Melting of MSW Incineration Fly Ash by Swirling-flow Melting Furnace

Kawabata, H.[A], Ito, T.[A], Suzuki, T.[A],
[A] Kobe Steel, Ltd., Kobe, Japan

At present, most municipal solid wastes (MSW) in Japan are incinerated to ash and disposed of by use in landfill. Wide attention is now being paid to the melting and solidification treatment of incineration ash, which can reduce overall volume, detoxify, and recover resources.

The authors performed melting experiments using a pilot-plant-scale swirling-flow melting furnace in order to establish a technique to melt fly ash discharged from MSW fluidized-bed incinerator.

Figure 1 shows the construction of the swirling-flow melting furnace. The cylindrical vertical type swirling-flow melting furnace comprises, from the top, the swirling-flow melting, slag separating, and slag extracting sections. In order to achieve a high slagging ratio in the furnace, a two-stage air blowing system is adopted for feeding combustion air; that is, the primary air is fed from the furnace top and the secondary air from the furnace side.

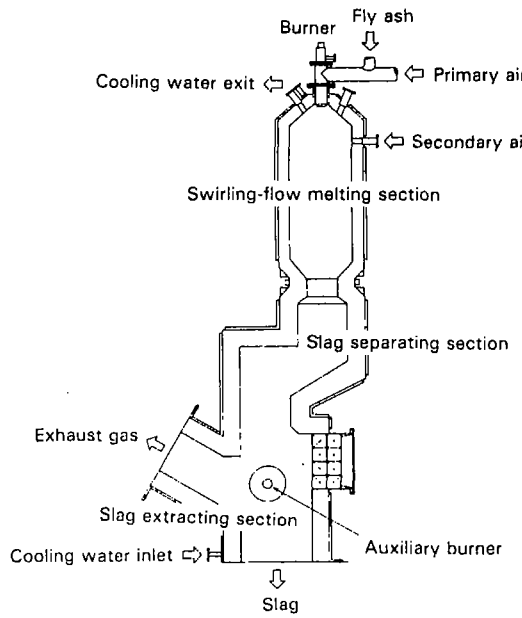

Fig. 1 Construction of swirling-flow melting furnace

Fly ash mixes with the primary air and is uniformly distributed and fed in the furnace as a solid-gas two-phase flow. The fly ash blown into the furnace is carried by a strong swirling-flow, heated and melted, and finally trickles down the wall as molten slag and is discharged from the bottom of the furnace.

The furnace wall is water-cooled to provide temperature gradient in the refractory so that refractory life is extended by the self-coating effects of molten slag.

In the experiment, a fly ash sample was used as shown in **Table 1.** The fly ash was collected at the fabric filter of a fluidized-bed incineration plant.

Table 2 shows the operation data. The furnace was preheated and the feed of fly ash was begun when the furnace temperature exceeded the melt-flowing point of fly ash. Stable furnace operation was achieved at a furnace wall temperature higher than 1250 ℃. The slagging ratio was more than 80% in the swirling-flow melting furnace. The CO concentration in the exhaust gas was less than 3 ppm and good combustion was obtained even at the low air ratio of around 1. 2.

Table 1 Analysis results of fly ash

Item		Fly ash
SiO_2	(Dry %)	23.08
CaO	(Dry %)	23.89
Al_2O_3	(Dry %)	11.71
Fe_2O_3	(Dry %)	3.57
K_2O	(Dry %)	2.18
Na_2O	(Dry %)	3.01
P_2O_5	(Dry %)	1.42
MgO	(Dry %)	1.99
Basicity	(−)	1.04
Melting point	(℃)	1,255
Melt-flowing point	(℃)	1,275
Average particle size	(μm)	21

Table 2 Operation data

Item		RUN
Ash feed rate	(kg/h)	100
Butane gas volume	(Nm^3/h)	27
Air volume	(Nm^3/h)	900
Air ratio	(−)	1.2
Furnace wall temperature	(℃)	1,296
Furnace outlet temperature	(℃)	1,472
Furnace inner pressure	(mmH_2O)	−3.9
Slagging ratio	(%)	80.4
CO	(ppm-O_2 12%)	2.9
NO_X	(ppm-O_2 12%)	117
SO_X	(ppm-O_2 12%)	< 2
HCl	(mg/Nm^3 O_2 12%)	785

Table 3 shows the analysis results of dioxins ($PCDD_S$ and $PCDF_S$). The concentration of dioxins contained in the slag is 0.0012 ngTEQ/g, nearly hitting the lowest detection limit and confirming that the concentration of dioxins in fly ash can be greatly reduced by melting treatment.

Table 3 Analysis results of dioxins

	Fly ash ng/g	Slag ng/g	Dust ng/g	Exhaust gas ng/Nm³ O_2 12%
T_4 CDD_S	9.7	0.0070	5.0	1.6
P_5 CDD_S	11	0.0040	7.2	2.1
H_6 CDD_S	24	0.011	6.5	4.0
H_7 CDD_S	41	0.046	14	22
O_8 CDD_S	17	0.020	4.6	12
Total $PCDD_S$	100	0.087	37	42
T_4 CDF_S	44	0.0050	1.3	6.5
P_5 CDF_S	34	0.0050	1.5	11
H_6 CDF_S	28	0.0080	2.7	20
H_7 CDF_S	39	0.036	11	65
O_8 CDF_S	11	0.0077	6.7	43
Total $PCDF_S$	150	0.062	23	150
Total $PCDD_S/PCDF_S$	250	0.15	60	190
TEQ (International)	2.8	0.0012	0.45	1.8

Figure 2 shows the balance of dioxins at the melting furnace installation. More than 98% of dioxins are decomposed and removed by melting treatment and the environmental load can be greatly reduced.

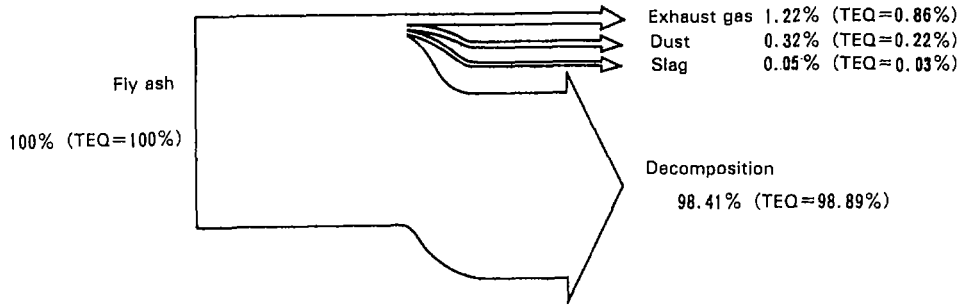

Fig. 2 Balance of dioxins

Table 4 shows leaching test results of slag. Even leaching values obtained by a low pH method are below the detection limit, confirming the soundness of the slag.

Table 4 Leaching test results of slag (unit: mg/l)

Analysis method / Items	Standard method (Japan)	Low pH method (pH 4)	Leaching standard for landfill
T-Hg	<0.0005	<0.0005	<0.005
Pb	<0.01	<0.01	<3
Cd	<0.01	<0.01	<0.3
Cr^{6+}	<0.02	<0.02	<1.5
As	<0.01	<0.01	<1.5
Org-P	<0.1	<0.1	<1
PCB	<0.0005	<0.0005	<0.003
CN	<0.01	<0.01	<1

The experiment has confirmed the effectiveness of the melting treatment for MSW incineration fly ash using the swirling-flow furnace.