Two Investigations of Dioxin Emission from the Incineration of Waste and PVC

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1.Introduction

In Japan there exist about ten thousands of small-scale incinerators that fall outside of the legal regulatory framework. Used mainly to burn paper or wood scrap, they can be found in the backyards of homes and on the grounds of small factories. Their number has declined sharply in recent years as public concern over the issue of dioxins continues to mount; but many of these small incinerators are still in operation just as before, and very little data of the level of dioxins they produce is available [1]. There also has been much debate on the issue of whether PVC in waste has an effect on dioxin emission levels [2, 3].

We conducted experiments in which polyvinyl chloride (PVC) was intentionally added to office waste and burned in such a smal-scale, fixed-bed incinerator having insufficient combustion control and off-gas treatment capabilities.

At a large-scale MSW incineration plant having a well-managed system of combustion control,we also conducted experiments by adding waste plastic.

The purpose of these two sets of experiments is to examine the relation between PVC waste and dioxin emission in these two cases and, by this, provide additional information for consideration in that debate.

2.Test 1: Small-scale Incinerator

2-1.Method

Table 1 presents the general specifications of the small-scale incinerator used for this investigation; Fig. 1 shows its general appearance. Dioxin concentrations were measured in flue gas and ash for three types of waste having different chlorine (Cl) contents. RUN 1 was conducted with waste consisting of paper and wood only (no PVC). RUN 2 was carried out with waste collected from a factory office (this type of waste is processed by the facility on a daily basis). RUN 3 was performed with waste prepared by adding PVC to the waste of RUN 2 to increase the HCl content of flue gas by approximately 15 times.

To avoid the large fluctuation of waste gas amount that can occur from ejector air near the measurement port, we took gas measurements through a measurement port within an extension pipe fastened to the top of the stack.

Table 1.Small-scale Incinerator

Apparatus Outline	
Furnace Type	Batch operation Fixed bed
Capacity	80 kg/h
APC	Cyclone
Gas cooling	Air mixturer
Draft	FDF,Ejector
Charging Cycle	1batch/2hours

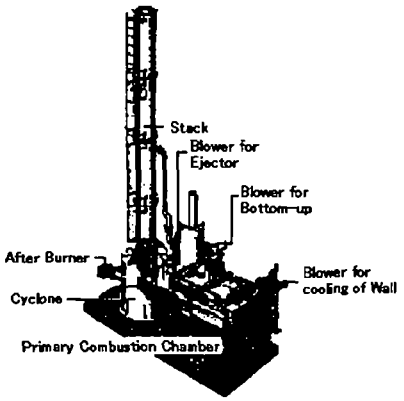

Fig.1.Small-scale Incinerator

2-2.Results

Chemical analytical results are shown in Table 2. Two dioxin samples were taken -- the first over a four-hour period including "start-up," "steady-state," "interim charging (one occurrence)," "steady-state," and "shutdown"; and the second, over a one-hour period including "post-interim-charging steady-state."

Dioxin emission levels were observed at 1.6-4.4 ngTEQ/m^{3}N in case of RUN 1 (paper and wood) , at 11-86 ngTEQ/m^{3}N in case of RUN 2(daily waste) and at 29-36 ngTEQ/m^3 N in case of RUN 3 (daily waste + PVC) . It can be said that in case of complex waste burnt in this type of incinerator, dioxin emission lebel is higher.

Table 2. Analysis data of Test-1 (Concentration in gas:O2=12% Converted)

	Item	unit	RUN1	RUN2	RUN3
	Waste composition		Paper+Wood	Daily waste	Daily waste+PVC
Flue gas	CO	ppm	840* / 11**	240* /140*	840* /200*
	HCl	mg/m^{3}N	<30	165	2,790
	dust	mg/m^{3}N	32	170	655
	CBs	μg/m^{3}N	15* / 13**	5.7* / 78**	36* / 21*
	CPs	μg/m^{3}N	4.9* / 2.3**	5.6* / 130**	226* / 49**
	PCDD/F(I-TEQ)	ng/m^{3}N	1.6* / 4.4**	11* / 86**	36* / 29*
Bottom ash	PCDD/F(I-TEQ)	ng/g	0.048	0.21	1.4
Fly ash	PCDD/F(I-TEQ)	ng/g	0.024	0.44	0.27

*sample for 4hours of all batch type of operation **sample for 1hour of steady-state

3.Test 2: Large-scale MSW Incineration Plant

3-1.Method

Used for the investigation was a large-scale MSW incineration plant having grate-type furnaces with a processing capacity of 5.2 t/h per line. The flow sheet of this facility is presented as Fig. 2. The dioxin regulatory value of the facility is below 1.0 ngTEQ/m^{3}N (design value: below 0.5 ngTEQ/m^{3}N).

We simultaneously measured HCl and dioxin concentration at the boiler outlet and in the middle of the stack while varying waste composition. Two runs under normal operating conditions (RUN 4 and RUN 5) were carried out on different days. RUN 6, which was conducted on the same day as RUN 5 after adding 10% waste plastic to the waste with a crane, corresponds to a case with a higher Cl content in the waste. The waste was also sampled on that day and closely examined to determine its composition (Fig. 3).

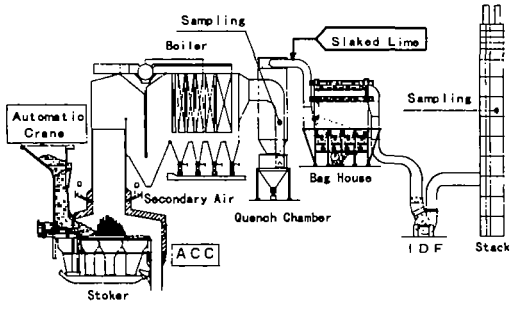

Fig. 2 Large-scale MSW Incineration Plant

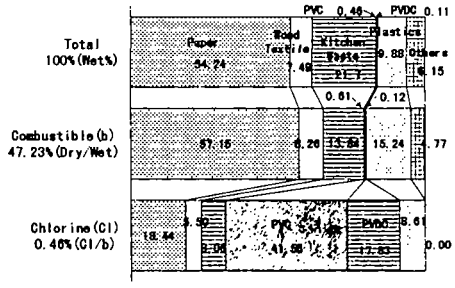

Fig. 3 Waste Composition

3-2.Results

Chemical analytical results are shown in Table 3.

Table 3. Analysis data of Test-2 (Concentration:O2=12% Converted)

		RUN4		RUN5		RUN6	
Waste composition		Normal operation		Normal operation		RUN5 + Plastics	
Item	unit	Boiler*	Stack**	Boiler*	Stack**	Boiler*	Stack**
CO	ppm	-	5.0	-	7.3	-	10.8
HCl	mg/m^{3}N	657	4.7	398	30	651	12
dust	mg/m^{3}N	-	0.2	2,320	1.4	2,060	4.5
PCDD/F(I-TEQ)	ng/m^{3}N	1.5	0.082	2.3	0.39	1.7	0.29

*Boiler outlet **Stack middle height sampling point

4.Discussion

Test 1 utilized a small-scale incinerator, which, because it is operated on a batch basis, has insufficient combustion control and produces a high CO concentration. The reason that the dioxin level was low during the four-hour sampling period of RUN 1 in spite of the high CO concentration during this period might be because of the low Cl content of the waste. With the exception of data from the four-hour sampling period of RUN 1, all data from RUN 1 through RUN 6 exhibits a correlation between CO concentration and dioxin level (Fig. 4).

We were able to clearly vary the HCl concentration in the flue gas in Test 1. RUN 3 had 15 times higher HCl concentration but dioxin level seemed in the same as RUN 2. The effect of PVC additions on dioxin level is apparent rather in the bottom ash (Fig.5).

We also put past data of the large-scale incineration plant on Fig.4 and 5 for the reference. From the data of Run 4,5,and 6, dioxin levels at boiler outlet and at stack remained

sufficiently low and less clear correlation with HCl was found. Besides the amount of chlorine in the waste, other parameters (operating history, combustion control, etc.) might have rather stronger effect on dioxin concentration.

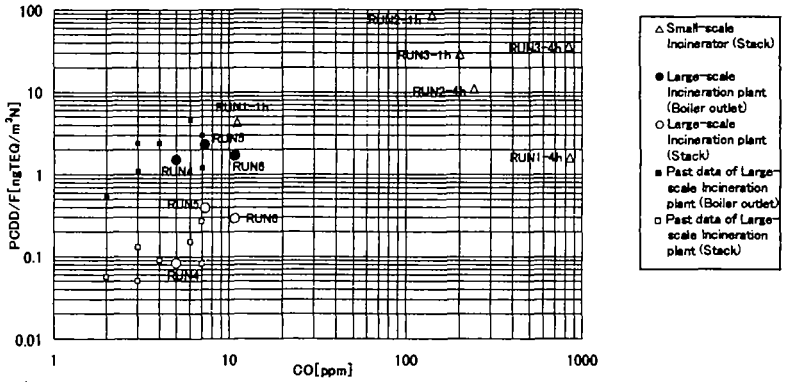

Fig. 4 Relation between CO and PCCD/F (I-TEQ)

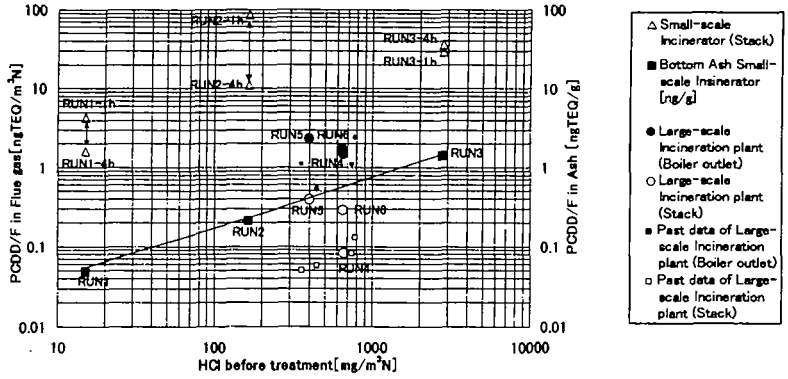

Fig. 5 Relation between HCl and PCCD/F (I-TEQ)

5.References

1) Wakimoto, T.: Actual Dioxin Emission from Small Simple Incinerator (in Japanese). INDUST Vol. 12, No. 3, 13-16, 1997.
2) Rigo, H. Gregor, et al.: The Relationship Between Chlorine in Waste Streams and Dioxin Emissions from Waste Combustor Stacks. ASME Research Report CRTD-Vol. 36, 1995.
3) Cosner, Pat.: Correlation of Chlorine Input and Dioxin Output from Combusters: A Review and Reanalysis. Organohalogen Compounds Vol. 32, 436-440, 1997.