations in the Augsburg area 1992-1993 and 1994-1996

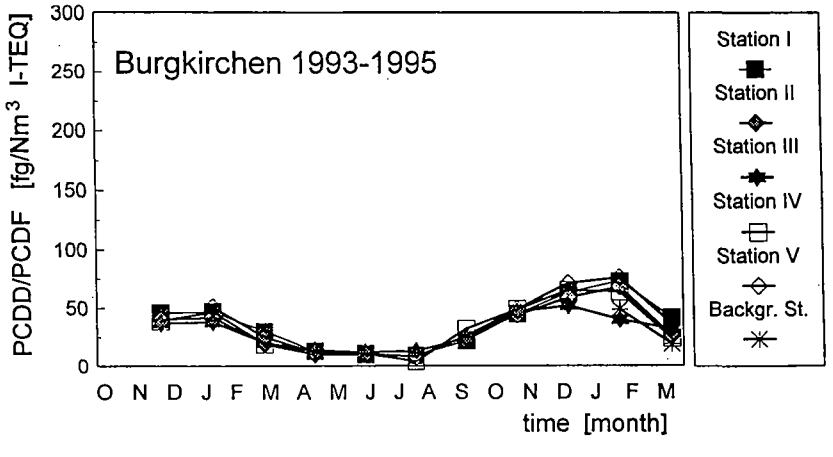

Figure 4: Total PCDD/PCDF concentrations in the Burgkirchen area 1993-1995

The monitoring system is able to detect point sources of dioxins. One of the sampling points in the Augsburg area (station D) showed elevated concentrations of PCDD/PCDF throughout the year.

Detailed analysis by principal component analysis[11] and cluster analysis show a significant difference in the PCDD/PCDF-pattern at station D. An example of a cluster tree plot (sampling period 2, 2,3,7,8-Cl congener concentrations normalized to I-TEQ) is shown in figure 5. One can see that there is a very homogeneous pattern at the different stations in Augsburg including the background station and a significant difference to station D. With a directional sampler the source of PCDD/PCDF tentatively could be identified[1].

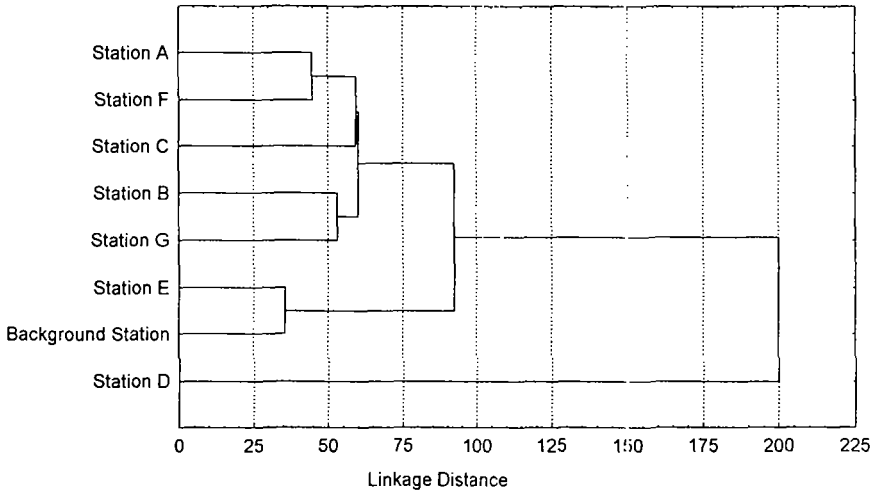

Figure 5: Cluster analysis of sampling period 2, Augsburg area (2,3,7,8-congener concentrations normalized to I-TEQ-values, single linkage, euclidian distances)

4. Conclusion

The monitoring system can characterize the impact of emitters and detect single point sources in the observed area, which then can be identified by directional sampling. The first results concerning total PCDD/PCDF concentrations, the spatial distribution and the distribution of the profile of chloro-homologues in Augsburg and Burgkirchen show no impact from the municipal waste combustion plant.

Further monitoring and the evaluation of the concentrations of heavy metals, PCB, PCN and PAH will allow more detailed evidence on the environmental impact from municipal waste incinerators.

At the moment we further evaluate the contribution of the different sources using chemometric methods, which allow to determine even low impacts of different sources. As shown by the use of cluster analysis to detect pattern differences, such methods are valuable tools for the evaluation of the local immission situation.

We intend to compare the results of the monitoring at both plants with the results of dispersion modeling, which goes far beyond AUSTAL-calculations. The model will consider dry and wet deposition and is based on k-ε-theory of turbulent flow modeling[10].

5. REFERENCES

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6. ACKNOWLEDGEMENTS

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