GENERATION OF DIOXINS FROM WASTE PLASTICS COMBUSTION IN FLUIDIZED BED INCINERATOR

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Introduction

The industrial waste incinerated in Japan amounts to roughly 16,500,000 tons/year, while incineration of municipal solid waste (MSW) reaches almost 40,000,000 tons/year. The total dioxin emission in 1998 was 2,900~2,940 g-TEQ/year, of which 960 g-TEQ/year came from the industrial waste incineration, and 1,340 g-TEQ/year from MSW[1]. A lot of data have been gathered concerning dioxin emission control from MSW incineration. However, data on industrial waste

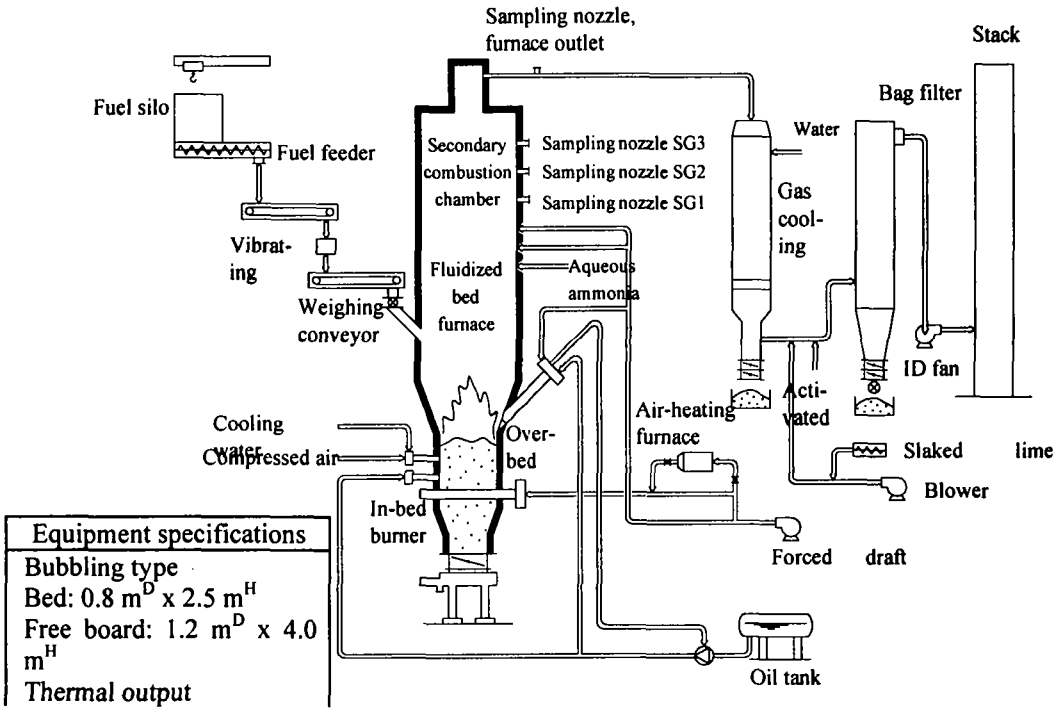

Fig. 1 "Fluidized bed furnace" flow sheet

are much less, because the industrial wastes include a wide variety of waste such as waste wood, waste oils, sludge, waste plastics and so forth, and also there are numerous types and sizes among the furnaces[2]. This prevents the development of an effective means of dioxincontrol in the industrial waste incinerators. We conducted an incineration test of waste plastics with high chlorine content as a typical industrial waste. A fluidized bed furnace was adopted for the test as it is commonly used for burning industrial waste. We checked the combustion temperature, residence time and CO concentration, and studied the effect of these parameters on the dioxin generation and behavior within the furnace. We also studied the effect of ammonia injection on the dioxin generation as a method for the dioxin control.

Method

The flow sheet is shown in **Fig. 1**. The waste used for this test was crushed plastics (a mixture of 91.2% PE and 8.8% PVC, of 5~15 mm diameter). The combustion temperatures were selected to be 700°C for RUN 1, 800°C for RUN 2 and 900°C for RUN 3. Combustion gas was sampled simultaneously at nozzle SG 1, SG 2 and SG 3 located along the secondary combustion chamber, and CO, dioxins and others were measured. Residence time at each nozzle was approximately 1 second, 2 second and 3 second in this order. At RUN 4, ammonia was injected into the furnace for reducing dioxins generation inside the furnace. **Table 1** lists the experimental conditions.

Table 1 Experimental conditions

Feed rate	RUN No.	Design combustion temperature (TD) and symbols in the graphs	Measured items at each sampling nozzle (Residence time)				Ammonia injection into furnace
			SG1 (1 sec)	SG2 (2 sec)	SG3 (3 sec)	Furnace outlet (5 sec)	
PE 36.5 kg/h	1	700 C ◆	a	a	b	a	□
PVC 3.5 kg/h	2	800 C ◈	a	a	b	a	□
	3	900 C ◇	a	a	b	a	□
Total□□40 kg/h	4	900 C ◆	a	a	b	a	0.3 kg/h

(Measured items)

a : PCDD, PCDF, Co-PCB, CO, O_2

Results and Discussion

The actual combustion temperature (TA) differed from the design combustion temperature (TD) by up to ±30°C. HCl concentration values of all runs were so high as 1,700-2,050 mg/m^3_N. **Fig. 2** shows the relationship between the combustion temperature and the concentration of dioxins

(DXN = PCDD + PCDF + Co-PCB) in the furnace. The symbol of ◆ in the graph, for example, means the data at Sampling nozzle SG1, the design residence time is 1 sec and TD is 700°C. DXN decreased substantially at 800°C and 900°C compared with 700°C. The correlation coefficient between TA and DXN at each sampling nozzle was as high as 0.68~0.94, and the DXN decreased as the combustion temperature rose and the residence time increased (**Fig. 3**). DXN concentration and unburned carbon in fly ash also fell as the temperature rose, as shown in **Fig. 4**.

The data for ammonia injection came from just one point in RUN 4, but it showed roughly 70% reduction in DXN generation as shown in **Fig. 5**.

DXN concentration is high with CO above 1,800 ppm, though it decreases with CO below approx. 10 ppm. Longer residence time is effective in reducing CO concentration at the same combustion

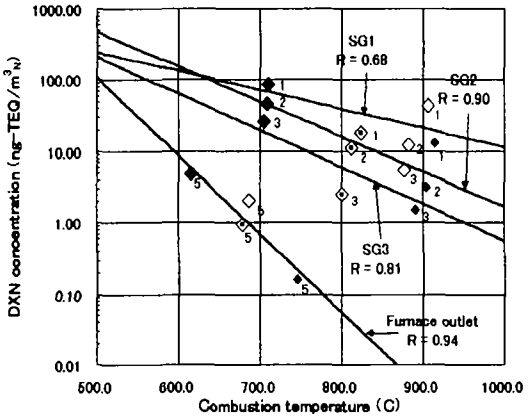

Fig. 2 Combustion temperature versus DXN concentration

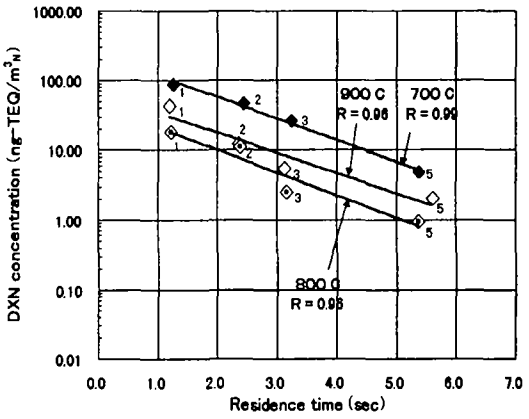

Fig. 3 Residence time versus DXN concentration

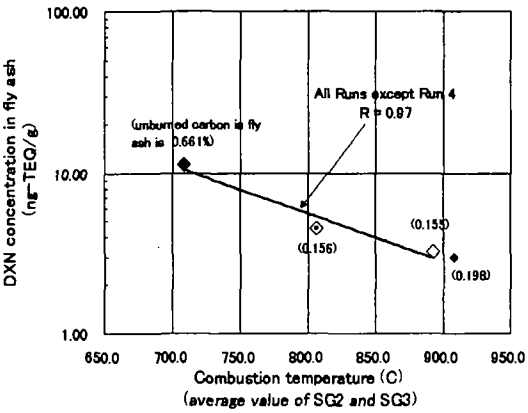

Fig. 4 Combustion temperature versus DXN concentration in fly ash

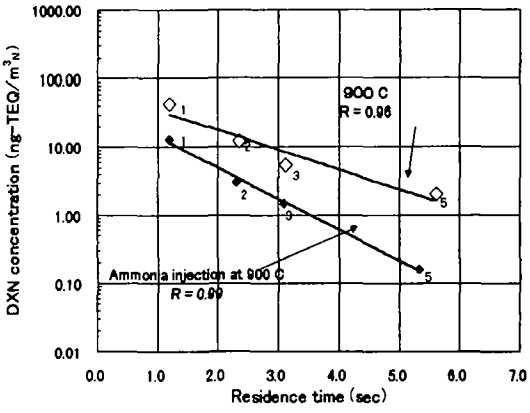

Fig. 5 Difference of DXN concentration depend on ammonia injection

temperature as shown in **Fig. 6.**

Some reports implied the correlation between DXN concentration and HCl concentration[3]. But in this study, it was not found because HCl concentration was so high and the plots were located near each other.

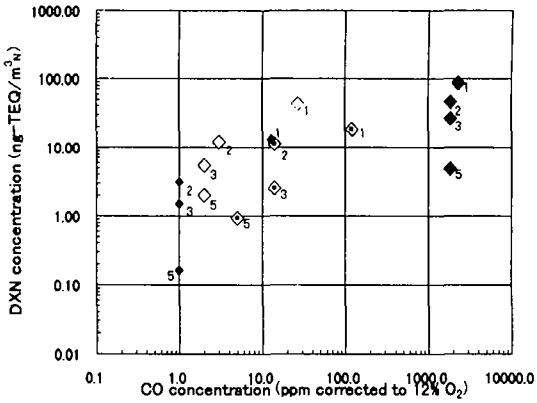

Fig. 6 CO concentration versus DXN concentration

Conclusions

Tests have been conducted burning waste plastics in a experimental fluidized bed furnace. The following results have been obtained regarding with DXN concentration in flue gas and fly ash:

1) Higher combustion temperature and longer residence time are effective in controlling DXN generation.
2) Higher combustion temperature is effective to reduce DXN in fly ash.
3) Ammonia injection into the high-temperature zone of the furnaceseems to be effective in reducing DXN.
4) DXN concentration is high with CO above 1,800 ppm, though it decreases with CO below approx. 10 ppm. Longer residence time is effective in reducing CO concentration at the same combustion temperature.

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References

[1] Fact sheet (1999) by Water Supply and Environmental Sanitation Department, Ministry of Health and Welfare

[2] Katsumi Yamamura, Takashi Ikeguchi and Hatsuo Uehara, (1999), Study of the Emission of Dioxins from Various Industrial Waste Incinerators, 19th International Symposium on Halogenated Environmental Organic Compounds and POP's, Vol. 41, p. 298

[3] Motoharu Kondo, Mitsuhiko Hamai, Masataka Yamaguchi and Sigekatu Mori, (1999), Papers submitted to the 10th annual conference of Japan Society of Waste Management Experts, p. 802