# COMPARATIVE PCDD/PCDF-INVESTIGATIONS IN A MSWI PLANT BEFORE AND AFTER THE DESIGN MODERNIZATION

U. Düwel*, A. Nottrodt**, K. Ballschmiter***

* Institut für Gewässerschutz und Umgebungsüberwachung - IGU -
Geierstraße 1, D-2000 Hamburg 60, W-Germany

** Goepfert, Reimer & Partner, Bramfelder Straße 70,
D-2000 Hamburg 60, W-Germany

*** Universität Ulm, Albert-Einstein-Allee 11,
D-7900 Ulm, W-Germany

## ABSTRACT

During several test-runs before and after the design modernization of a Municipal Solid Waste Incineration (MSWI) plant a reduction of the PCDD/PCDF-levels in the flue gas and in the electrostatic precipitator (ESP) dust was determined. Possible reasons for the reduction were found due to measuring data and design modifications.

## INTRODUCTION

A consistent process optimization of combustion, boiler and flue gas cleaning is the precondition for an effective reduction of PCDD/PCDF-concentrations and related trace organics (PIC) in the flue gas of MSWI plants with the object of securely remaining under 0.1 ng 2,3,7,8-TCDD TE/m³. Within the framework of a long-term R/D-project experimental contributions were to be made to analyse the PCDD/-PCDF-formation in MSWI plants. A MSWI plant in the federal state Schleswig-Holstein gave the opportunity to investigate at the same plant the PCDD/PCDF-emissions before and after the modernization.

## EXPERIMENTAL

Figure 1 comprises the most important features of the old and the new plant. The old plant operated without boiler unit and heat utilization. The flue gases, leaving the combustion at a temperature of 800°C, were abruptly cooled down to approx. 270 °C by means of a quench reactor. Sodium hydroxide was added to the cooling water for the removal of acid gases. Accumulated dusts and salts formed during evaporation were then separated in the ESP. The most important feature of the old plant is the fact that the so-called critical temperature area for the dioxin formation - e.g. from 500°C to 270 °C [1] - was passed very fast and hence, actually did not exist.

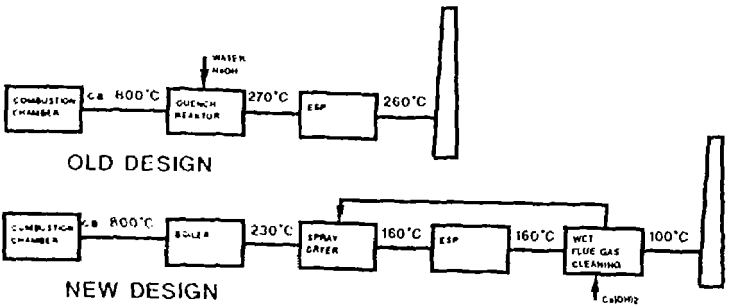


FIGURE 1: SCHEMATIC SKETCH OF THE OLD AND NEW PLANT DESIGN

The new plant consists of a boiler unit with heat utilization and a wet scrubber and spray dryer absorber. With 230°C at boiler exit the flue gases enter the spray absorber, where the salts, formed in the scrubber, and the fly ashes are evaporated to residues. In the following, the remaining dry residues are separated in the ESP. Then, the flue gas passes the wet scrubber (hydrated lime) and finally emits in the atmosphere.

The PCDD/PCDF-sampling was carried out in the flue gas of the plant by means of a water-cooled probe [1]. The PCDD/PCDF were sampled in a sorption unit with collection of condensate and collection in impingers. The analyses of the samples were done at the University of Ulm. Furthermore, in both plants the residues - such as dusts from the ESP - were sampled and analyzed with regard to PCDD/PCDF.

The measuring of the flue gas composition was carried out by means of continuous stack gas monitoring and manual sampling. In the combustion chamber, besides the concentrations of CO, $CO_2$ and $O_2$, the true gas temperature - measured with a suction pyrometer (with silimanite shields) - was determined. The sampling took place on one level in the way of multipoint scanning (eight measuring points).

All suitable data (operating data, flue gas, combustion chamber) were recorded in a data-processing system and analysed correspondingly.

In the old plant two test-runs were carried out each over 5 days, in the new plant one test-run over 3 days. The PCDD/PCDF-sampling in the flue gas was carried out each day over approx. eight hours for all measurings. During the whole PCDD/PCDF-sampling period all other plant data (operating data, flue gas, combustion chamber) were recorded, so that via the calculation of mean values data related to the sampling time are available.

RESULTS AND DISCUSSION

In Figure 2 the chlorohomologues of PCDD/PCDF in the flue gas are compared for the three test-runs of the new and the old plant. Those are mean values which are calculated from five individual values with regard to test-runs one and two and from three individual values with regard to test-run three. The results of both test-runs in the old plant show a comparable level, though the second test-run was carried out several months later. The good repeatability warrants reliable test-results which indicate a lower PCDD/PCDF-emission for the new plant - as most clearly to be seen for the PCDD in Figure 2. A similar result shows Figure 3 for the ESP dust. If the toxic equivalents in the flue gas are regarded instead of the homologue-sums, 3.8 ngTE/m³ (NATO, 11% $O_2$) were found in the new plant as against approx. 10 ngTE/m³ in the old plant.

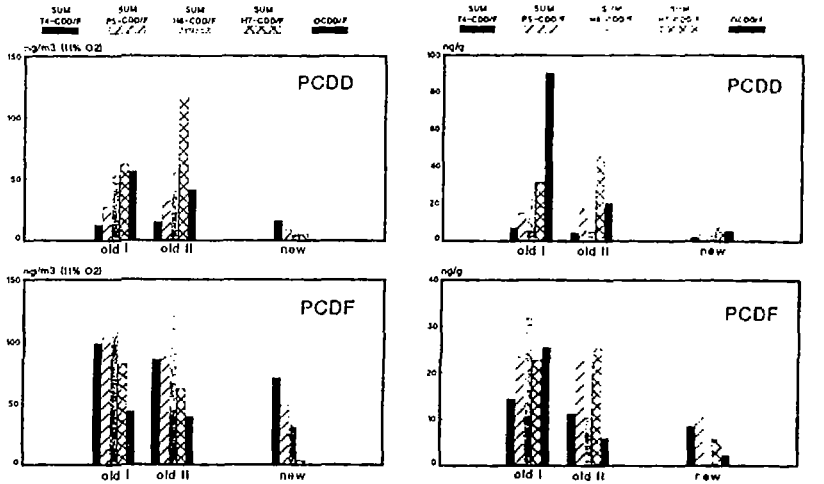


FIGURE 2: FLUE GAS PCDD/F LEVELS FIGURE 3: ESP DUST PCDD/F LEVELS

EFFECT OF THE DESIGN MODERNISATION

Furthermore, the values indicate that only abrupt cooling via a quench reactor behind the combustion chamber does not suffice to reduce PCDD/PCDF-formation.

Besides design modifications from the old to the new plant, the combustion chamber data show the following values (Table 1): The order of magnitude of the CO-level did not change from the old to the new plant. However, the new plant operates with a considerable lower $O_2$-excess (levels of $O_2$ and $CO_2$). The temperature of the combustion chamber had the same level during any of the three test-runs. The

lower $O_2$-excess and, in consequence, higher $CO_2$-concentrations were also found in the flue gas and confirm the combustion-chamber values. The lower concentration of CO in the flue gas of the new plant is explained by secondary reactions in the boiler. The THC-levels too are lower in the new plant.

| | | FLUE GAS/OPERATION | | | COMBUSTION CHAMBER | | |
|---|---|---|---|---|---|---|---|
| MSWI DESIGN | | OLD | OLD | NEW | OLD | OLD | NEW |
| TEST RUN | | #1 | #2 | #3 | #1 | #2 | #3 |
| CO | mg/m³ | 106 | 125 | 35,2 | 159 | 219 | 244 |
| $CO_2$ | % | 4,31 | 4,28 | 7,88 | 7,68 | 7,57 | 10,4 |
| $O_2$ | % | 16,2 | 15,8 | 11,3 | 12,2 | 13,0 | 8,62 |
| TEMPERATURE | °C | 266 | 258 | 101 | 867* | 848* | 906* |
| THC | mgC/m³ | 4,34 | 6,73 | < 3 | | | |
| $H_2O$ | g/m³ | 255 | 238 | 187 | | | |
| DUST | mg/m³ | ca. 20 | ca. 20 | 2,3 | | | |
| STEAM FLOW | Mg/h | - | - | 14,2 | | | |
| FEED RATE | Mg/h | ca. 5 | ca. 5 | 4,6 | | | |

Table 1: *Comparison of Measuring Data*

* The temparatures of the combustion chambers in the new and in the old plant cannot exactly be compared due to the different design.

By the present state of knowledge the following features could have influenced the reduced formation of PCDD/PCDF in the new plant (listed without the pretension of rating):

- improved combustion
- lower oxygen excess
- operation of the electrostatic precipitator at lower temperature (160° instead of 260°C)
- influence of the flue gas cleaning (e.g. due to a considerable lower concentration of dust in the flue gas)

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REFERENCES

[1] U. Düwel, A. Nottrodt, K. Ballschmiter. "Simultaneous Sampling of PCDD/PCDF inside the Combustion Chamber and on Four Boiler Levels of a Waste Incineration Plant", DIOXIN 89, September 17-22, 1989, Toronto, Canada, Chemosphere in press.