

Waste Melting Systems Offered by JFE Engineering†

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Abstract:

JFE Engineering has constructed and supplied a large number of waste treatment facilities for over 30 years. To meet the recent demands for utilizing inorganic constituents of waste by melting, various types of melting systems have been developed and supplied to the market. For the requirement of direct melting of waste, two types of systems are offered: a gasifying and melting system called JFE High-Temperature Gasifying and Direct Melting System, respectively. In addition a unique hybrid system of waste incineration and ash melting furnaces being directly connected, called JFE Hyper 21 Stoker System, has been newly developed. Also, two types of individual ash melting systems heated either by electric resistance or plasma are lined up as products.

1. Introduction

Creation of a recycling-oriented society has become an important issue not only in Japan, but worldwide.

JFE Engineering has built up its business as a constructor of waste treatment plants for more than 30 years, pursuing an optimal balance of safe treatment, cost reduction, and the recycling of materials and energy from the waste. Over the decades the company has garnered a rich and diverse track record in the engineering and construction of waste combustion systems, gasifying and melting systems, ash melting systems, material recovery systems, and more.

This paper reports the features of two representative waste melting systems developed by JFE Engineering: a gasifying and melting system (the JFE High-Temperature Gasifying and Direct Melting System) and an

advanced stoker firing system integrated with ash melting system (the JFE Hyper 21 Stoker System).

2. Waste Melting Systems Developed by JFE Engineering

Waste melting process takes place by gasifying and burning moist combustibles in waste, and then melting incombustibles such as the ash, metals and others that remain. The process is effective for both detoxifying waste and utilizing incombustibles.

Waste melting systems are broadly classified into two types. The first, the gasifying and direct melting system, gasifies and incinerates waste as well as melts the remaining incombustibles in a single furnace. The second, the combustion plus ash melting system, melts ash generated from a waste incinerator in a separated ash-melting furnace.

JFE Engineering uses the melting systems shown in Fig. 1 for waste treatment applications.

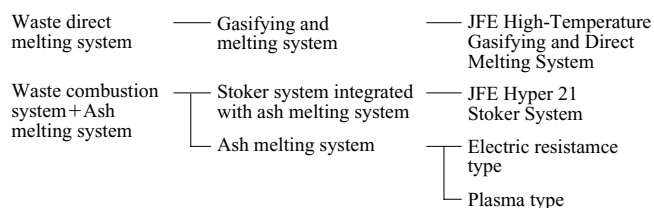


Fig. 1 Various waste melting systems

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3. Waste Melting Systems

3.1 Gasifying and Melting System (JFE High-Temperature Gasifying and Direct Melting System)

3.1.1 Outline of

JFE High-Temperature Gasifying and Direct Melting System

The JFE High-Temperature Gasifying and Direct Melting System is an advanced waste melting system that combines waste treatment technologies for incinerators with the melting techniques for blast furnaces applied in ironmaking. The system stably melts various types of waste and recovers energy from waste with high efficiency.

JFE Engineering began developing this system in 1992. After constructing and running a practical-scale pilot plant in 1995, the system was granted a technical certificate in 1998 from Japan Waste Research Foundation. In 2000 the first order of the plant consisting 3 furnaces was awarded and another 9 plants (17 furnaces) have been constructed since, including some still under construction¹⁻³⁾. **Table 1** shows the track record with the system.

The furnace of the gasifying and direct melting system is a compact shaft-type one with combined functions for waste gasification in an upper part and residue melting in a lower part. The system performs high-temperature and melting in a reduction atmosphere using coke.

3.1.2 Features of

JFE High-Temperature Gasifying and Direct Melting System

The system has three important features:

- (1) Applicable to various types of waste.
- (2) All of the waste processed can be melted within a

compact furnace.

- (3) The final disposal of waste can be substantially reduced by the utilization of generated high quality slag.

Figure 2 shows a system configuration of the JFE high-temperature gasifying and direct melting system. **Figure 3** is a structural diagram of the furnace.

As shown in Fig. 3, waste is charged together with coke and limestone. Once charged, the waste is rapidly heated and gasified with continuous stirring. In time, incombustibles and other residues in the waste move to a lower layer together with coke and limestone, and the volatile components and moisture move to a free board.

Coke and the fixed carbon in the waste that have moved to the lower layer are combusted at high-temperature due to the oxygen-enriched air supplied from a main tuyere, and the incombustibles are melted by the heat. The melt drips to the bottom of the furnace and is tapped outside.

The melt can be tapped continuously; hence the burden of the tapping work is reduced. The high-temperature melting in the reduction condition by the use of coke generates high-quality slag.

Meanwhile, the product gas that has moved to the free board is completely combusted in a secondary combustion chamber and the heat energy in the flue-gas is recovered and cooled by a boiler.

Because this system is based on a coke-bed-type high-temperature gasifying and direct melting furnace, the incombustible residues from bulky waste recycling facilities and excavated waste from final disposal sites can be also treated without installing pretreatment equipment. Hence, the recycling rates are improved and the life of the final disposal sites is extended.

4. Waste Combustion and Melting Systems

4.1 JFE Hyper 21 Stoker System

4.1.1 Outline of JFE Hyper 21 Stoker System

The newer waste combustion systems must offer sharper reductions of environmental burdens, a higher efficiency energy use, and lower installation costs. To meet these requirements, JFE Engineering has pushed ahead with a high priority project to develop an advanced stoker firing system.

A demonstration plant for this advanced stoker system was installed at the company's Environmental R&D Center, and demonstration tests were performed. Since then, actual-furnace tests have been conducted at an existing municipal solid waste incineration plant^{4,5)}.

This system is a combustion-melting integrated system incorporating the possessed stoker furnace technology.

Table 1 Reference list of High-Temperature Gasifying and Direct Melting furnace

Reference plants	Capacity×Furnace	Completion date
Hidaka, Hokkaido	19 t/day × 2 furnaces	Feb. 2003
Kakamigahara, Gifu	64 t/day × 3 furnaces	Mar. 2003
Amagi, Fukuoka	60 t/day × 2 furnaces	Mar. 2003
Morioka-Shiwa, Iwate	80 t/day × 2 furnaces	Mar. 2003
Saiki, Oita	55 t/day × 2 furnaces	Mar. 2003
Fukuyama, Hiroshima	314 t/day × 1 furnace	Mar. 2004
Kasama, Ibaraki	72.5 t/day × 2 furnaces	Mar. 2006
Aki, Kochi	40 t/day × 2 furnaces	Mar. 2006
Hamada, Shimane	49 t/day × 2 furnaces	Nov. 2006
Chikushino, Fukuoka	125 t/day × 2 furnaces	Mar. 2008

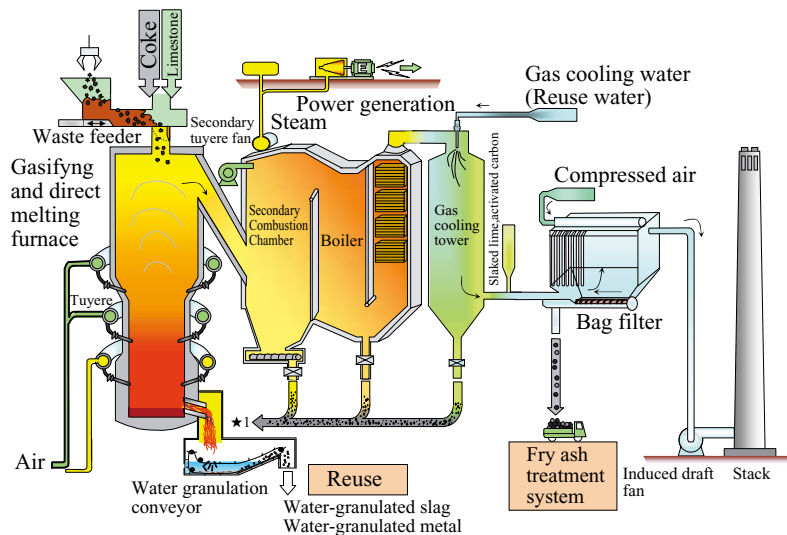


Fig. 2 High-Temperature Gasifying and Direct Melting System flow chart

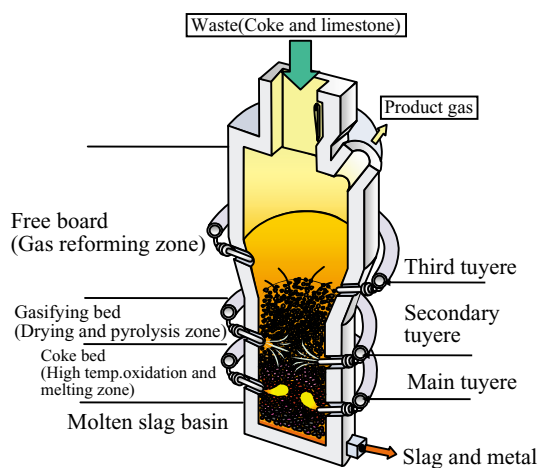


Fig. 3 High-temperature Gasifying and Direct Melting furnace

gies, such as the two-way gas flow type incinerator and a hybrid ACC (automatic combustion control) system, with new technologies such as a flue gas re-circulation system, a JFE water-cooled HYPER grate, and an integrated ash treatment system. The construction track record is shown in **Table 2**.

4.1.2 Features of JFE Hyper 21 Stoker System

This system has three important features:

- (1) The low excess-air combustion reduces the exhaust gas volume and improves the waste heat recovery rate.
- (2) High-calorific refuse can be processed and the grate

life is extended by the use of a water-cooled grate.

- (3) A compact ash treatment system is incorporated with a stoker furnace.

Figure 4 shows a system configuration of the JFE hyper 21 stoker system. **Figure 5** is a structural diagram of the furnace.

In this stoker system, a mixture consisting of a high-temperature air and exhaust gas is blown into the combustion-ignited zone of a JFE two-way gas flow type incinerator at a high speed from both sidewalls. This realizes stable combustion under a lower excess-air condition incapable of being achieved in conventional stoker furnaces. The system sharply reduces the NO_x concentration and concentrations of dioxins at the same time.

Because the system integrates an incinerator and an ash treatment furnace, bottom ash generated from the incinerator can be directly charged into the ash treatment furnace without any complex pretreatment equipment. Furthermore, because the flue gas of the ash treatment furnace is led to the boiler and flue gas treatment equipment connected to the incinerator, it enables heat recovery and treatment of the gas. This simplifies the ash treatment furnace and reduces both the running cost and the number of operators required.

5. Ash Melting System

5.1 Ash Melting Furnace

In addition to the above-described melting systems, JFE Engineering offers ash-melting systems capable of volume reduction, detoxification, and resource recycling of incineration residues discharged from waste incineration facilities.

Based on the rich experience that has been garnered

Table 2 Reference list of Hyper 21 Stoker System

Reference plants	Capacity × Furnace	Completion date
Tomakomai, Hokkaido (Pilot plant)	105 t/day × 2 furnaces	Mar. 1999

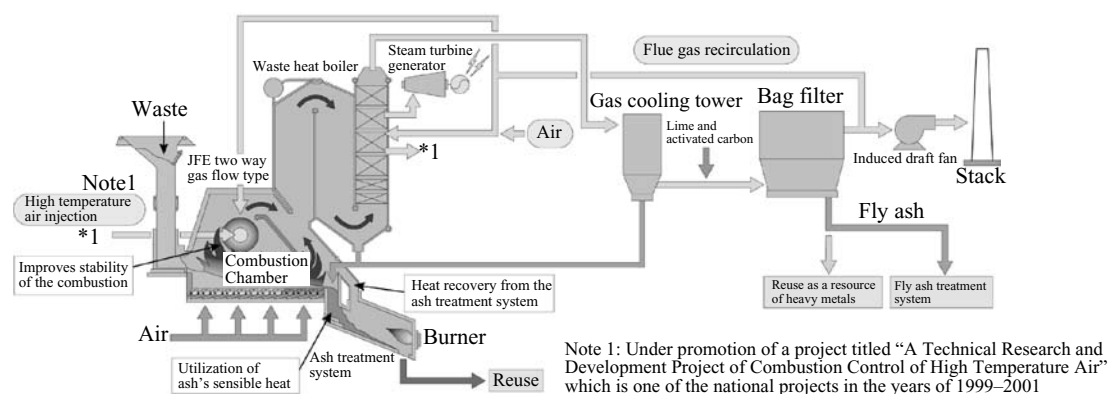


Fig. 4 Hyper 21 Stoker System flow chart

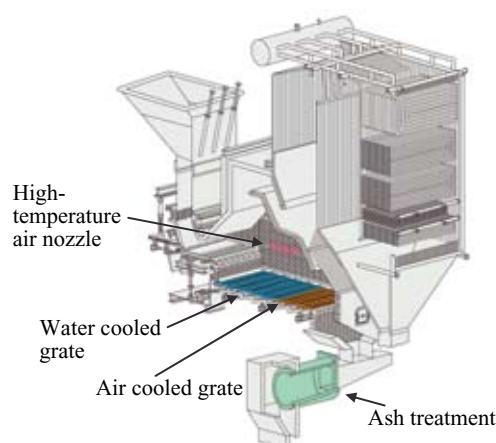


Fig. 5 Hyper 21 Stoker System furnace

from more than 30 years of constructing and operating municipal solid waste incineration facilities, also with its ample experience in manufacturing and operating electric furnaces for steelmaking, JFE Engineering offers ash melting furnaces that are capable of detoxifying municipal solid waste incineration ash, reducing ash volume, and recycling resources from the processed materials.

JFE Engineering has commercialized two types of ash melting furnaces, the electric resistance type and the plasma type, as electric furnaces for ash melting capable of yielding high-quality slag and operating with small environmental burden.

The development of the electric resistance type ash melting furnace commenced with fundamental experiments in 1991, followed by the construction of a

commercial-scale pilot plant with a capacity of 24 t/d in 1995⁶⁾. At present, five plants (eight furnaces) have been supplied and another two (three furnaces) are now under construction.

The development of the plasma type ash-melting furnace has been started with a fundamental experiment in 1987, followed by the construction of a test demonstration plant in 1993. Since then three plants (four furnaces) have been constructed⁷⁾.

6. Concluding Remark

This paper described the melting systems in the waste treatment systems developed by JFE Engineering. JFE Engineering offers a lineup of optimal waste treatment systems suited to the requirements of customers. Henceforth we will continue to engineer technologies to save resources from waste and to help achieve a recycling-oriented society.

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