

COMPARISON OF ORGANOCHLORINE COMPOUNDS IN THE FLUE GAS OF WASTE INCINERATION; WASTE GASIFICATION AND COAL COMBUSTION.

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ABSTRACT

Organochlorine compounds like chloronaphthalenes, chlorobiphenyls, chlorophenols and chlorobenzenes are formed by waste incineration, waste gasification and coal combustion and are detected in the flue gas.

INTRODUCTION

An extended analysis on the emissions of waste gasification of a pilot plant in the "Lurgi Eco Gas" procedure have been previously analysed (1). A comparable spectrum of compounds was detected in the flue gas of waste incineration from a plant of the German Babcock (2) and in the Circulating Fluid Bed (CFB) combustion of coal, a plant constructed by Lurgi (3).

The formation of the organochlorine compounds could be explained by electrophilic aromatic substitution at the surface of fly ash particles (4) as well as by homogenous gas phase reactions (5).

EXPERIMENTAL

Flue gases both of waste gasification and coal combustion were collected in cooled nonane. The emitted compounds from the waste incinerator were adsorbed on XAD-2 resin. After gasification in a reactor (temperature 1000°C) the gas was quenched to 60°C, purified and combusted at about 1000°C. The flue gas temperature was 160°C. The gas of the waste incineration (combustion chamber temperature 1000°C) and coal combustion (temperature in the CFB chamber 850°C) streams through a convective pass air heater and an electrofilter. In the case of waste incineration there is an additional cleaning by a HCl/HF scrubber. The flue gas temperatures were 200°C (coal combustion) and 120°C (waste incineration), respectively.

The free oxygen in the flue gas was 12-13 Vol.% (waste incineration), 9-10 Vol.% (waste gasification) and 3.5-4 Vol.% (coal combustion).

The analysis was performed at a Finnigan 5100 coupled GC-MS system. The column used was a J&W DB-5.

FORM

RESULTS

Figure 1 shows the concentrations of chlorinated benzenes, biphenyls, naphthalenes and phenols in flue gas of waste incineration, waste gasification and coal combustion.

$\mu\text{g}/\text{Nm}^3$

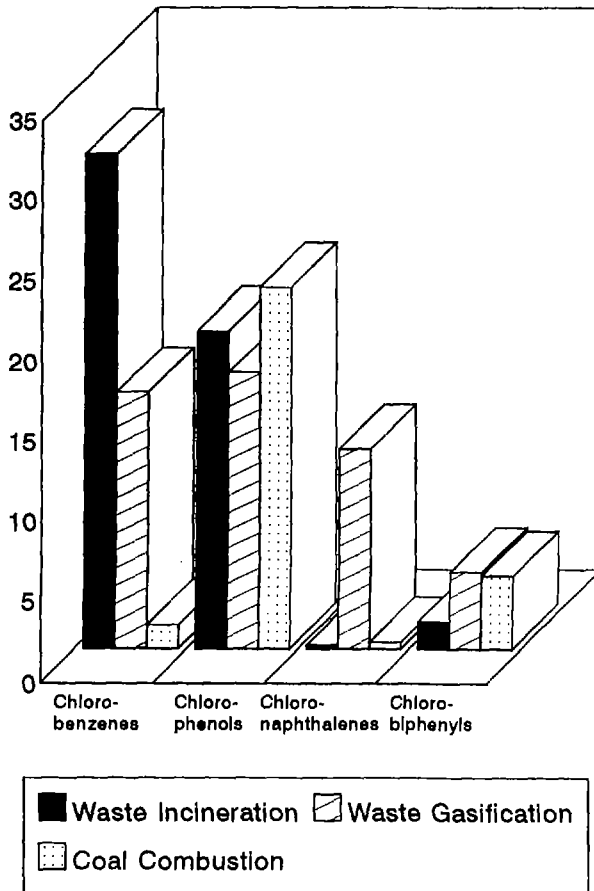


Figure 1: Concentrations of organochlorine compounds in flue gas

In the calculation for figure 1 all detected aromatic organochlorine compounds were considered (Table 1).

Table 1: Detected groups of organochlorine congeners, which were considered in the calculation

	Waste Gasification	Waste Incineration	Coal Combustion
Chlorobenzenes	di- to hexa-	di-to hexa-	di-,tri-
Chlorophenols	di- to penta-	di-to penta-	tri-
Chloronaphthalenes	mono-,di-,tetra-,octa-	mono-,di-	mono-
Chlorobiphenyls	tri- to deca-	tri-to hepta-	tri-

Whereas the concentration of chlorobenzenes decreases from waste incineration, through waste gasification to coal combustion, the concentration of chlorobiphenyls increases. This tendency supports the hypothesis that a reaction channel exists, most evident in the waste incineration, where the chlorobiphenyl molecules are split into chlorobenzene molecules. The concentration of the chlorophenols remains almost constant for all three combustion methods. Waste gasification shows relatively high values for chloronaphthalenes.

This might be explained by the difference in the emitted naphthalene concentrations (waste gasification: $29.000 \mu\text{g}/\text{Nm}^3$; waste incineration: $103 \mu\text{g}/\text{Nm}^3$; coal combustion: $1\mu\text{g}/\text{Nm}^3$).

Figure 2 shows the concentration of different chlorobenzenes and chlorophenols in waste incineration and waste gasification.

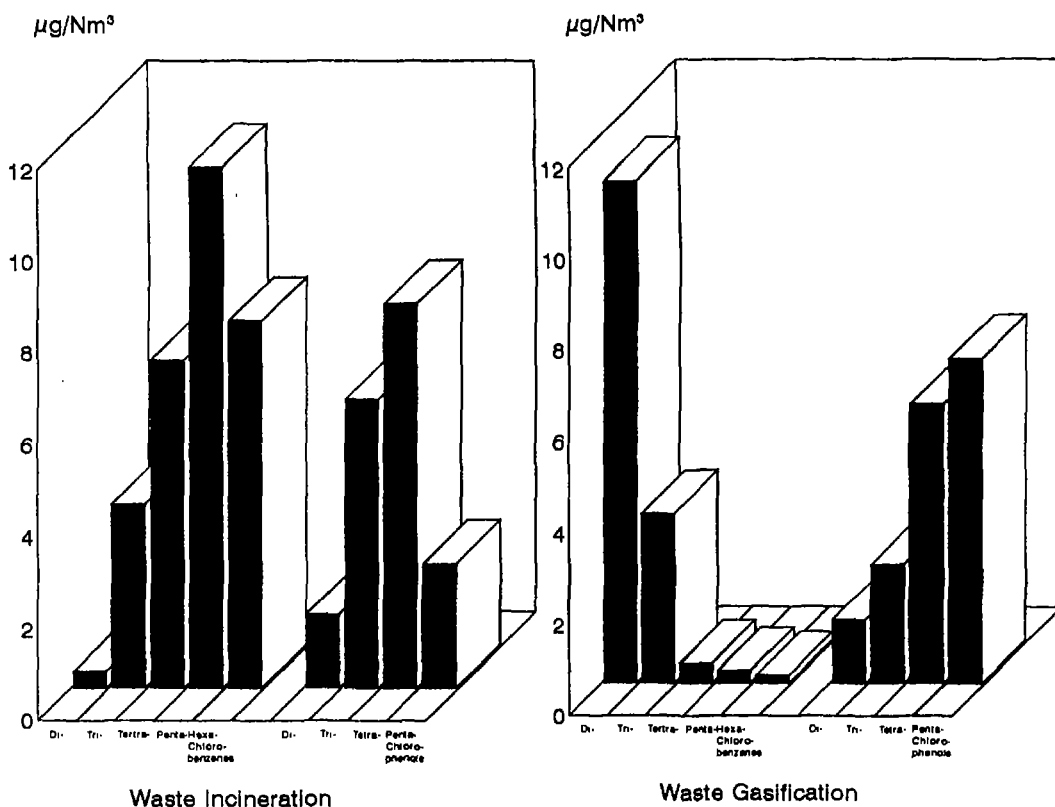


Figure 2: Concentrations of chlorobenzenes and chlorophenols in emissions of waste incineration and waste gasification

FORM

During waste gasification the concentrations of the chlorobenzenes decrease with the degree of chlorination from the low to the higher chlorinated benzenes. The chlorophenols show the reverse tendency. This phenomenon could be explained by assuming electrophilic substitution reactions between Cl_2 and the aromatics, where the high + M effect of the phenolic hydroxy group is activating the reactivity. The electrophilic aromatic substitution reactions are favoured in the presence of Lewis catalysts, especially transition metals, which are selectively eroded from the fly ash surface (4). This reaction mechanism takes place mainly in the quenching step (1).

The formation of organochlorine compounds in the coal combustion are assumed to be electrophilic substitution reactions on coal particles analogous to the waste gasification (3).

In waste incineration the concentrations of the chlorobenzenes as well as the chlorophenols are statistically distributed analogically. This presentation is consistent with the possibility of homogenous gas phase formation from the aromatics with chlorine in the sense of a radical reaction mechanism (6).

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