Detailed Balancing of PCDD and PCDF Flow in an Experimental Flue Gas Cleaning Line

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Introduction

The behaviour of PCDD and PCDF in waste incinerators has been studied extensively. Because of the large number of possible isomers, detailed discussion on a homologue and congener specific basis seems informative (1). Also, experimental observations are the net results of the physical and chemical processes involved, e.g. PCDD and PCDF formation and destruction, chlorination and dechlorination, adsorption and desorption, gaseous and solid phase distribution (2). Useful information may be gained by considering the PCDD and PCDF flow in experimental facilities in more detail.

Material and Methods

Tests were done in a fluidized-bed combustor desinged mainly for incineration of industrial wastes. A small amount of flue gas from the combustor was introduced to an experimental flue gas cleaning line consisting of a boiler, a quench chamber, a fabric filter and a coke filter. Flue gas samples for PCDD and PCDF analysis were taken at the boiler inlet and outlet, fabric filter inlet and outlet, and coke filter outlet; and ash samples were taken at the boiler and fabric filter discharge. Sampling and analysis procedures for PCDDs and PCDFs were according to reference (3).

Results and Discussion

Detailed balancing of PCDD/F flow for the boiler and air pollution control devices sections in this experimental flue gas cleaning line is shown in Figs. 1 and 2, respectively. These test results were obtained when incineration of industrial plastic wastes having a Cl content ca. 4% wt. was attempted in the combustor. It is seen in Fig. 1 that the homologue distribution of PCDD/Fs in the boiler section is skewed towards O_8CDF; this homologue distribution is different from those observed in municipal waste incinerators where the PCDD/F homologues usually show a maximum at T_4CDF or P_5CDF or be flater than Fig. 1 (1). The higher Cl content in the plastic wastes being burned as compared to municipal wastes which have a Cl content ca. 1% wt. is a possible explanation. In the 2,3,7,8 chlorine-substituted congener pattern, a similar trend can be found, showing the dominance of O_8CDF, 1,2,3,4,6,7,8- and 1,2,3,4,7,8,9-H_7CDF, O_8CDD and 1,2,3,4,6,7,8-H_7CDD; these

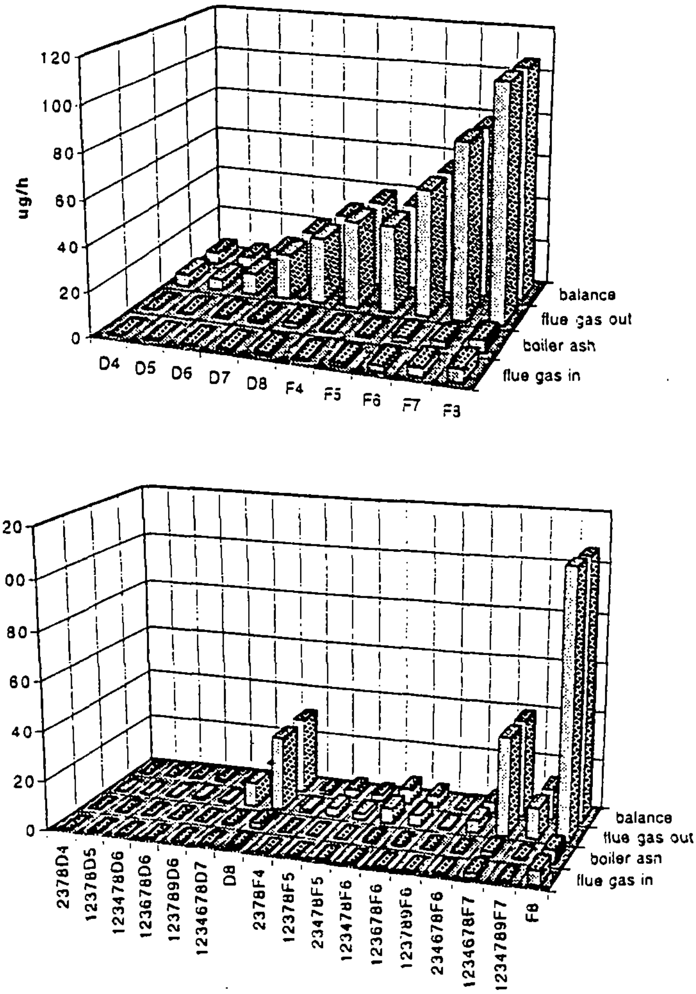

Fig. 1 Detailed balancing of PCDD/F flow for the boiler section; (above: tetra to octa dioxin and furan homologues; below: 2,3,7,8 chlorine-substituted, tetra to octa dioxin and furan congeners).

congeners have low TEQ factors and do not make much contribution to the TE output.

It is generally known that the removal of PCDD/F from flue gases by fabric and coke filters is highly efficient. As is evident in Fig. 2 almost all PCDD/F homologues and congeners have been collected by the APCDs; the filter ashes contain a slightly higher amount of PCDD/F than the clean gases, though both are in extremely small quantities. The PCDD/F removed from flue gases have probably been deposited in

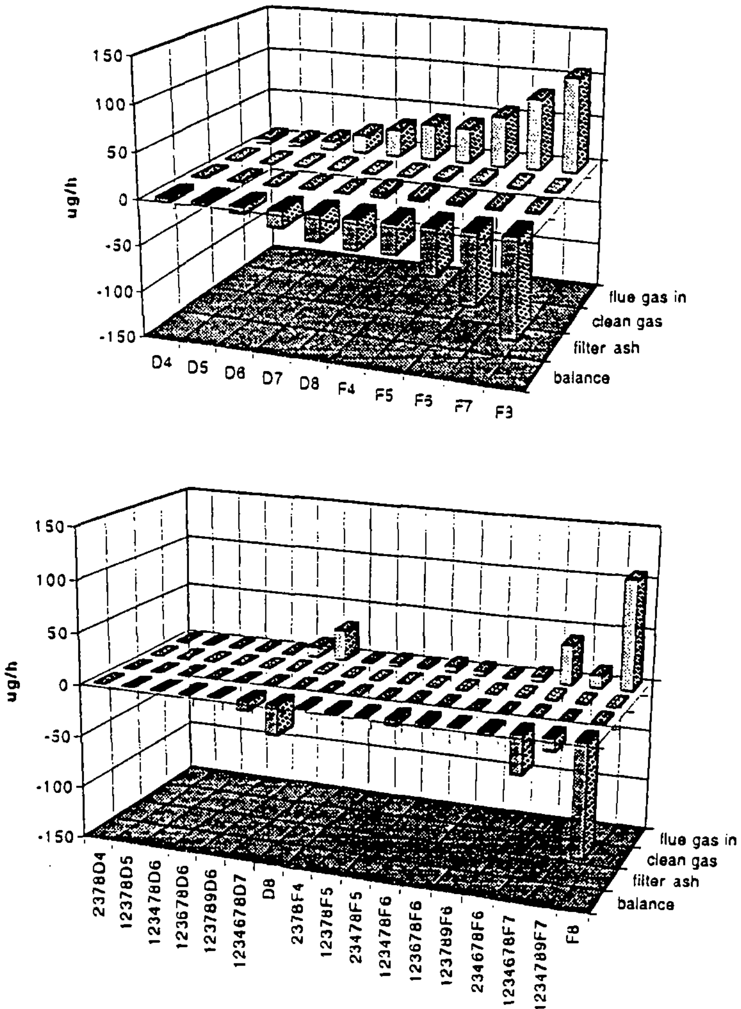

Fig. 2 Detailed balancing of PCDD/F flow for the air pollution control devices section; (above: tetra to octa dioxin and furan homologues; below: 2,3,7,8 chlorine-substituted, tetra to octa dioxin and furan congeners).

the coke bed. Contaminated cokes can then be disposed of in the combustor easily. The balance of 2,3,7,8-T_4CDD flow in the APCD section has a positive value; this is mainly due to measurement uncertainties; another consideration is that this light weight congener has a higher vapour pressure and is more difficult to be collected; on the other hand heavy weight congeners like O_8CDD have a lower vapour pressure and are easier to be collected.

In Fig. 3 are shown the homologue profile and 2,3,7,8 chlorine-substituted

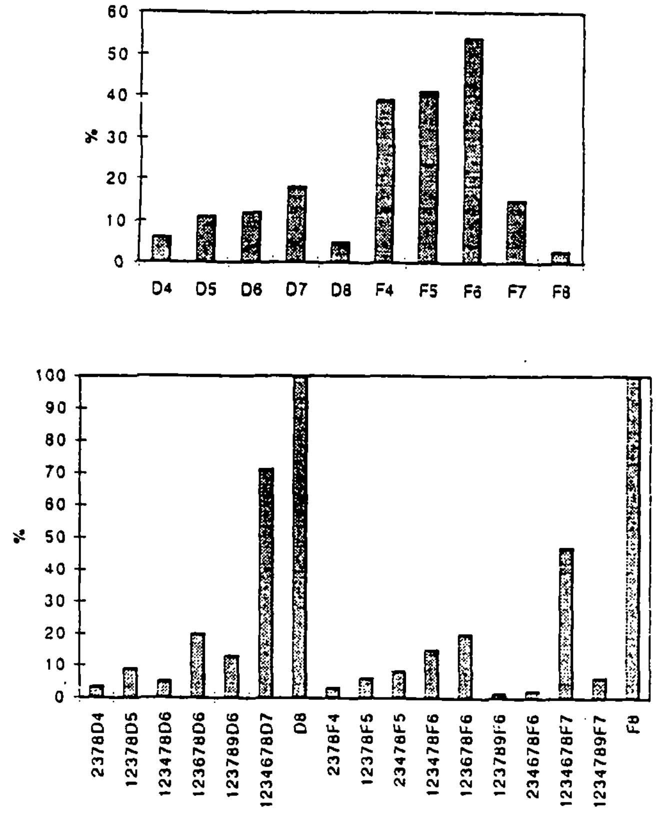

Fig. 3 Homologue profile (above) in % wt. as normalized to the PCDD/F total amount and the 2,3,7,8 chlorine-substituted congener pattern (below) in % wt. as normalized to the corresponding homologue weight, from (4).

congener pattern of PCDD/Fs from a laboratory experiment reported by Schoonenboom et al. (4) where a mixture of fly ash and activated carbon was heated in air at 300°C for 2 hrs. Comparing Figs. 1 and 3 it can be seen that the homologue profiles measured at the flue gas cleaning line and laboratory experiment are quite different, although both have a PCDF/PCDD ratio of about 3. On the other hand, the agreement of the 2,3,7,8 congener patterns from the flue gas cleaning line and laboratory experiment is much better, e.g. in H_7CDF, 1,2,3,4,6,7,8-H_7CDD has a higher amount than 1,2,3,4,7,8,9-H_7CDD, and in H_6CDF, 1,2,3,4,7,8-H_6CDF and 1,2,3,6,7,8-H_6CDF are higher than 1,2,3,7,8,9-H_6CDF and 2,3,4,6,7,8-H_6CDF. These observations indicate that thermodynamic factors play a role in the PCDD/F formation and destruction, and chlorination and dechlorination processes.

References

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