

## **PCDF/D in Input Material, Solid Residues and Flue Gas from a Municipal Waste Incinerator During the Co-Combustion of Mixed Separated Plastic Waste**

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### **1. Introduction**

Prior to the commissioning of this study on co-combustion of mixed waste plastics with municipal solid waste (MSW), there have been few authenticated commercial scale tests on the effect that polymers have on the combustion process. It has been generally accepted that waste plastics can contribute significantly as a fuel source during combustion, but these effects have not been quantified in terms of relative heat values, emissions and residues.

In order to categorise the relative effects of polymers on the combustion of MSW two campaigns were done. The project described here studied three different test cases within 10 measurement series at the MSWC plant in Würzburg, Germany, during October 1993 and 3 conditions in January 1994 using line with active carbon in the flue gas before fabric filter.

It is the objective of this paper to summarize the results with respect of dioxin/furan destruction during MSW combustions.

### **2. Experimental**

Test conditions aimed to replicate the effects of plastics within a real operating environment. This meant that the addition of plastics, with an average heat of combustion three times higher than standard MSW, caused the total feed to the combustor to be reduced accordingly.

# EMCO

This experimental design was selected as most MSWCs operate at the full heat load capacity of the boiler - an operation commonly known as heat removal limited case.

During the tests the three different feed condition studies were identified as:

- A = normal MSW content. Base case
- B = MSW + 7.5 per cent by weight mixed plastics. Medium polymer case
- C = MSW + 15 per cent by weight mixed plastics. High polymer case

Due to the changing conditions found within furnace and boiler during combustion, the first test campaign was based on the following sequence of feed streams, using lime as a neutralising additive in the flue gas before fabric filter:

A, A, C, C, A, A, B, B, A, A.

The second campaign using a lime and active coke mixture in the flue gas before fabric filter did follow the sequence

A, A, B, C.

During these conditions the aromatic hydrocarbons like

- polychlorinated dibenzofurans and dibenzo(p)dioxins (PCDF/Ds)
- polychlorinated brominated dibenzofurans and dibenzo(p)dioxins (PBDF/Ds)
- polychlorinated brominated/chlorinated dibenzofurans and dibenzo(p)dioxins (PBCDF/Ds)
- polychlorinated biphenyls (PCBs)
- polychlorinated benzenes (PCBzs)
- polychlorinated phenols (PCPhs)
- polycyclic aromatic hydrocarbons (PAHs)

and other substances not described here were measured in input plastic materials, residues and flue gas before cyclone (after boiler), after cyclone and before stack (after fabric filter). The Würzburg plant has a standard dry scrubbing system after cyclone.

### 3. Results

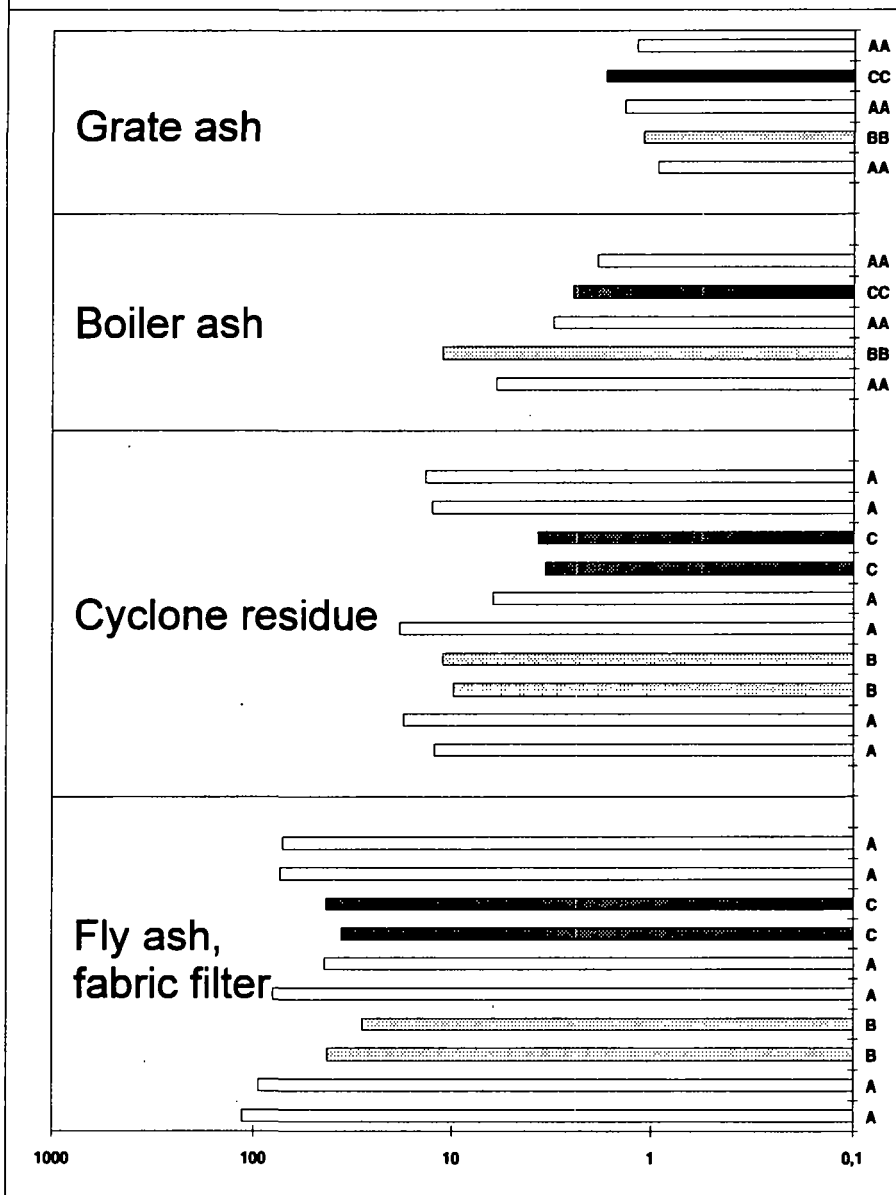
During these tests, A to B to C, the mean heat value increased from 11 to 12.8 to 14.7 GJ/mt feed. The maximum polymer content fed to the combustor was 22 per cent by weight in the C sample mix considering the other waste streams like compost residues, water cleaning residues etc. The plant was operated at full thermal load conditions, producing approximately 30 mt/h steam of 43 bar and 400 DGC.

To overcome the difficulties of representative measurement posed by accumulation of different quantities of dust in the boiler - which would hinder accurate comparison being achieved for the samples - soot blowing was carried out two hours before, and at the end of every six hour sampling period of the substances as mentioned above. Change over times from one condition to another - ie A to C - were a minimum period of 12 hours to ensure stable boiler conditions.

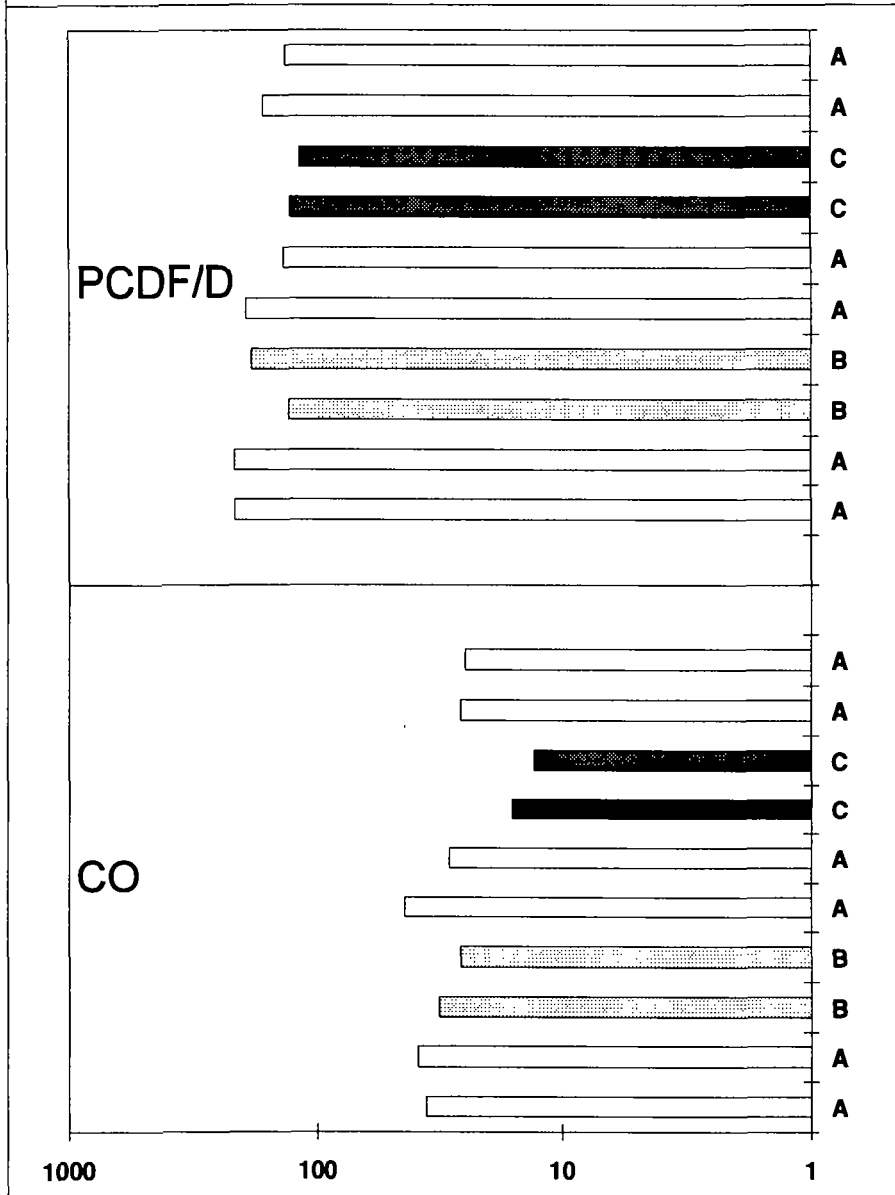
The main results of the test program can be summarized as follows:

- The different input material yields similar PCDF/D profiles which are typical for each residue compared to profiles of residues from municipal waste incinerators.
- The limits for PCDF/Ds of the German Gefahrstoffverordnung are not exceeded in any residue.
- The PCDF/D concentrations in the cyclone and fabric filter residue slightly decrease during the operating states B and C (see Fig. 1).
- The PCDF/D concentration as well as the CO concentration in the flue gas before cyclone slightly decreases during the operating states B and C (see Fig. 2).
- The PCDF/D concentrations in the clean gas are in the range that is typical for modern municipal waste incinerators. As expected, no correlation between the PCDF/D concentration and the different operating states can be observed in the clean gas. It depends on the operating conditions and efficiency of the clean gas devices.
- If an active carbon containing additive is used, the clean gas PCDF/D concentrations are a factor 10 below the limit of  $0.1 \text{ ng I-TE/m}^3$  of the German 17. BImSchV.
- The PCB, PCBz, PCPh and PAH concentrations in grate ash, boiler ash and flue gas before cyclone are not significantly influenced by the different operating states of the MSWC plant.
- The PCDF/D output of the incinerator (ie the PCDF/D mass flow in the grate ash, the boiler ash and the flue gas before cyclone) is significantly lower than the PCDF/D input on the basis of conservative low the PCDF/D literature data for MSW ( $60 \text{ ng I-TE/kg}$ ). An example for the operating state B is given in Fig. 3.
- PCDF/Ds are produced between the sampling locations "flue gas before and after cyclone" as well as "flue gas after cyclone" and "clean gas before stack" under the general operating conditions during the tests. The input/output calculations show typical 'de novo' PCDF/D profiles. The de novo synthesis after the sampling location „flue gas before cyclone" is probably due to the high gas temperature ( $\geq 200 \text{ }^\circ\text{C}$ ) and the residence time of the PCDF/D precursors in the flue gas and not to the air pollution control system itself.
- Addition of more plastic waste will improve a better burn out. Thus, the TOC content in the raw gas dust decreases and the de novo synthesis of PCDF/Ds between the sampling locations „flue gas after cyclone" and „clean gas before stack" seems to decrease slightly during the operating states B and C.
- The overall PCDF/D balance indicates a decrease of these compounds in the MSWC plant in Würzburg based on the literature data for PCDF/Ds in the MSW.

**Fig. 1: Tetra- to OctaCDF/D concentration ( $\mu\text{g}/\text{kg}$ ) in residues during operating states A, B, and C**



**Fig. 2: Tetra- to OctaCDF/D concentration (ng/m<sup>3</sup>) and CO concentration (mg/m<sup>3</sup>) in the flue gas before cyclone during the operating states A, B, and C**



**Fig. 3: Mass flow of the Tetra- to OctaCDF/D homolog groups (mg/h) as well as decrease / increase profiles - incinerator / boiler (example)**

**a Literature data: low contaminated municipal waste (60ng I-TE/kg)**

