BROMINE AND WASTE INCINERATION - AN ENVIRONMENTAL RISK?

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Abstract

Process factors influencing the production of brominated aromatics in waste incinerators are bromine load and combustion quality. Emission measurements does not indicate unacceptable environmental risks from controlled combustion and advanced flue gas cleaning.

Introduction

Environmental risks connected with brominated flame retardants have caused concern in recent years. One particular aspect is the formation of toxic micro-pollutants in combustion processes. Polybrominated dioxins and dibenzofurans are formed during the pyrolysis of brominated flame retardants (1). These results have by some workers been interpreted as evidence for health risks from incineration of these materials,, together with other municipal wastes (2).

In controlled combustion we can disregard formation of toxic halogenated aromatics from precursors (e.g. flame retardants) in the waste stream. It has been shown that halogenated aromatics, such as PCDD/PCDF, can be formed in thermal processes without an organic halogen source (3). Potential precursors, e.g. PCBs, can be incinerated without any increase in the production of PCDD/PCDF (4). The halogen load in itself is however an important process factor (5, 6).

We have earlier presented measurement data from combustion tests in a full-scale hazardous waste incinerator (6). Here we wish to present more results from this incinerator, a mass flow calculation for bromine in Swedish waste incinerators and measurement results from a municipal waste incinerator. These results may assist in the discussion of this particular aspect of bromine and brominated flame retardants in our waste streams.

Methods

The sampling and analysis of halogenated aromatics was performed as described in an earlier paper (6).

Results and discussion

Operating conditions

Combustion efficiency and halogen load have been shown to influence the formation of chlorinated aromatics. Our previous tests in the SAKAB hazardous waste incinerator indicated a similar relationship for brominated aromatics (6). In figure 1 we present results from further sampling in this incinerator, illustrating this relationship. Figure 2 show the response surface calculated with multiple linear regression, r=0.98, n=9 and p<0.01, for the same samples.

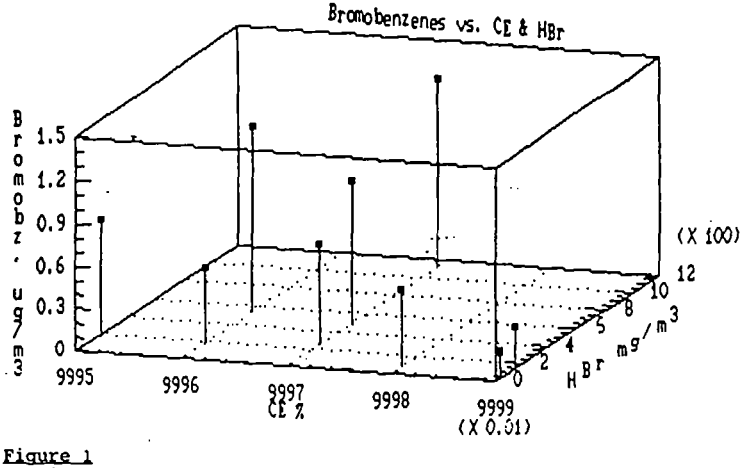

Figure 1
Brominated and bromochlorinated benzenes, µg/m3 sdg at 10% CO2, as a function of combustion efficiency (CE) and HBr, mg/m3 sdg at 10% CO2.

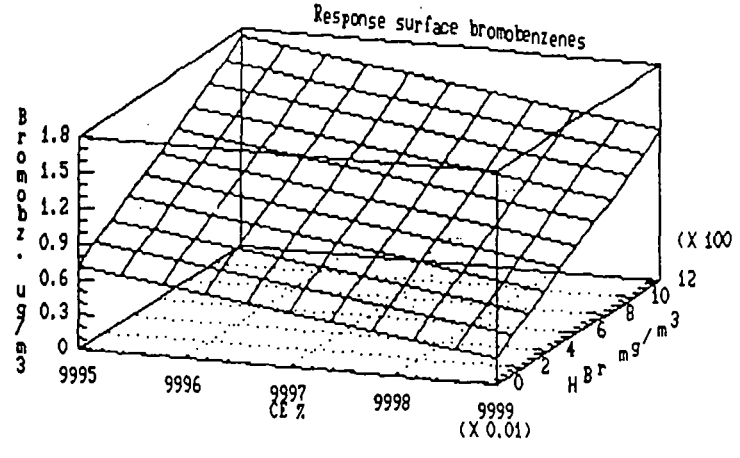

Figure 2
Response surface for brominated and bromochlorinated benzenes

Mass flow calculation

The average concentration of HBr in the flue gases before cleaning, from Swedish municipal waste incinerators, is approximately 25 mg/m3 sdg at 10% CO2 (6, 7). 1 ton of MSW produces about 5000 m3 flue gas at 10% CO2. About 1.6 Mton MSW is incinerated each year in Sweden. The total bromine flow through Swedish MSW incinerators can be calculated to approximately =25x10E-9x5000 x1.6xE6 ton =200 ton. Approximately 100 ton of bromine goes with municipal waste that is landfilled, assuming an equal composition as the waste incinerated.

In 1988 the total import of brominated flame retardants to Sweden was estimated to range between 1400 and 2000 tons, and a total amount of 500 tons were exported in different products (8). The HBr concentration in the flue gases will increase, above 25 mg/m3 sdg at 10% CO2, if all of this net import of brominated compounds end up in municipal waste.

Mesurements in a municipal waste incinerator

These measurements were conducted in the stack after flue gas cleaning, in a plant equipped with efficient flue gas cleaning and operated at a high combustion efficiency. The emission of TCDD-equivalents (calculated according to Eadon) were in both samples 0.1 ng/m3 sdg at 10% CO2.

In table 1 we present summary data for different brominated aromatics. High-boiling brominated compounds were not detected after this fabric filter.

Table 1
Flue gas, 2 samples, MSW incineration

Components	Concentration µg/m3 sdg 10% CO2
Σ Monobromochlorobenzenes	0.12 / 0.11
Σ Bromobenzenes	0.007 / 0.01
Σ Monobromotoluenes	0.26 / 0.35
Σ Monobromochlorophenols	0.36 / 0.28
Σ Bromophenols	0.086 / 0.10
Σ Monobromotrichlorodibenzofurans	< / < *
Σ Monobromtrichlorodibenzo-p-dioxins	< / < *
Σ Dibromodichlorodibenzo-p-dioxins	< / < *
Σ Tetrabromodibenzofurans	< / < **
Σ Tetrabromodibenzo-p-dioxins	< / < **
Σ Pentabromodibenzo-p-dioxins	< / < **

* = detection limit for single isomer ≤0.03 ng/m3 sdg at 10% CO2
** = detection limit for single isomer ≤0.4 ng/m3 sdg at 10% CO2

Conclusions

The data we have presented here does not indicate that bromine in waste can cause any unacceptable environmental risks when treated in incineration plants with good combustion conditions and equipped with efficient flue gas cleaning. However, it has recently been shown that fires in waste landfills can cause substantial emissions of both polychlorinated dioxins and dibenzofurans as well as toxic coplanar PCBs (9). It seems likely to us that these frequent accidental fires also can cause emissions of brominated organic micro-pollutants. Therefore controlled combustion should be favoured as treatment method for municipal waste instead of landfilling.

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