A STDUY OF DIOXIN-LIKE BROMINE COMPOUNDS AT A MSW INCINERATION PLANT

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Introduction

Halogenated dioxin compounds emission from waste incineration facilities is becoming a new interest of late. In order to estimate the input/output balance of such dioxins, we have conducted a study of dioxins and dioxin-like compounds contained in the waste brought into the MSW incineration plant, and in the flue gas and incineration residue (bottom ash and fly ash).

Method and Materials

The plant is a continuously operating stoker-type incinerator with a boiler that was built in accordance with the"Guideline for controlling PCDDs/DFs in MSW Management– PCDDs/DFs Reduction Program–". **Table 1** and **Fig. 1** describe the outline of this plant.

Table 1 Outline of the Plant

Throughput	3 X 85t/24h=255t/day
Furnace Type	Stoker Furnace + Boiler (with Power Generation)
Flue Gas Treatment	Quenching Chamber + BF (Activate Carbon Injection)

The items for which concentrations have been analyzed are as follows: polychlorinated dibenzo-p-dioxins(PCDDs/DFs), coplanarPCBs (Co-PCBs) and polybrominated dibenzo-p-dioxins and dibenzofurans(PBDDs/DFs: monobromo- through hexabromo- compounds). In addition, polybrominated diphenyl ethers (PBDEs) were analyzed with the refuse feedstock, and polybromochloro dibenzo-p-dioxins and dibenzofurans (PXDDs/DFs: monobromo-polychlorodibenzo- and dibromo-polychlorodibenzo- compounds only), and polycyclic aromatic hydrocarbons (PAHs) were analyzed with the flue gas and incineration residues.

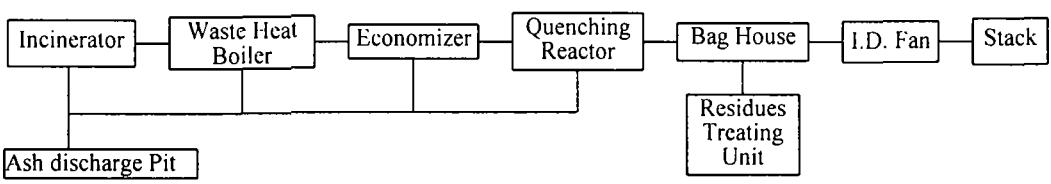

Fig. 1 Process Flow of the Testing Plant

The analyses of PCDDs/DFs and Co-PCBs, using GC-MS, were based on JIS K0311 standard method for flue gas. Those of waste, bottom ash and fly ash were in accordance with "Standard Manual for Measuring Dioxins in Waste Management", by Ministry of Health and Welfare

Welfare (Feb. '97). Analyses of dioxin-like compounds also used GC-MS.

Three samples of feedstock waste were collected. They were: mostly normal household waste collected from the waste pit (Normal #1), Normal #1 plus some crushed waste (Normal #2) and the crushed waste stream coming from the bulky-waste crushing facility next door. Roughly 40kg of specimen was reduced from 200kg of waste (about 50kg in case of crushed waste) by quartering, and adjusted according to its physical composition before analysis.

The measurement of dioxin compounds in the flue gas and incineration residue was conducted at the Furnace No.1 of the 3-furnace facility. **Table 2** lists the operating conditions of Furnace No.1 at time of sampling.

Table 2 Furnace No.1 Operating Condition

Item	Unit	11/25/99
Throughput	ton/day	83
Flue Gas Volume, Wet	m^3_N/h	41,300
Flue Gas Volume, Dry	m^3_N/h	36,200
O_2	%	14.8
CO (corrected to 12% O_2)	ppm	3
Gas Temperature (in furnace · after bag house)	C°	900 · 167
Amount of Ash	kg/day	7,600
Amount of Fly Ash	kg/day	2,500

Results and Discussion

1. Dioxin Compound Concentration in Feedstock Waste

The results of analyzing sample wastes, flue gas and incineration residues for dioxins and dioxins -like compounds are shown in **Table 3.**

Table 3 Analysis of Dioxins & Dioxins -like Compounds (TEQ:WHO-TEF, 1998)

	Specimen	Normal Waste #1	Normal Waste #2	Crushed Waste	Flue Gas (Particulates)	Flue Gas (Gaseous)	Fly Ash	Bottom Ash
	Unit	(ng/g) ng-TEQ /g	(ng/g) ng-TEQ /g	(ng/g) ng-TEQ /g	(ng/m^3_N) ng-TEQ /m^3_N	(ng/m^3_N) ng-TEQ/ m^3_N	(ng/g) ng-TEQ /g	(ng/g) ng-TEQ /g
PCDDs/ DFs	Total PCDDs	(0.95)	(0.23)	(3.4)	(0.14)	(0.54)	(35)	(0.24)
	Total PCDFs	(0.074)	(0.040)	(0.31)	(0.062)	(0.21)	(29)	(0.14)
	Total PCDDs/DFs	(1.0)	(0.27)	(3.7)	(0.20)	(0.75)	(64)	(0.38)
	PCDDs TEQ	0.0020	0.00067	0.0015	0.00013	0.0040	0.28	0.0032
	PCDFs TEQ	0.00090	0.00054	0.0014	0.000067	0.0042	0.59	0.0021
	PCDDs/PCDs TEQ	0.0029	0.0012	0.0029	0.00019	0.0082	0.86	0.0052
Co-PCBs	Co-PCBs TEQ	0.00054	0.00043	0.00035	N.D.	0.000015	0.086	0.00022
PBDDs/DFs		(0.53)	(1.4)	(2.9)	(0.15)	(0.24)	(0.30)	(0.0058)
PXDDs/DFs		–	–	–	N.D.	N.D.	(25)	(0.021)
PBDEs		(15)	(51)	(88)	–	–	–	–

Note: "N.D." stands for "not detected, and "–" for "no analysis done." Figures in brackets ( ) designate total sum concentration. Flue gas analysis values are corrected to 12% O_2.

Fig. 2 displays the distribution of PCDDs/DFs homologue concentrations contained in the Normal #1, Normal #2 and Crushed wastes. The total PCDDs/DFs concentration values in pg/g-dry were 1,000 for Normal #1, 270 for Normal #2 and 3,700 for Crushed waste, respectively.

The percentages of PCDDs were higher in all the wastes. Normal #1 waste (mostly household waste) contained more T_4CDDs and P_5CDDs while the crushed waste had more O_8CDD. Normal #2, the mixture of the two, possessed the characteristics of both kinds. Co-PCBs distributions were similar in all the samples showing largest concentration of P_5CB #118, followed by P_5CB #105, H_7CB #180 and T_4CB #77, as shown in **Fig. 3.** This tendency was similar to the one reported previously. [1] The total TEQ of PCDDs/DFs + Co-PCBs in pg-TEQ/g-dry were 3.4 (Normal #1), 1.6 (Normal #2) and 3.3 (Crushed).

The concentrations of PBDDs/DFs were 530 (Normal #1), 1,400 (Normal #2) and 2,900 (Crushed) pg/g-dry, increasing as the percentage of crushed waste goes up. Generally, PBDF concentrations were higher. As for PBDEs, only dibromo- and tetrabromo- compounds were detected, and showed the tendency to increase as the ratio of crushed waste goes up, similar to PBDDs/DFs.

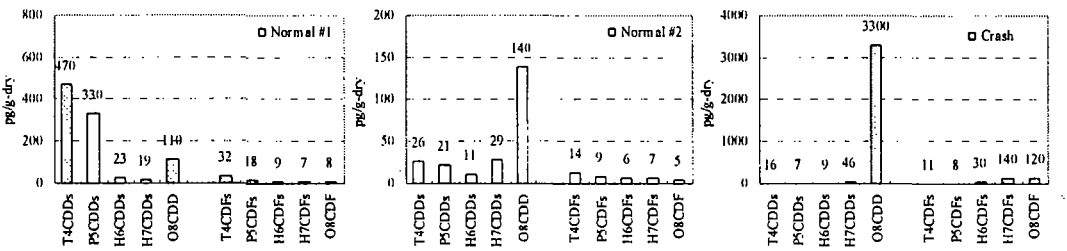

Fig. 2 Distribution of Dioxn Homologue Concentrations in Feedstock Waste

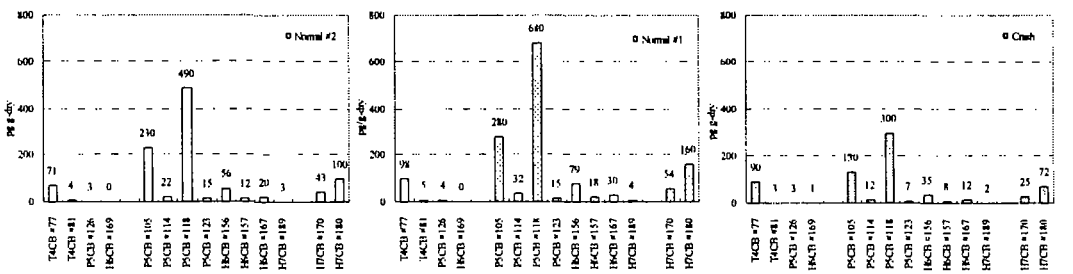

Fig. 3 Distribution of Co-PCB Cogener Concentrations in Feedstock Waste

2. Dioxin Compound Concentration in Flue Gas and Incineration Residues

The concentrations of PCDDs/DFs in the flue gas, bottom ash and fly ash from the facility used for tests were similar to the results of tests conducted a year earlier. [2] No Co-PCBs were detected in the particulate phase of flue gas, and the gaseous phase had roughly 0.2% (in TEQ value) of the PCDDs/DFs, a very small ratio. Meanwhile, the bottom ash and fly ash yielded Co-PCBs up to 4% and 10% of PCDDs/DFs respectively, in TEQ values.

PBDDs/DFs were detected in the flue gas, bottom ash and fly ash, but were not high in fly ash, as PCDDs/DFs. PXDDs/DFs were not detected in the flue gas but were found in fly ash,

somewhat similar to the distribution of PCDDs/DFs and Co-PCBs.

3. Dioxins (TEQ values) as Substance Flow

The concentration of dioxins, including Co-PCBs, in the waste stream (Normal #1 and Normal #2) entering this facility, were between 1.0 and 1.8μg-TEQ/ton of waste (wet base). Meanwhile, the dioxins emission from the flue gas and the incineration residues was estimated to be 30μg-TEQ/ton of waste (wet base). The total emission was 17 to 30 times as large as that contained in the total waste stream, and 98% of the total emission was loaded on the fly ash. The environmental load of flue gas itself is 0.059μg-TEQ/ton of waste.

Conclusion

Dioxins and related compound concentrations were measured with the feedstock waste, flue gas, bottom ash and fly ash from a continuously operated waste incinerator built according to the dioxins guideline, and obtained the following results.

1) The cogener distribution of PCDDs/DFs in the feedstock waste varied due to the addition of crushed waste, while that of Co-PCBs displayed similar results among the three kinds of waste.
2) Total dioxins release (TEQ value) from the facility, including Co-PCBs, was 30μg-TEQ/ton of waste, with 98% carried by the fly ash.
3) The feedstock waste contained PBDDs/DFs to the same order as PCDDs/DFs. After incineration, PBDDs/DFs were found in the flue gas and incineration residues, and PXDDs/DFs were mostly found in the fly ash. Further studies with wider scope are necessary to fully understand the general trend of polyhalogenated compounds.

Acknowledgements

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