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Development of Eco Burner Ash Melting Furnace System

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1. Abstract

In recent years, the creation of waste recycling society has been required to cope with the traditional ways of waste treatments. In accordance with the package recycling law in force, calls for the developments of new waste treatment techniques suitable for 21st century are growing higher.

A new ash melting furnace system named " Eco Burner Ash Melting Furnace System" has been developed. It is a burner type ash melting system in which the fluffs made of the plastics segregated from municipal solid wastes are directly fired at high temperature in the furnace. This system provides an economical ash melting system because plastic wastes or paper scraps that have heretofore been considered hard to recycle are used in compensation for fossil fuel.

In this paper, we describe the ash melting test results obtained from a substantiative facility.

2. Substantiative facility

Figure 1 shows the schematic diagram of Eco Burner Ash Melting Furnace System. The fluff of waste plastics (is given the name of pla-fluff as a short form hereafter) is carried and stored in the fluff hopper. Then from the fluff hopper, pla-fluff is fed by the feeder through the scale hopper, carried to the burner pneumatically, ejected into the furnace, and burned at high temperature. On the other hand, after treated by the magnetic separator, the dehydrator, and the vibrating screens, ash is conveyed to the ash hopper and then fed into the furnace by the malti-pusher type feeder. Having been melted in the ash melting furnace, fed ash is discharged as molten slag flow. Exhaust gas from melting chamber is resided in the secondary combustion chamber over 2 seconds and combustibles burned completely. Then flue gas passes through the

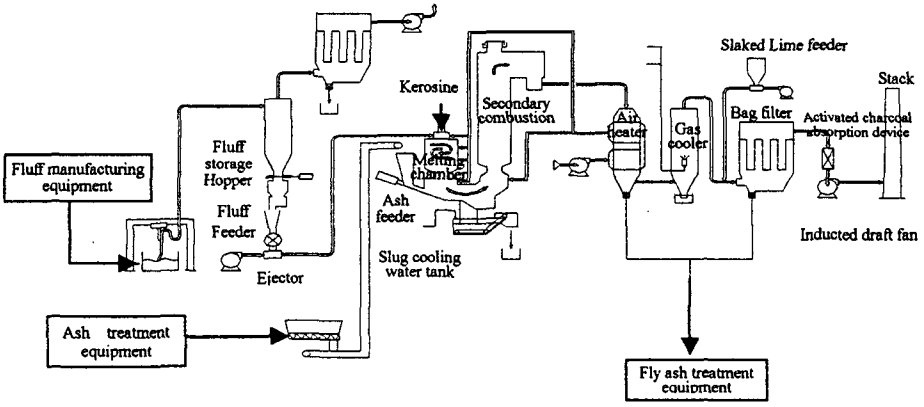

Fig 1 Flow of Eco Burner system

air heater, the gas cooler, the bag filter, the activated charcoal adsorption device, and finally discharges into the atmosphere. Combustion air is heated up to 200℃ in the air heater. The characteristics of this system is that the light and the heavy weight pla-fluff are separated in the pulverizing step. Then the heavies are mixed into the ash, and the lights are used as burner fuel. Figure 2 shows the schematic figure of the melting furnace. Melting furnace is consisted of melting chamber, secondary combustion chamber, and slag chamber. Ash is fed into the furnace in succession by ash feeder. In the melting chamber, radiative heat from the down firing flame of pla-fluff/oil combinational burner forces ash to heat up to 1200~1500℃ and melts it away from its surface. Molten slag gathers toward the outlet of slag located at the center of the melting furnace bed and flow down into the cooling water.

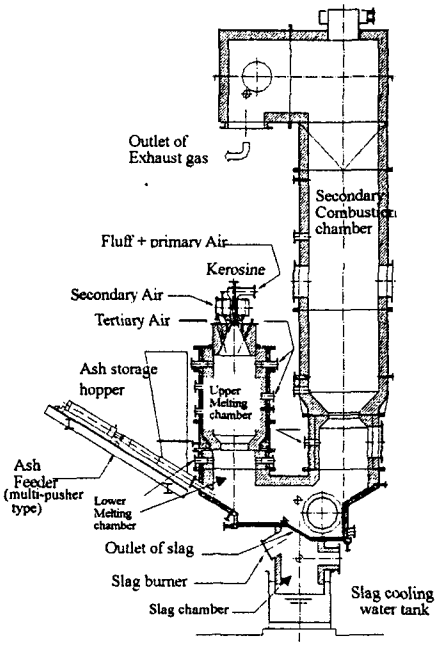

Fig 2 The schematic figure of melting furnace

3. The characteristics of the fuel and ash

3-1. The characteristics and composition of the ash

Ultimate analyses of ash mixed with fly ash were performed and the results are summarized in table 1. They consist of 16.7~33.9% of moisture and 4.13 ~12.7% of combustibles. The wide fractuation range of the combustibles is due to the method of analysis, in which heavy weight plastics mixed in ash are estimated as combustibles. Average melting temperature is 1315℃ and the basicity is 1.07, which is equal to it of the mixed ash of the traditional municipal solid wastes.

Table 1 Analysis of ash

Item		unit	value
Proximate analysis	Moisture	%	26.0
	Combustible (Ignition loss)	%	6.47
Melting point analysis	Softening point	℃	1,188
	Melting point		1,250
	Fusion point		1315
Ultimate analysis (water free)	Ca	%	26.1
	Si	%	15.9
	Fe	%	5.09
	Na	%	2.27
	K	%	2.34
	Cl	%	4.66
	Pb	mg/kg	981
	Basicity	—	1.07
Dioxin		ng-TEQ/g	1.91

3-2. The characteristics of the pla-fluff

The characteristics of the pla-fluff used in these experiments are listed in table 2. Pla-fluff is under 5mm sized, and it's net calorific value has a range between29,100kj/kg and 38,800kJ/kg(ave.33,390kJ/kg), and it generaly consists of 2.6 % of moisture, 3.6% of ash, and 2.1% of chlorine .

Table 2 The analysis of the pla-fluff

Item	carbon	hydrogen	nitrogen	Oxygen	Sulfur	chlorine	Net calorific value
Unit	%(water free)						kJ/kg
Value	69.6	9.72	0.79	1.32	0.05	2.59	33,390

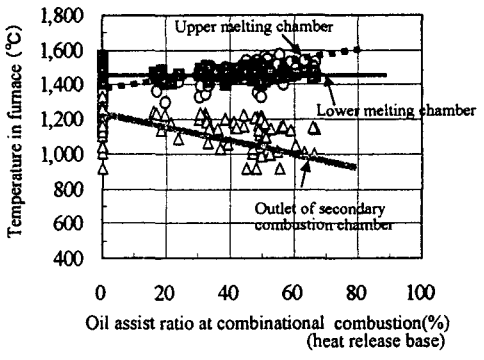

Fig3 The influence of combinational combustion

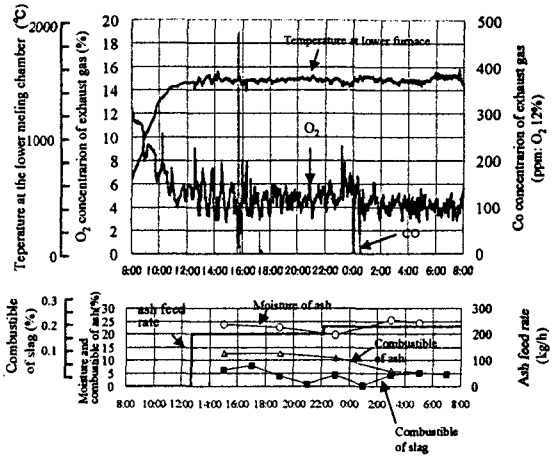

Fig 4 A representative of trends chart in operation

4. Experimental results

4-1. Experimental procedure

After heating the furnace up to the certain temperature by oil combustion, ash is fed into the furnace by pusher and feed of fluff starts up. Then, the oil and fluff feed rates are set for the certain values gradually.

4-2. Effect of combinational combustion

Figure 3 shows the oil assist ratio versus furnace temperature. This figure indicates that increasing the oil asist ratio leads the temperature of the upper chamber in the furnace to rise, but the temperature of the lower chamber to remain around 1450℃ in any case. Air ratio at the outlet of the secondary combustion chamber is almost 1.2～1.25 in any oil assist ratio. So at any combinational combustion ash is completely melted at the low air ratio. And the combustible of every slag is under 0.1%, thus ash containing about 10%wt heavy weight plastics could almost burn up in the lower melting chamber.

Table 3 The characteristics of discharged materials

Item		unit	value
Analysis of exhaust gas	Gas volume	Wet·Nm3／h	3,200
	HCl	ppm	920
	SO_2	ppm	58
	Nox	ppm	96
	CO	ppm	<1
	Dust	g/Nm3	1
	Dioxin	ng-TEQ/Nm3	0.0049
Elution test of Slag	Pb	mg/l	<0.005
	Cd		<0.005
	As		<0.005
	Hg		<0.0005
	Cr^{6+}		<0.01
	Se		<0.005
Analysis of fly ash	Na	%	3.01
	Mg	%	0.59
	Ca	%	30.5
	Cl	%	30.5
	Pb	mg/kg	2,040
	Cu	mg/kg	2,280
	Dioxin	ng/g	0.16

4-3. Stable melting in operation

Figure 4 shows the representative trends of the temperature in the furnace, the fuel consumption, and the composition of exhaust gas at the fluff burning period. As described above, the temperature of the lower chamber is maintained around 1450℃. This means that stable ash melting was occurred. From 12:40 to 22:10 ash feed rate is 200kg/h contained 10%wt heavy weight plastics, and it is 230kg/h with no heavy weight plastics from 22:00 to 8:00. Supported by the results that the combustible of the slag is under 0.1%, our concerns about the CO generation and the increase of the combustible in the slag, which is caused by mixing heavy weight plastics into the ash, turned out to have no problem.

4-4. The characteristics of the discharged materials (exhaust gas, slag, fly ash, etc)

The analyses of the exhaust gas and the fly ash, and the elutriation test result of the slag are given in table 3. This table shows that the concentration of the dioxin in the exhaust gas at stack is under 0.1ng-TEQ/m^3 in each case. But the re-composition of dioxin in the exhaust gas stream from the furnace outlet to bag filter, and the reduction of the dioxin removal efficiency of bag filter are subjects in future.

5. Conclusions

1) We established the technique of burning the spreaded solid particles in the order of 10^{-3}m size at high temperature.
2) We explained that we can use the waste plastics as alternative fuel of fossil for the ash melting furnace.
3) This pla-fluff combustion system could be one of the useful ways of recycling the waste plastics which have some difficulty in material recycling.
4) It can lengthen the life of landfill that the waste plastics which mainly depended on the landfill, can be used as fuel for ash melting furnace.
5) A new combinational burner developed can not be applied only to the pla-fluff but also to the combined fuel of pla-fluff and oil at various rate.
6) Analyses of the dioxin in the exhaust gas and elutriation test of slag confirmed the safety in fluff burning.