Dioxin-like Compounds from An Incineration Plant of Normal Municipal Solid Waste

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Introduction

In Japan the concentration of dioxins in emission gas from the municipal solid waste(MSW) incineration plants has been decreasing sharply since it is regulated below 0.1 ng-TEQ/m^3N. While this time the methods of burning and treatment of flue gas have been improved.

Meanwhile, dioxin-like compounds, such as polybromo dibenzo-p-dioxins(PBDDs), polybromo dibenzofurans(PBDFs), polybrominated biphenyls(PBBs) and polybromochloro dibenzo-p-dioxins and dibenzofurans(PXDDs/DFs), are generally paid attention, but research of those compounds has not been carried out enough.

We have investigated the levels of dioxin and such dioxin-like compounds at the large-scale MSW incineration plant in order to obtain the data enable to evaluate for emission control technologies of such compounds. In this paper, we report the results of this investigation.

Materials and Methods

For the investigation we have used a large-scale MSW incineration plant having grate-type furnaces with a processing capacity of 6.7 t/h per line. The flow sheet of this facility is presented as Fig. 1. In this plant flue gas passes bag house and catalytic denitrification equipment. This system is one of the most advanced process for emission control of dioxin. We had attention to keep the usual operation conditions.

In this examination, as for flue gas, waste, bottom ash and fly ash, we analyzed not only PCDDs/DFs but PBDDs/DFs, PBBs , monobromo polychloro dibenzo-p-dioxins(MoBPXDDs), monobromo polychloro dibenzofurans (MoBPXDFs), dibromo polychloro dibenzo-p-dioxins(DiBPXDDs) and dibromo polychloro dibenzofurans(DiBPXDFs).

Next to this plant, waste recycling plaza is operated and from there shredded combustible solid waste is conveyed to MSW incineration plant. This shredded waste is considered to contain more brominated comounds than normally collected household waste, because shredded waste is originated from used electrical items. But in this investigation shredded waste was not conveyed into incineration plant. Only normal waste put into incinerator was well mixed at waste bunker and consisted mainly of general combustible waste.

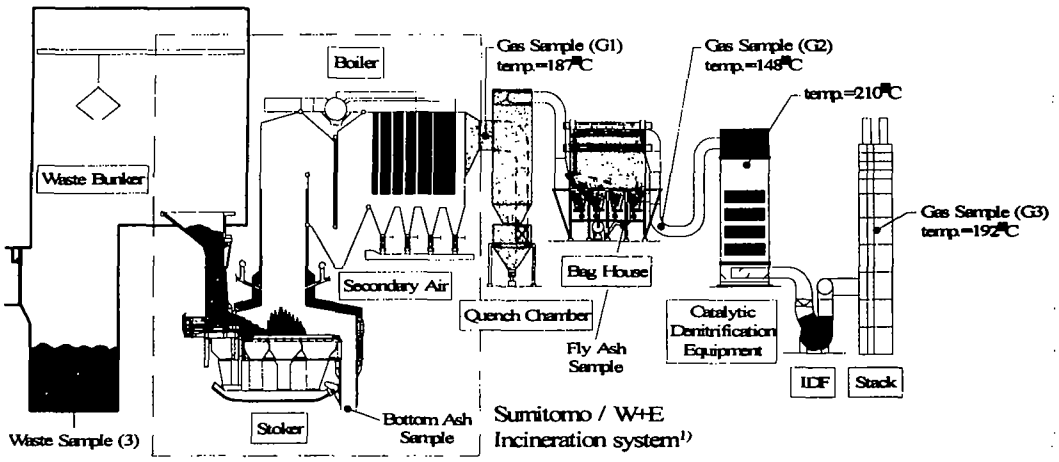

Fig. 1 Process flow diagram

Results and Discussion

The results of flue gas analysis are given in Table 1. The results of waste, bottom ash and fly ash analysis are given in Table 2.

Table 1. Flue Gas Analysis Data (converted to O_2=12%)

Item	unit	Boiler outlet (G1)	BF outlet (G2)	Stack (G3)
Dust	g/m^{3}N	2.2	0.0032	0.0015
SOx	ppm	64	5.0	6.2
HCl	mg/m^{3}N	530	15	10
HF	ppm	1.5	<0.5	<0.5
HBr	ppm	0.37	0.26	0.17
NOx	ppm	140	110	20
CO	ppm	2	2	2
PAHs	ng/m^{3}N	6,700	1,300	17,000
PCDDs/DFs	ng/m^{3}N	80	3.3	2.7
TEQ-'88	ng-TEQ/m^{3}N	1.1	0.059	0.033
TEQ-'97	ng-TEQ/m^{3}N	1.2	0.065	0.036
PCBs	ng/m^{3}N	39	3.2	18
Co-PCBs	ng/m^{3}N	6.0	0.20	1.5
TEQ-'93	ng-TEQ/m^{3}N	0.079	0.0019	0.0032
TEQ-'97	ng-TEQ/m^{3}N	0.079	0.0019	0.0030
Total TEQ-'97	ng-TEQ/m^{3}N	1.3	0.067	0.039
PBDDs/DFs	ng/m^{3}N	0.48	0.26	0.23
MoBPXDDs/DFs	ng/m^{3}N	1.56	-	-
DiBPXDDs/DFs	ng/m^{3}N	<0.02	-	-
PBBs	ng/m^{3}N	2.93	0.58	1.07

Table 2. Normal Municipal Solid Waste, Bottom Ash and Fly Ash Analysis Data

Item	unit	Normal Municipal Solid Waste			Bottom ash	Fly ash
		Sample 1	Sample 2	Sample 3		
PCDDs/DFs	ng/g	0.54	0.87	0.39	0.71	27
TEQ-'88	ng-TEQ/g	0.0028	0.0022	0.0015	0.010	0.42
TEQ-'97	ng-TEQ/g	0.0026	0.0017	0.0014	0.012	0.46
PCBs	ng/g	12	14	8.2	0.62	10
Co-PCBs	ng/g	0.66	0.90	0.60	0.060	2.1
TEQ-'93	ng-TEQ/g	0.00060	0.00055	0.00034	0.00086	0.032
TEQ-'97	ng-TEQ/g	0.00057	0.00052	0.00033	0.00085	0.032
Total TEQ-'97	ng-TEQ/g	0.0032	0.0022	0.0017	0.013	0.49
PBDDs/DFs	ng/g	0.093	0.030	0.40	0.012	0.082
MoBPXDDs/DFs	ng/g	N.D.	-	-	0.02	1.65
DiBPXDDs/DFs	ng/g	N.D.	-	-	<0.02	<0.02
PBBs	ng/g	8.20	5.92	6.10	0.61	4.16

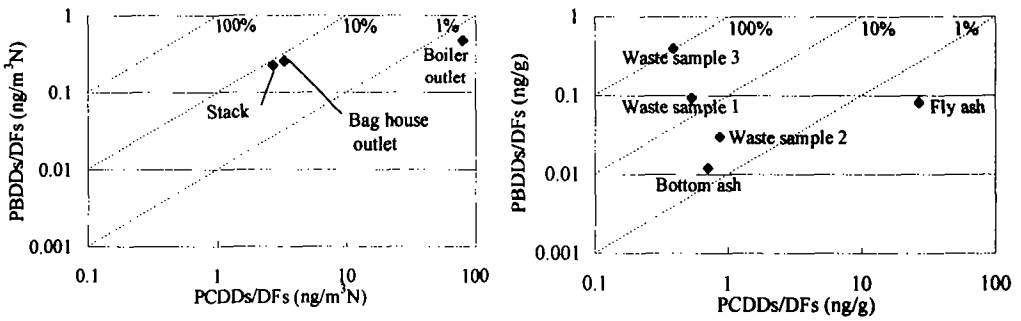

Fig. 2 Relation to PBDDs/DFs and PCDDs/DFs(Flue gas and Solid samples)

Fig. 2 shows the value of PBDDs/DFs compared to PCDDs/DFs. The ratio of PBDDs/DFs to PCDDs/DFs in flue gas is 0.6% at boiler outlet, 7.9% at bag house outlet and 8.5% at stack. This ratio can be changed by the bromine/chlorine content of input waste materials. All rates is under 10%. The rate in waste is from 3.4% to 103%, which is variable between samples.

Fig. 3 shows the reduction of PCDDs/DFs and PBDDs/DFs in flue gas with air pollution control system (APCS). PCDDs/DFs is removed over 95% after bag house and catalytic denitrification equipment. The removal rate of PBDDs/DFs is a little less than that of PCDDs/DFs, but due to the treatment of flue gas the concentration of PBDDs/DFs is declined.

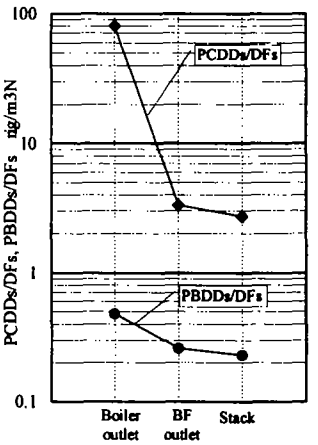

Fig. 3 Reduction of PCDDs/DFs and PBDDs/DFs in flue gas with APCS

Table 3 shows homologue profiles of PCDDs/DFs, PBDDs/DFs and MoBPXDDs/DFs. Meanwhile DiBPXDDs/DFs is not detected in any sample.

Table 3 Congener of PCDDs/DFs, PBDDs/DFs and MoBPXDDs/DFs

Flue gas (Boiler outlet) unit :ng/m³N

PCDDs/DFs		PBDDs/DFs		MoBPXDDs/DFs	
T4CDDs	18	T4BDDs	0.0038	MoBTrCDDs	< 0.02
P5CDDs	14	P5BDDs	<0.01	MoBTeCDDs	< 0.02
H6CDDs	8.2	H6BDDs	<0.05	MoBPeCDDs	< 0.02
H7CDDs	8.1	H7BDDs	<0.05	MoBHxCDDs	0.3
O8CDD	13	O8BDD	<0.05	MoBHpCDDs	1.53
PCDDs	61	PBDDs	0.0038	MoBPXDDs	1.83
T4CDFs	20	T4BDFs	0.0058	MoBTrCDFs	< 0.02
P5CDFs	16	P5BDFs	<0.01	MoBTeCDFs	< 0.02
H6CDFs	11	H6BDFs	<0.05	MoBPeCDFs	< 0.02
H7CDFs	6.6	H7BDFs	<0.05	MoBHxCDFs	< 0.02
O8CDF	1.5	O8BDF	<0.05	MoBHpCDFs	< 0.02
PCDFs	55	PBDFs	0.0058	MoBPXDFs	0
PCDD/DFs	120	PBDD/DFs	0.0096	MoBPXDDs/DFs	1.8

Bottom ash unit :ng/g

PCDDs/DFs		PBDDs/DFs		MoBPXDDs/DFs	
T4CDDs	0.10	T4BDDs	<0.0002	MoBTrCDDs	< 0.02
P5CDDs	0.081	P5BDDs	<0.001	MoBTeCDDs	< 0.02
H6CDDs	0.073	H6BDDs	<0.005	MoBPeCDDs	< 0.02
H7CDDs	0.064	H7BDDs	<0.005	MoBHxCDDs	< 0.02
O8CDD	0.11	O8BDD	<0.005	MoBHpCDDs	0.02
PCDDs	0.43	PBDDs	N.D.	MoBPXDDs	0.02
T4CDFs	0.12	T4BDFs	0.0011	MoBTrCDFs	< 0.02
P5CDFs	0.073	P5BDFs	<0.001	MoBTeCDFs	< 0.02
H6CDFs	0.045	H6BDFs	<0.005	MoBPeCDFs	< 0.02
H7CDFs	0.033	H7BDFs	<0.005	MoBHxCDFs	< 0.02
O8CDF	0.0093	O8BDF	<0.005	MoBHpCDFs	< 0.02
PCDFs	0.28	PBDFs	0.0011	MoBPXDFs	< 0.02
PCDD/DFs	0.71	PBDD/DFs	0.0011	MoBPXDDs/DFs	0.02

Waste sample 1 unit :ng/g

PCDDs/DFs		PBDDs/DFs		MoBPXDDs/DFs	
T4CDDs	0.020	T4BrDDs	0.013	MoBTrCDDs	N.D.
P5CDDs	0.010	P5BrDDs	0.0051	MoBTeCDDs	N.D.
H6CDDs	0.037	H6BrDDs	<0.005	MoBPeCDDs	N.D.
H7CDDs	0.093	H7BrDDs	<0.005	MoBHxCDDs	N.D.
O8CDD	0.32	O8BrDD	<0.005	MoBHpCDDs	N.D.
PCDDs	0.48	PBrDDs	0.018	MoBPXDDs	N.D.
T4CDFs	0.021	T4BrDFs	0.0066	MoBTrCDFs	N.D.
P5CDFs	0.013	P5BrDFs	0.013	MoBTeCDFs	N.D.
H6CDFs	0.0082	H6BrDFs	0.043	MoBPeCDFs	N.D.
H7CDFs	0.0077	H7BrDFs	<0.005	MoBHxCDFs	N.D.
O8CDF	0.0090	O8BrDF	<0.005	MoBHpCDFs	N.D.
PCDFs	0.059	PBrDFs	0.063	MoBPXDFs	N.D.
PCDD/DFs	0.54	PBrDD/DFs	0.081	MoBPXDDs/DFs	N.D.

Fly ash unit :ng/g

PCDDs/DFs		PBDDs/DFs		MoBPXDDs/DFs	
T4CDDs	1.6	T4BDDs	0.00019	MoBTrCDDs	0.13
P5CDDs	2.3	P5BDDs	<0.001	MoBTeCDDs	0.17
H6CDDs	3.3	H6BDDs	<0.005	MoBPeCDDs	0.25
H7CDDs	2.7	H7BDDs	<0.005	MoBHxCDDs	0.23
O8CDD	2.8	O8BDD	<0.005	MoBHpCDDs	0.33
PCDDs	13	PBDDs	0.00019	MoBPXDDs	1.11
T4CDFs	4.9	T4BDFs	0.0088	MoBTrCDFs	< 0.02
P5CDFs	4.0	P5BDFs	0.0074	MoBTeCDFs	0.06
H6CDFs	2.8	H6BDFs	<0.005	MoBPeCDFs	< 0.02
H7CDFs	1.6	H7BDFs	<0.005	MoBHxCDFs	0.06
O8CDF	0.32	O8BDF	<0.005	MoBHpCDFs	0.05
PCDFs	14	PBDFs	0.016	MoBPXDFs	0.17
PCDD/DFs	27	PBDD/DFs	0.016	MoBPXDDs/DFs	1.3

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