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Report on Operation of Thermal Waste Recycling Process for Shredder Dust

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Abstract: The car shredder dust has conventionally been deposited on landfill without recycling. It has high energy and further valuables such as iron, aluminum and copper. The first commercial plant was constructed for the purpose of material and thermal recycling, reduction in volume and pollution free. The plant has 90 tons/day treatment capacity. This paper reports the plant performance and the stability of pyrolysis with indirect heating pyrolysis system. The plant reduces the waste from scrapped car 15% of car to 0.6% , produces 2000kW electric power and recovers the valuables.
Key words: Pyrolysis, Melting, Shredder dust, Recycle,Waste to material and thermal recycle

1. INTRODUCTION

The car shredder dust (hereafter to be referred as "CSD") has conventionally been deposited on landfill without being recycled, though it is provided with a high energy and further with valuables such as iron, aluminum and copper, etc. which can be recovered with a proper process. The amount of CSD all over the country is totaled to approx.1,200,000 tons per year. The landfill was also changed from "Stabilized type" to "Management type", and it has become much more difficult to secure the final disposal area.

Thermal waste recycling process was developed by Siemens AG. The process are composed with waste treatment, pyrolysis, residue separation, high temperature combustion and flue gas cleaning stage. The features of process are extremely high recycling factor, no leachable substances produced and minimum emission.[1)]

The plant presented in this paper is the first one commercially designed and constructed by TAKUMA Co., Ltd. on 1998 in Japan as an advanced material and thermal recycle system from the typical industrial waste for the purpose of reduction in volume, pollution-free, material and thermal recycling by the combined process of pyrolizing and combustion melting the CSD discharged from KANEMURA Co., Ltd. after recovery of valuables.

This paper will report the stability of the heating pyrolysis type of high-temperature combustion/melting operation, safety and low-pollution of molten slag, which must be confirmed through the practical operation of plant, and improvement of recycle ratio to be brought about by this plant.

2. GENERAL DESCRIPTION OF PLANT

Table- I shows the plant specifications. Figure 1 shows the plant flow, and Table- II shows the CSD analysis example respectively.

Table- I Plant specifications.

Material to be treated	Car shredder dust
Amount of material treated	90 tons/day
Pyrolysis drum	Indirect heating pyrolysis drum(1 unit)
High-temperature combustion chamber	Cylindrical type furnace: (1 unit)
Waste heat boiler	Natural circulating water tube type boiler(1 unit) 48atg(saturation) 20 tons/h
Power generation	2,000kW

Table- II CSD analysis example.

Items	Unit	Analysis value
Ash content	%-dry	32.4
C	%-dry	50.7
H	%-dry	3.2
N	%-dry	10.6
O	%-dry	0.9
S	%-dry	0.3
Cl	%-dry	1.9

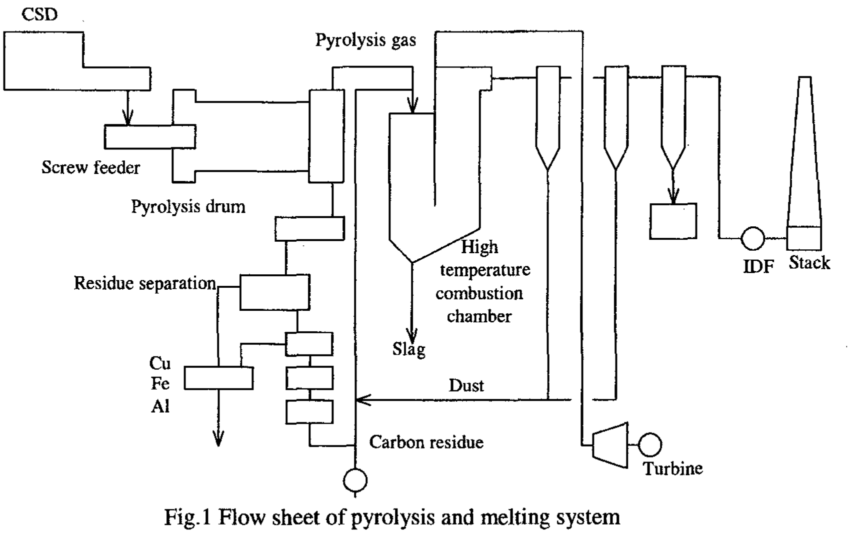

Fig.1 Flow sheet of pyrolysis and melting system

3. CONDITION OF OPERATION

3.1 Pyrolysis

The CSD is compressed and supplied into the pyrolysis drum by the screw feeder. Then CSD is subjected to agitation by the rotation of pyrolysis drum and is further heated to 450° C for approx.1 h by the heating tube arranged at the inside. Figure 2 shows the temperature distribution of temperature pyrolysis drum inside, which indicates that the temperature is increased gradually as the pyrolysis progresses. The CSD is divided finally into "Pyrolysis gas" and "Pyrolysis residue", the former of which is lead directly to the high-temperature combustion chamber. The pressure at the outlet of pyrolysis drum is controlled to a constant level by the induced draft fan(IDF). The record of pressure at the outlet of pyrolysis drum is as shown in Fig.3, which indicates that the pyrolysis occurs gently, causing the pressure at the outlet of drum to be stabilized at $-20 \pm 6mmH_2O$. The stabilized pyrolysis that is a feature of indirect pyrolysis method has been confirmed.

An example of analysis value for pyrolysis gas is shown in Table-III. The major components of pyrolysis gas are moisture, CO_2, CO, H_2 and hydro-carbons. The calorific value to be calculated from the components provides the high value of 4,440kcal/Nm^3 on the wet base, which indicates that the combustion at the proceeding high-temperature combustion chamber is highly executable.

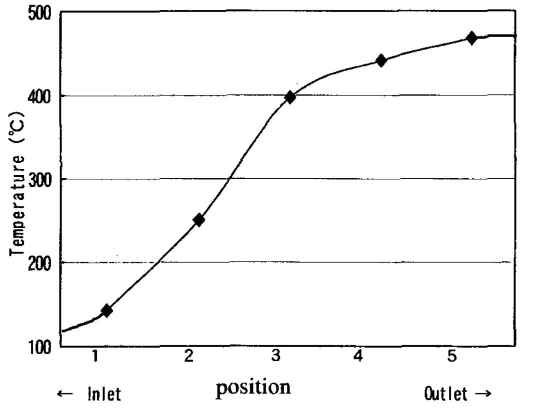

Fig.2 Distribution of temperature in pyrolysis drum.

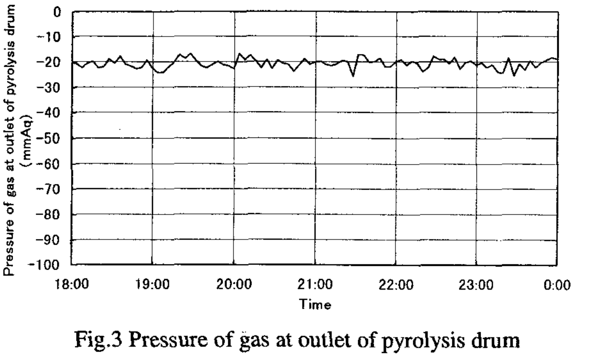

Fig.3 Pressure of gas at outlet of pyrolysis drum

After the valuables, etc. have been separated from the pyrolysis residue, the pyrolysis residue is ground by the mill, and it turns out to "Carbon residue".The carbon resiude is pneumatically blown as a fuel in the high-temperature combustion chamber Table-IV shows the carbon residue analysis. Both the carbon residue and pyrolysis gas indicate the high calorific values. The valuables separated from the pyrolysis residue are mainly the entwined copper wire. When the inside of pyrolysis drum was checked, the drum was found to be in proper condition without any copper wire, etc. remaining or clogging in the drum or without adhesion of any plastic to the heating tube, etc.

Table-III Example of pyrolysis gas content.

Items	Unit	Analysis value
Moisture content	%	82.9
CO_2	%−dry	30.8
CO	%−dry	3.7
H_2	%−dry	14.5
CH_4	%−dry	5.2
C_2H_6	%−dry	2.8
C_2H_4	%−dry	2.2
C_3H_8	%−dry	1.4
C_3H_6	%−dry	3.8
O_2	%−dry	0.6
N_2	%−dry	17.2
Benzene	ppm	2,050
Tar	kg/Nm	2.7
Lower calorific value	kcal/Nm^3-dry	4,440

Table-IV Example of carbon residue content.

Items	Unit	Analysis value
Ash content	%-dry	65.4
Volatile content	%-dry	12.6
Fixed carbon	%-dry	21.9
Bulk density	g/cm^3	0.53
Average grain size	μm	40
Lower calorific value	kcal/kg-dry	2,280

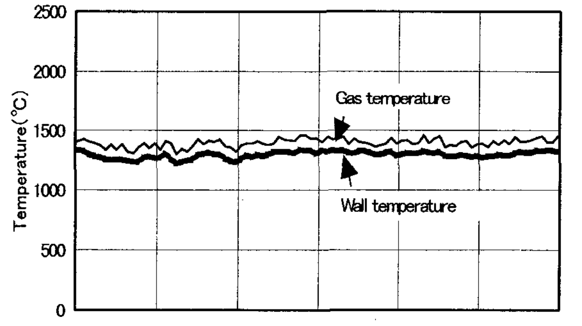

Fig.4 Temperature in combustion chamber.

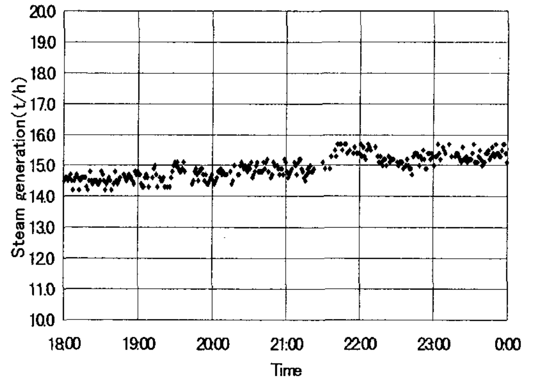

Fig.5 Steam generation .

Table-V Leaching test.

Items	Unit	test result	Soil environment standard value
Cr^{6+}	mg/l	<0.05	<0.05
Cd	mg/l	<0.01	<0.01
Pb	mg/l	<0.01	<0.01
As	mg/l	<0.01	<0.01
T-Hg	mg/l	<0.0005	<0.0005
Se	mg/l	<0.01	<0.01

Table-VI Exhaust gas properties.

Items	Unit	Emission standard	Value measured at stack
NOx	ppm	250	62
7.5	ppm	(K=14)	
HCl	ppm	430	296
Smoke dust	g/Nm	0.1	0.02

O_2=12%(converted value)

3.2 High-temperature combustion chamber

The pyrolysis gas, carbon residue and dust for dust collector are fed spirally into the high-temperature combustion chamber from the top of chamber, where they are burnt and melted. The combustion air is supplied dividedly in the primary, secondary and tertiary stages. The combustion chamber is operated at the low air ratio with oxygen concentration limited to 4.5%. The operation temperature is controlled to 1,200 ° C for primary zone, and to 1,350 ° C for slag outlet, respectively. Figures 4 and 5 show the temperature of combustion chamer and the steam generation flow rate,. respectively. The temperature and steam generation flow rate are stabilized, as the pyrolysis gas flow rate generated in the pyrolysis drum is stable and the carbon residue is blown in quantitatively. The molten slag flow starts up at the temperature of approx.1,300 ° C. Even if the thermal load is approx.50%, the molten slag starts continuously without any auxiliary fuel. The slag flows down into the conveyor flled with water, and is discharged as granulated slag.

Table-V shows the result of leaching test of slag.The test was performed in accordance with the 46 notice of Environment Agency. The test result shows that the value given is lower than the standard environment value concerned with soil contamination.

Table-VI shows the properties of exhaust gas, in which the value of each item indicates the value smaller than the emission standard. The value of NOx is limited, as the multi-stage combustion is executed. The value of dioxins was 0.02ngTEQ/Nm^3, as the activated carbon is blown in.

3.3 Mass balance

Figure 6 shows the physical balance of scrapped car treated by KANEMURA Co., Ltd. The slag is utilized for a road pavement material and the burnt component of CSD is used for power generation. In other words, the CSD(15%) having been conventionally disposed as a waste is treated by this plant, and only the Bag Filter(BF) ash content(0.6%) is disposed.[2)]

4. SUMMARY

The paper reported the stability of pyrolysis and combustion, and low emission which were proved through the operation of this plant with improved recycle ratio to be brought about by this plant. It is convinced that this system is proved to be a system which can satisfy the re-cycle, reduction in volume and low emission which are required for next-generation type of waste treatment system.

REFERENCE

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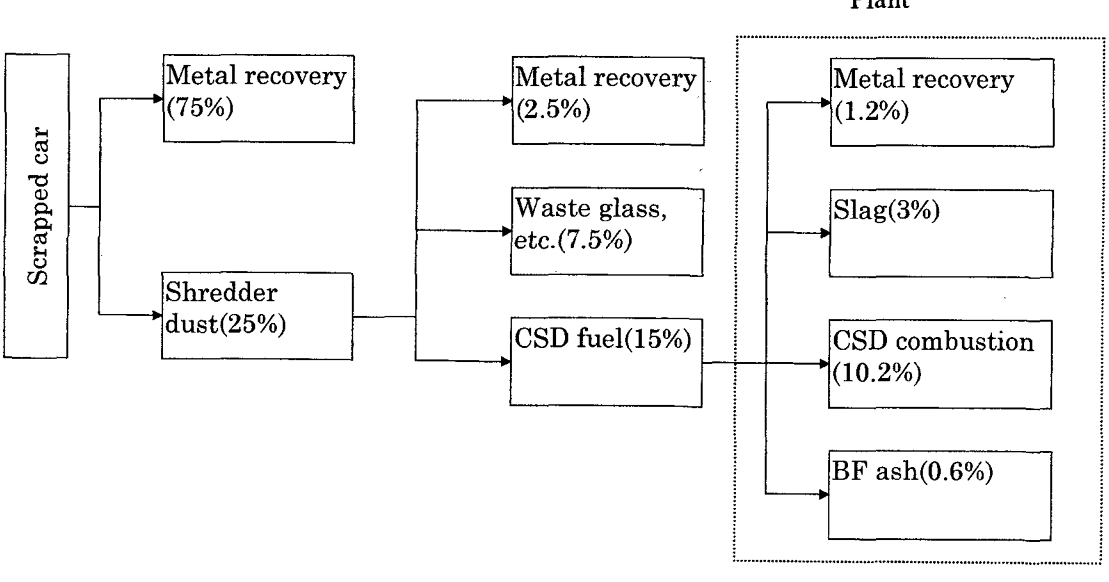

Fig.6 Material balance from the scrapped car.

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