Governmental Research for Controlling Dioxin Emitted in MSW Treatment

Matsuzawa,Y.[A], Tanaka,M.[A], Watanabe,I.[A], Kawakami,I.[B], Horii,Y.[C], Hiraoka,M.[D]
[A] The Institute of Public Health, 6-1, Shirokanedai 4-chome, Minato-ku, Tokyo 108 Japan
[B] Sumitomo Heavy Industries,Ltd., Sumitomo Jukikai Bldg.1, Kanda Nishiki-cho 2-chome, Chiyoda-ku, Tokyo 101,Japan
[C] Kubota,Ltd., 2-47, Shikituhigashi 1-chome, naniwa-ku, Osaka 556 Japan
[D] Kyoto University, Yoshidahonmati, Sakyo-ku, Kyoto 606-01 Japan

Introduction In Japan, incineration is the main method of municipal solid waste (MSW) treatment. Thus, since the financial year (FY) 1985, the Institute of Public Health and the Ministry of Health and Welfare carried out two series of research projects on dioxin emission control for MSW incinerators. Based on the results of the first project, which was conducted from FY 1985 to FY 1989, the Ministry of Health and Welfare established "Guidelines for Controlling Dioxin and Dibenzofurans in Municipal Waste Treatment"[1] in FY 1990. The second term project aimed to develop methods of dioxin emission control for mechanical batch incinerators and to clarify the level of dioxin discharge from landfill sites where MSW incinerator ash was disposed. The results of the second term project are presented in this paper.

Outline of the Project The project was entitled "A Study on the Reduction of Toxic Substances from MSW Incinerators" and was carried out for three years from FY 1990 to FY 1992. The budget was about 75 million yen for three years. To get expert knowledge and cooperation, an advisory experts committee was organized. The committee consisted of experts in waste management engineering, mechanical engineering, toxicology, analytical chemistry and risk management. These experts from universities and private companies joined the committee and set up the research programs. In this project the following investigations were conducted.

1.Investigation on mechanical batch incinerators (1)Quantification of total dioxin emission (2)Reduction of dioxin emission (3)Correlation between dioxin and its precursors
2.Investigation on landfill sites for MSW incinerator ash (1)Dioxin discharge from landfill sites (2)Release of dioxins from landfill sites (3)UV light decomposing process applying fly ash leachate

Investigation on mechanical batch incinerators Mechanical batch incinerators are widely spread in Japanese municipalities. Mechanical batch type is standard for small scale incinerators which are operated intermittently with start-up and shut-down every day. Incinerators tend to emit unburnt organic compounds at high levels under unstable conditions during start-up and shut-down. Therefore, mechanical batch incinerators are apt to emit dioxins at high levels under these unsteady conditions. Municipalities which have a small population introduce the mechanical batch type. In Japan, almost 90% of all municipalities have a population of less than 50 thousand. 905 facilities of mechanical batch type existed in FY1990. The average capacity of one facility is 27 tons per day. Facilities often have two or three lines, so that the actual average capacity of incinerators is smaller. Investigation was carried out in two facilities and their outline is shown in Table 1. Facility A represents the ordinary mechanical batch incinerator. Facility B, which was newly built, is fully equipped with dioxin removal technology.

PCDD/PCDF concentrations in stack gas were measured. One day (one batch) operation was divided into start-up, steady state, shut-down and night time. At each state sampling was performed. Investigation was conducted four times in facility A and two times in facility B. In facility A, stock-fire operation[2] and burn-out operation[2] were conducted in order to compare dioxin emission quantities under these two operations. PCDD/PCDF emission(mg/ton) in each batch operation is shown in Table 2.

Total daily emission was reduced to about 1/3 by changing stock-fire operation for burn-out operation. Emission contribution to total daily emission of each of the four conditions is shown in Figure 1. For facility A, the cases of stock-fire operation and burn-out operation are illustrated in the Figure. It can be seen from Figure 1 that the emission contribution of the unsteady state is not negligible.

Dioxin emissions from all mechanical batch MSW incinerators in Japan which was calculated from emissions in Table 2 is shown in Table 3. Here we assume that all the facilities are operated 270 days per year. Dioxin emission quantity from mechanical batch incinerators calculated from the emission factors of facility A which represents ordinary mechanical batch incinerators is about 5 to 10 I-TE kg in a year.

Relation between PCDD/PCDF and chlorobenzenes (sum of CB) and chlorophenols (sum of CP), and polychlorinated biphenyls (sum of PCB) is shown in Figure 2 and Figure 3, respectively.

Investigation on landfill sites for MSW incinerator ash In Japan, almost all combustible MSW is incinerated. The amount of incinerated MSW is 36,676 thousand tons a year and the amount of incinerator ash is 5,991 thousand tons a year in FY1990. Incineration ash contains dioxins so that the existence of dioxins in the soil at landfill sites and discharge of dioxins from landfill sites should be investigated. In the project, investigation was conducted in 8 landfill sites where liner, leachate collection, removal and treatment systems are facilitated. Only incinerators ash and

incombustible waste were landfilled in all sites.
PCDD/PCDF concentrations in leachates and effluents of leachate treatment systems of the sites are shown in Figure 4. The concentrations are quite low. In one of the sites, dioxin content in soil was investigated. Core samples of MSW incinerator ash landfilled in 1979 and 1981 were taken and samples at 1meter, 2meters and 3meters in depth were subject to dioxin analysis. PCDD/PCDF contents in these core samples are shown in Figure 5. The distribution of PCDD/PCDF content suggests a vertical movement of dioxins in the soil.
Experiments on UV light decomposing process were performed. Fly ash eluted by leachate was subject to the experiment. UV dose with/without ozone blowing (high and low) cases were applied and in each condition the reaction time was set at 30, 150 and 300 minutes. Blank tests were performed in order to confirm UV light decomposition. Decomposition rates of PCDD/PCDF in the experiments were 52% to 87% (see Figure 6).

Conclusions Conclusions of the project are as follows.
1. In mechanical batch incinerators, emission of unsteady states such as at start-up, shut-down and night time is not negligible.
2. Total daily emission was reduced to about 1/3 by changing from stock-fire operation to burn-out operation.
3. Total daily emission from a newly built facility(B) which satisfies the guidelines was about 1/7 of the emission(burn-out) from an existing facility(A) designed before the guidelines were established.
4. Dioxin emissions from all mechanical batch MSW incinerators in Japan is about 5 to 10 I-TE kg per year.
5. Dioxin concentrations in leachate and effluent of leachate treatment systems of the landfill sites are quite low.
6. In the landfill sites, there is a possibility of vertical movement of dioxin contained in the soil.
7. UV-decomposition of dioxin in the fly ash leachate was confirmed.

References
1 Yoshida H. Japan's Guidelines for Controlling Dioxins and Dibenzofurans in Municipal Waste Treatment. *Dioxin'91* PD83, North Carolina, USA, 1991
2 Kawakami I. Emission of Dioxin and Related Gases from Intermittent Operation Incinerators for Municipal Waste. *Dioxin'90* Vol.3, Bayreuth, Germany, 1990

Table 1. Outline of Facilities

Facilities	Type	Capacity (ton/8h/line)	Gas cooling	Completion time	Dust collector
A	stoker	10	water spray	1986	electrostatic precipitator
B	stoker	12.5	water spray	1992	bag filter

Table 2. PCDD/PCDF Emission of the facilities

Facilities	operation (stock-fire/burn-out)	PCDD+PCDF (mg/ton)		I-TE (mg/ton)	
		run1	run2	run1	run2
A	stock-fire	98	160	1.8	1.9
A	burn-out	46	53	0.84	0.79
B	burn-out	6.1	7.4	0.11	0.11

EF=(Total daily emission of dioxin)/(amount of treated MSW)

Table 3. Dioxin Annual Emission from Mechanical Batch Incinerators in Japan

Facilities	operation (stock-fire/burn-out)	PCDD+PCDF (kg)		I-TE (kg)	
		run1	run2	run1	run2
A	stock-fire	650	1000	12	13
A	burn-out	300	350	5.5	5.2
B	burn-out	40	49	0.7	0.7

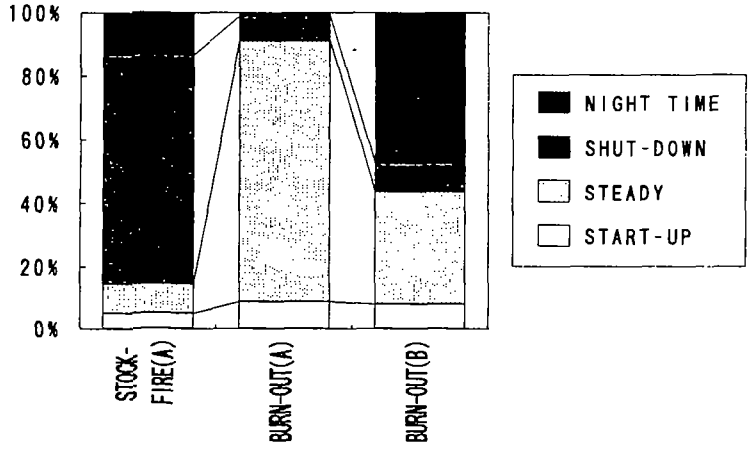

Figure 1. Dioxin Emission Contribution of Each operation condition

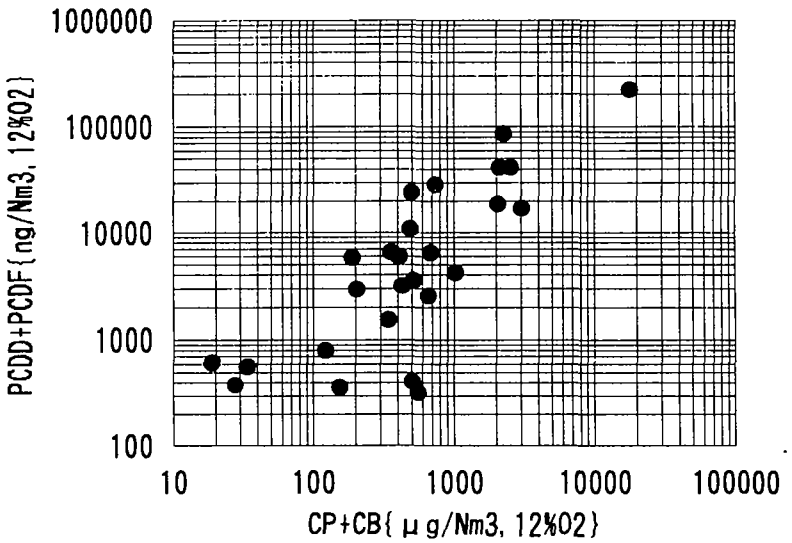

Figure 2. Relationship between CP/CB and PCDD/PCDF

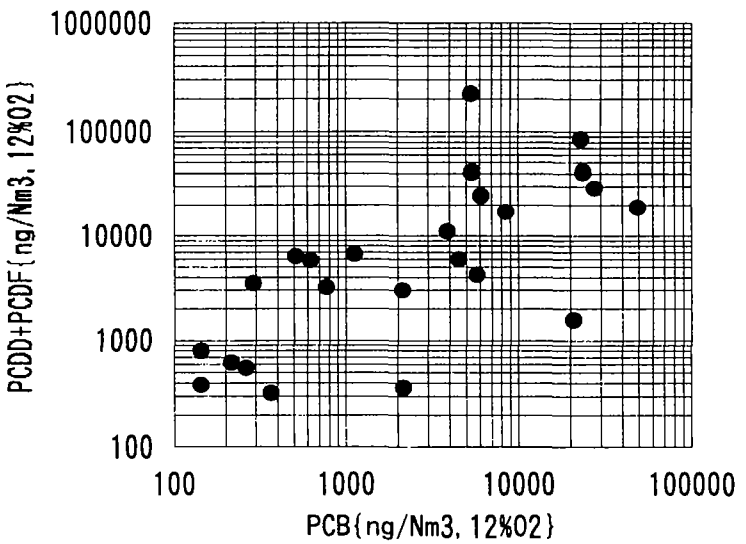

Figure 3. Relationship between PCB and PCDD/PCDF

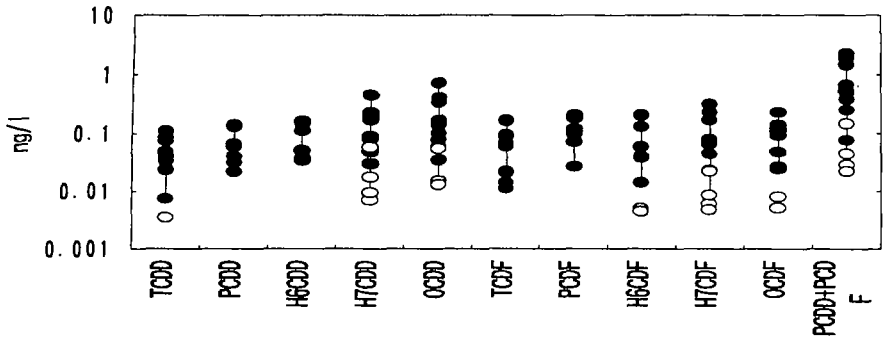

Figure 4. Dioxin Concentration in the Leachate (●) and Effluent(○)

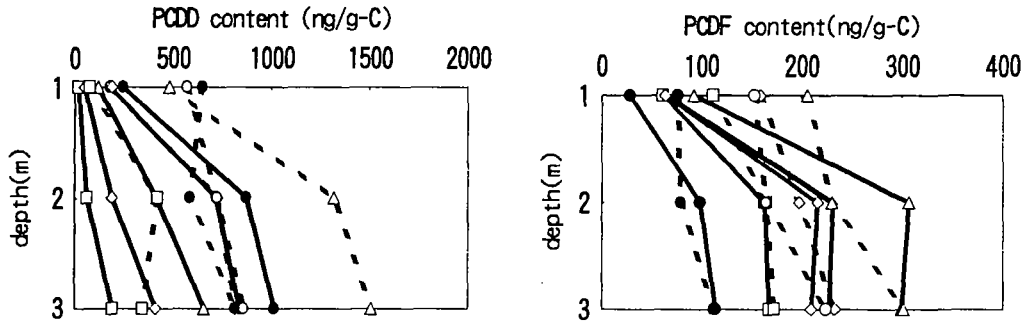

Figure 5. Vertical Distribution of PCDD/PCDF Content in the Soils of the Landfill Sites (broken lines: 1979 ash , solid lines: 1981 ash, □:4CDD/DF, ◇:5CDD/DF, △:6CDD/DF, ○:7CDD/DF, ●:8CDD/DF)

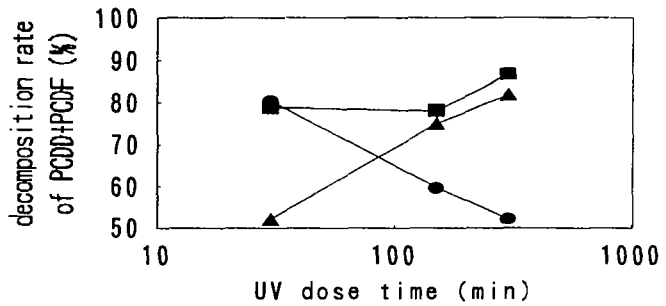

Figure 6. Decomposition Rate of PCDD/PCDF
(■:UV without O_3, ●:UV+low-O_3, ▲:UV+high-O_3)