USE OF INCINERATOR EXIT GAS TEMPERATURE AND CO-CONTENT AS SURROGATE FOR PCDD/F EMISSIONS

Vladimir Boscak
Vølund Miljøteknik A/S, Abildager 11, 2605 Brøndby, Denmark

ABSTRACT

The major finding in Danish Ministry of Environment (Miljøstyrelsen) study on PCDD/F emission from MSW and hospital waste combustion was a clear correlation between the emission and exit gas temperature.

This correlation indicates that the exit gas temperature can serve as a surrogate for PCDD/F emissions with the several advantages including simplicity and the real time measurement.

CORRELATION BETWEEN PCDD/F EMISSIONS AND EXIT GAS TEMPERATURE

The best correlation between PCDD/F emission and the measured parameters is obtained when one plots the emissions versus the exit gas temperature (see Figure 1). The circles on the left illustrate the exponential increase of PCDD/F emissions with the linear increase in the exit gas temperature shown as a black slope on the bottom.

Figure 2 shows the correlation between the PCDD/F emission and the exit gas temperature at 4 plants. It can be seen that the PCDD/F emission is about 1000 ng/m^3 at 240°C but it drops below 100 ng/m^3 at the exit gas temperature below 190°C. The correlation is valid for both Reno-Nord and Syd plants even though they employ different incineration techniques and were designed by the different suppliers. The different exit gas temperature regime measured at the repeated test sequences can be attributed to the time intervals between test and the boiler cleaning. It is important to note that the correlation between exit gas temperature and PCDD/F emission is also valid for the hospital waste incinerators.

EXIT GAS TEMPERATURE AS A SURROGATE FOR PCDD/F EMISSION

The sampling and analysis for PCDD/F emission is both time consuming and costly. Typical analysis requires a couple of days and costs up to two thousand dollars.

Several researchers tried to find a surrogate for PCDD/F emission, with most of the work concentrating on CO.

The data presented in Figures 1 and 2 indicate that the exit gas temperature can be used as a surrogate for the emissions at least for the plants where an electrostatic precipitator is used for the particulate control.

The explanation is that PCDD/F are formed through a Deacon type reaction in the boiler, economizer and electrostatic precipitator at the temperature close to 300°C and are at least partially in a vapor form but condense on the fly ash as the temperature is lowered. Since the fly ash is removed in the electrostatic precipitator, low emissions are measured behind the precipitator (i.e. in exhaust duct or stack).

There are three major advantages of using exit gas temperature as a surrogate for PCDD/F emissions

1. Most plants already practice continuous measurement.
2. Exit gas temperature is a real time variable.
3. Temperature logs can be used as a compliance tools.

For example for Reno-Nord and Syd one can predict the PCDD/F emissions using the curves in Figure 2. If Miljøstyrelsen decides for example that PCDD/F emission at these plants should not exceed 50 ng/m^3 one can read from Figure 2 that the exit gas temperature of these plants should not exceed 180°C.

This is of course just the pseudo-quantitative way of monitoring emissions but with enough empirical correlation it may become a simple tool to check the compliance. In the cursury review of compliance Miljøstyrelsen would only have to examine the exit temperature logs to establish whether plant's PCDD/F emissions are acceptable.

It is here presumed that the regulatory agency will take a two-pronged approach to the dioxin issue. The first step is to prevent its emission into the atmosphere where it can be widely distributed. This is accomplished by the reduction of temperature and deposition of PCDD/F on the fly ash and their subsequent removal in the particulate control equipment. The second step is the destruction of PCDD/F in the fly ash by for example a thermal treatment.

This strategy is applicable to the existing facilities. In the future incineration facilities the formation of PCDD/F should be prevented by for example removal of fly ash at high temperature, neutralization of HCl, complete combustion of carbon, poisoning of copper catalytic activity, removal of copper from the waste, etc.

USE OF CO AND OTHER COMPOUNDS AS SURROGATE FOR EMISSION TOXICITY EQUIVALENCE

An interesting finding in the Miljøstyrelsen study was a rough correlation between the total sum of PCDD/F emissions and emission toxicity equivalence. A usable correlation based on the isomer specific analysis of the number of samples is:

Nordic toxicity equivalent = 0.015 x PCDD/F

It should be recognized that the above correlation applies only to the plant emissions with similar configuration and isomeric distribution as found in these measurements. If that is the case the first indication for emissions toxicity equivalence can be derived directly from the correlation between total PCDD/F emission and the exit gas temperature.

Figure 3 shows the ratio of various PCDD/F isomers in emissions from five MSW incineration plants; while PCDD isomers are skewed toward hepta and octa isomers PCDF's are more uniformly distributed.

The additional further qualitative information on the emission toxicity equivalence can be obtained by the examination of combustion conditions and a flue gas composition.

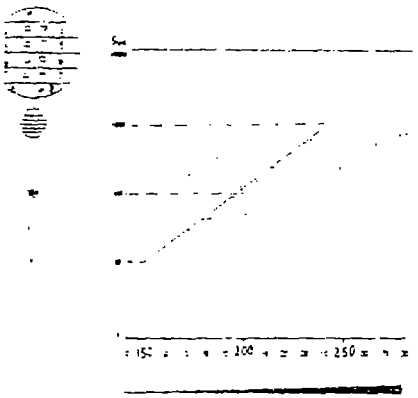
Nottrodt el al. (1984) indicated that the skewing toward higher chlorinated homologues of PCDD takes place in a good combustion characterized by the high temperature, flame oxidative state, low CO, etc. Stieglitz (1989) showed that dechlorination takes place at low O_2 content. The high moisture content favors the formation of low homologues.

Figure 4 correlates the emission of TCDD's with CO content at Århus Nord and Brøndby incineration facilities. While the PCDD emissions at Århus Nord show no tetra and penta isomers, Brøndby emissions have relatively high tetra and penta isomers ratio. These extremes correlate well with CO content at the two facilities. While Århus Nord had very low CO content in exit flue gas with about 2 ppm, Brøndby had high CO content of about 40 ppm. The correlation is even more pronounced when one correlates CO content and tetra isomers for some individual tests, but is not clear for the other plants.

More correlations between the flue gas composition and PCDD/F isomer distribution is needed before one can develop an algoritm for the prediction of its toxicity equivalence.

REFERENCES

Miljøstyrelsen (1989), Dioxins Emission from Waste Incineration, Miljøprojekt No. 117 (in Danish).
Nottrodt et al., Müll und Abfall, 11, 1984. (In German.)
Stieglitz, L. et al., Chemosphere, 18, Nos. 1-6, p. 1219-1226, 1989.



FROM MILJØPROJEKT Nr. 112
Danish Ministry of Environment

FIGURE 1

CORRELATION BETWEEN PCDD/F EMISSION AND EXIT GAS TEMPERATURE

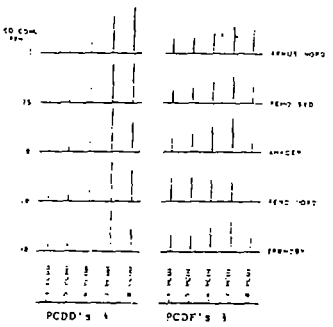


FIGURE 3

RATIO OF VARIOUS PCDD/PCDF ISOMERS IN EMISSIONS FROM FIVE MSW INCINERATOR PLANTS

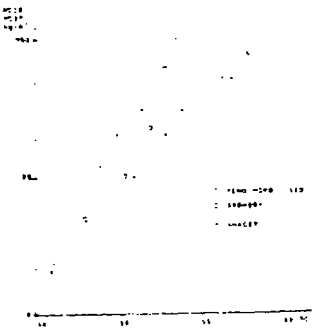


FIGURE 2

CORRELATION BETWEEN PCDD/PCDF EMISSION AND EXIT GAS TEMPERATURE AT FOUR MSW INCINERATOR PLANTS

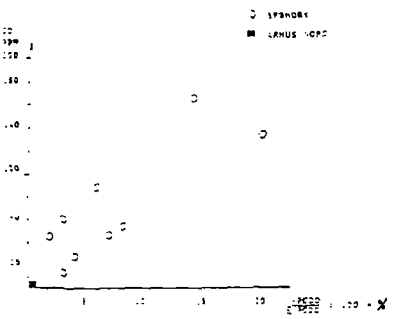


FIGURE 4

CORRELATION BETWEEN CO AND PERCENTAGE OF 4 PCDD'S FOR BRØNDBY AND ÅRHUS NORD INCINERATION PLANTS