

Melting of MSW Incineration Fly Ash by Plasma Melting Furnace

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Introduction

In Japan, about 73% of municipal solid wastes (MSW) are incinerated and the ash is disposed of in landfills. Wide attention is now being paid to the treating MSW incineration fly ash by melting and solidifying, which can reduce ash volume, render it non-toxic, and recover resources. This paper reports experiments information melting of MSW incineration fly ash using a pilot-plant-scale 300kw DC plasma melting furnace.

Outline of the plant

Figure 1 shows a schematic flow of the pilot plant. The plant consists of a plasma heating system (plasma torch, power supply, etc.), a furnace, an ash feeder , a slag discharge system and an exhaust gas treatment system.

Table 1 shows the plant

Table 1 Pilot plant specification

Plasma torch	Convertible arc torch
Plasma power	300 kW
Plasma gas flow rate	25-50 Nm ³ /h
Ash feeding rate	300 kg/h
Furnace size	1350 mm O.D. × 800 mm H.

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specifications. The plasma torch has a output capacity of 300kW and can operate in either the transferred mode or non-transferred mode. The furnace design capacity is 300kg of ash per hour and the furnace size is 1350mmO.D.× 800mmH. The upper part of the furnace wall is water cooled to provide a temperature gradient in the refractory so that refractory life is extended by the self-coating effects of slag. Fly ash is continuously fed to the furnace by a screw feeder and melted by the plasma heater. The molten slag is discharged from an overflow type tap hole. HCl and vaporized materials in the exhaust gas are removed by the gas treatment system.

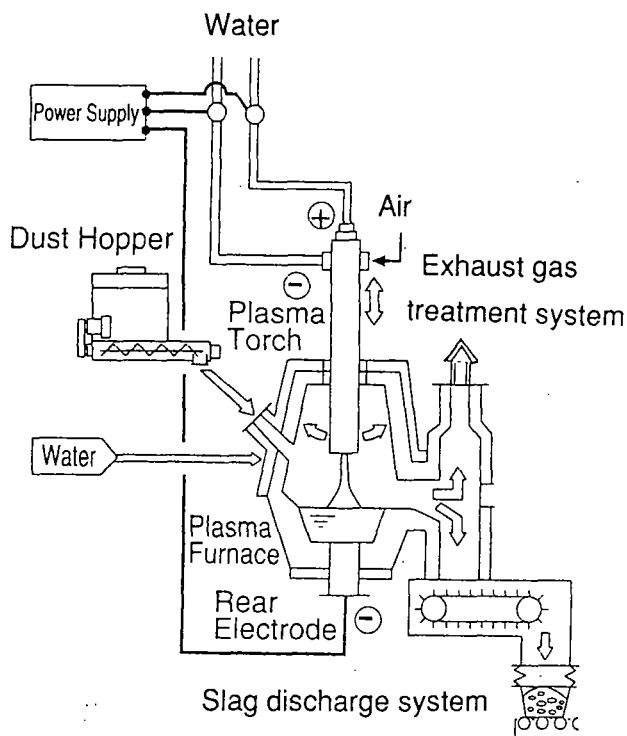


Fig. 1 Pilot scale plant

Experimental results

Composition of fly ash

Table 2 shows the composition of the fly ash used in the experiments. The fly ash was collected in the fabric filter of a fluidized-bed MSW incineration plant.

Operation

Table 3 shows typical operation data. The furnace was preheated and ash feeding began. A slagging ratio of more than 85% was obtained in the plasma melting furnace. Town gas (CH_4 , 88% C_2C_6 , 5% C_3H_8 , 5% C_4H_{10} , 2%) was injected into the tap hole, not only for NO_x reduction but also to heat the tap hole in render

to smooth the discharge of molten slag. NO_x concentration in the exhaust gas was reduced from 1500ppm to 160ppm (at O₂ 12%).

Behavior of dioxins and heavy metals

Table 4 shows the results of dioxins analysis (PCDDs and PCDFs). The concentration of dioxins contained in the slag is less than 0.01ng TEQ/g, confirming that the concentration of dioxins in fly ash can be greatly reduced by melting treatment.

Table 4 Analysis results of dioxins

	Fly ash (ng/g)	Slag (ng/g)
T ₄ CDDs	5.3	ND
P ₅ CDDs	9.7	ND
H ₆ CDDs	31	ND
H ₇ CDDs	22	ND
O ₈ CDDs	26	0.004
Total PCDDs	94	0.004
T ₄ CDFs	15	ND
P ₅ CDFs	20	ND
H ₆ CDFs	30	ND
H ₇ CDFs	32	0.005
O ₈ CDFs	18	ND
Total PCDFs	120	0.005
Total PCDDs+PCDFs	210	0.009
TEQ(International)	2.3	<0.01

Table 2 Analysis of fly ash

Item	Fly ash
SiO ₂ (Dry %)	20.65
CaO (Dry %)	27.33
Al ₂ O ₃ (Dry %)	17.60
Fe ₂ O ₃ (Dry %)	4.43
K ₂ O (Dry %)	3.02
Na ₂ O (Dry %)	3.42
P ₂ O ₅ (Dry %)	1.98
MgO (Dry %)	2.70
Basicity (-)	1.07
Melting point (°C)	1290
Melt-flowing point (°C)	1310
Average particle size (μm)	37

Table 3 Operation data

Ash feeding rate	260 kg/h
Plasma arc voltage	494 V
Plasma arc current	593 A
Plasma power output	293 kW
Furnace temperature	1385 °C
Slagging ratio	84.6 %
CO (at O ₂ 12%)	87 ppm
NO _x (at O ₂ 12%)	158 ppm
HCl (at O ₂ 12%)	2050 ppm

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Figure 2 shows the balance of dioxins in the plasma melting furnace installation. More than 98% of the dioxins are decomposed and removed by plasma heating greatly reducing the environmental load.

Table 5 shows the results of slag leaching tests. Leaching values are below the detection limit, confirming the non-toxicity of the slag.

Table 5 Leaching test results of slag (unit : mg/l)

Items	Leaching values	Leaching standard for landfill
T-Hg	<0.0005	<0.005
Pb	<0.01	<3
Cd	<0.005	<0.3
Cr ⁶⁺	<0.02	<1.5
As	<0.01	<1.5
Org-P	<0.1	<1
PCB	<0.0005	<0.003
CN	<0.01	<1

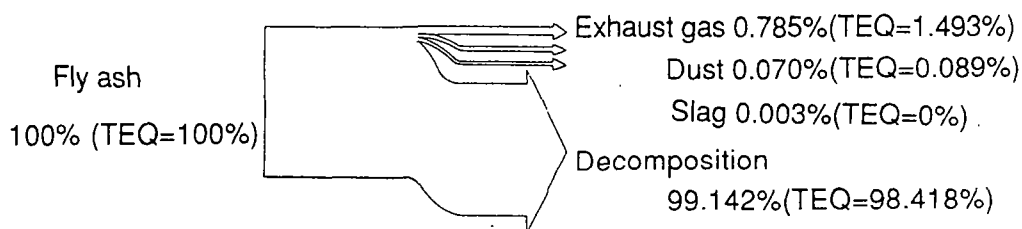


Fig.2 Dioxins balance

Summary

1. Melting experiments of MSW incineration fly ash by plasma heating were successful.
2. The concentration of dioxins contained in the slag is less than 0.01ng TEQ/g.
3. The slag shows no leaching of heavy metals above detection limits.