The Expansion of Biomass Utilization by Carbonization and Gasification

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In an effort to reduce greenhouse gases, the sewage sludge carbonization facility for Bio Fuel Co., Inc. and the Bureau of Sewerage of the Tokyo Metropolitan Government started operation in November 2007 using carbonization and gasification to sludge disposal. The woody biomass cogeneration facility for Maeda Road Construction Co., Ltd. is also now in the trial stage of operation. In addition, a sewage sludge incineration facility equipped with a circulating fluidized bed incinerator developed for the Environmental Planning Bureau of the city of Yokohama as a next generation sewage sludge incinerator started operation in September 2007. The equipment used to carbonize and recycle the sludge generated in its plants was developed by Mitsubishi Heavy Industries, Ltd. (MHI), and this report introduces MHI's efforts toward the reduction of greenhouse gases in these biomass-using plants.

1. Background of the development of biomass carbonization and gasification technology

In November 2000, in an effort to eliminate emissions, MHI developed equipment to carbonize and recycle the sludge generated in its plants. MHI then delivered a facility in March 2005 that gasifies woody biomass for use as an electric power generation fuel, and has continuously expanded the application of carbonization and gasification to biomass. Through these efforts, MHI has been increasing the numbers of facilities that apply carbonization and gasification to biomass such as woody biomass and sewage sludge, which are carbon neutral and can reduce greenhouse gases. This report describes the sewage sludge carbonization facility for Bio Fuel Co., Inc. and the Bureau of Sewerage of the Tokyo Metropolitan Government and the woody biomass cogeneration facility for Maeda Road Construction Co., Ltd. as examples of new MHI biomass carbonization and gasification facilities.

2. Introduction of biomass carbonization and gasification facilities

2.1 Sewage sludge carbonization facility

The sewage sludge carbonization facility for Bio Fuel Co., Inc. and the Bureau of Sewerage of the Tokyo Metropolitan Government is a commercial, coal-fired thermal power station that is capable of converting 300 tons of sewage sludge into carbonized fuel per day. This is the world's first facility that uses an alternative fuel to offset a portion of the coal input, contributing to a large reduction in N_2O emissions

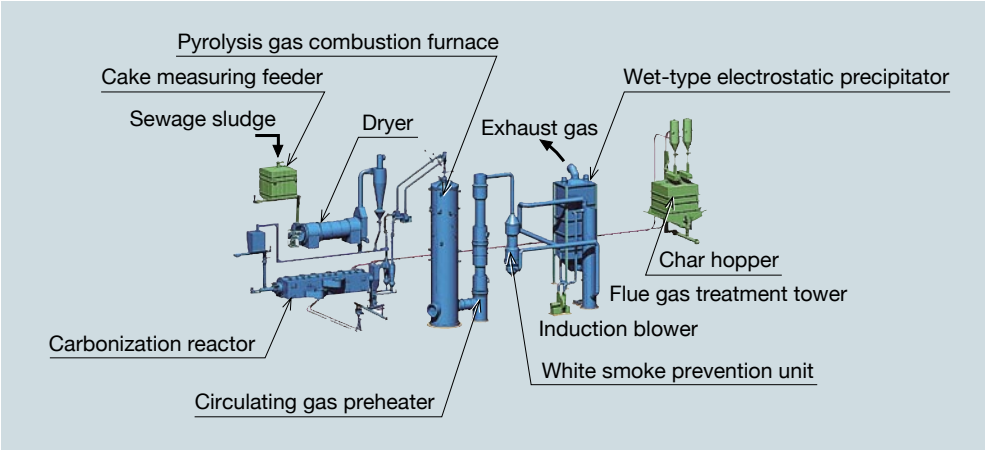

Fig. 1 Schematic diagram of a sewage sludge carbonization facility
The major equipment for the facility includes a dryer, carbonization reactor, pyrolysis gas combustion furnace, flue gas treatment tower, and wet-type electrostatic precipitator.

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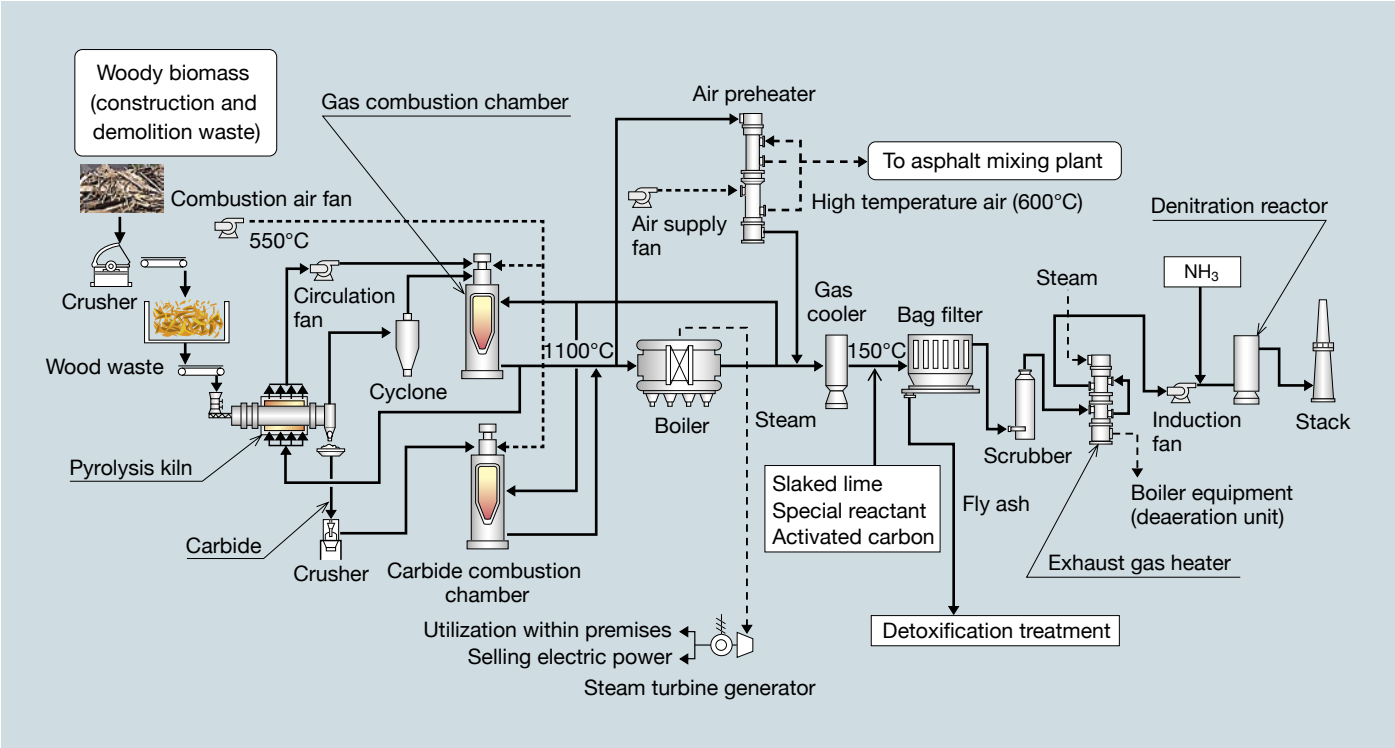

Fig. 2 Schematic diagram of a woody biomass cogeneration facility
The major equipment of the facility includes a pyrolysis kiln, gas combustion chamber, boiler, bag filter, scrubber, and denitration reactor.

(whose greenhouse effect is 310 times larger than CO_2). This facility started operation in November 2007. As shown in **Fig. 1**, it consists of a dryer for sewage sludge, carbonization reactor (indirect heating-type rotary kiln reactor), pyrolysis gas combustion furnace, flue gas treatment tower to treat exhaust gas, and wet-type electrostatic precipitator.

The advantages of this facility in reducing greenhouse gases are as follows.

(1) The facility reduces the N_2O generated from sludge by combusting pyrolysis gas at 950°C using the pyrolysis gas combustion furnace, producing an 80% increase in the reduction compared to a conventional incinerator.
(2) CO_2 is reduced by effectively utilizing carbon neutral sewage sludge carbide, which has a heavy oil equivalent of 2,500 kL per year, as an alternative fuel to coal.
(3) The facility reduces 37,000 tons per year of CO_2 through the above process. This amount is equivalent to the CO_2 absorbed by a forest whose area is about 1.7 times larger than the area encompassed by the Yamanote Line (63 km^2).

2.2 Woody biomass cogeneration facility

The woody biomass cogeneration facility for Maeda Road Construction Co., Ltd. is Japan's first facility to carbonate and gasify woody biomass (95 tons per day) and convert it into hot air as a heat source for heating asphalt or into electric power for use within the premises. This contributes to a large reduction in greenhouse gases through the use of woody biomass as a fuel. **Figure 2** shows a schematic diagram of the facility, which consists of a pyrolysis kiln (indirect heating-type rotary kiln reactor), gas combustion chamber, boiler, bag filter to treat exhaust gas, scrubber, and denitration reactor.

The advantages of this facility in reducing greenhouse gases are as follows.

(1) The facility pyrolyzes woody biomass (wood waste) and cleanly combusts the pyrolysis gas at a low air ratio to generate electric power.
(2) In concert with the operation of an asphalt mixing plant, the facility burns thermal decomposition residue (carbide) as a solid fuel to use this material effectively.
(3) With the aim of reducing the usage of fossil fuels (fuel reduction of about 1,400 kL per year) within the premises through (2) above, the facility reduces CO_2 by 3,700 tons per year, which represents a 45% reduction.

3. Introduction of next generation sewage sludge incinerator

In addition to the application of carbonization and gasification to biomass, a sewage sludge incineration facility for the Environmental Planning Bureau, city of Yokohama, started operation in September 2007 with the aim of reducing emissions of greenhouse gases through the introduction of a next generation sewage sludge incinerator—a circulating fluidized bed incinerator. This facility reduces the emission of N_2O generated from sludge and uses less power compared to conventional bubble fluidized bed incinerators by treating 200 tons of sewage sludge per day in the circulating fluidized bed incinerator greenhouse gas reduction system. As shown

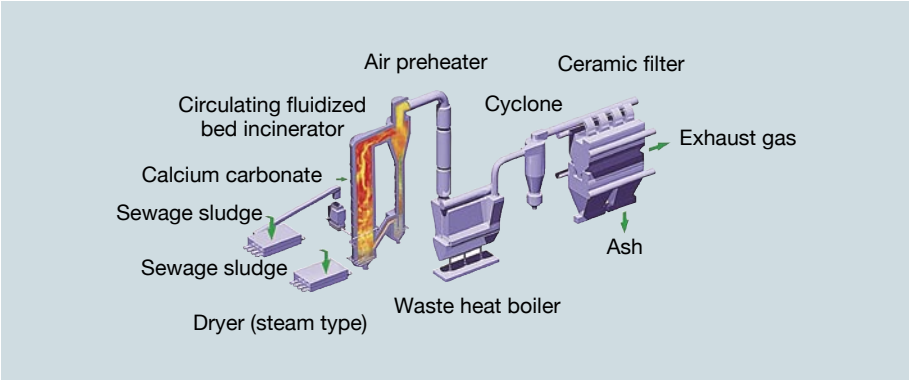

Fig. 3 Schematic diagram of the next generation sewage sludge incinerator
Major equipment of the facility includes a dryer (steam type), circulating fluidized bed incinerator, air preheater, waste heat boiler, cyclone, and ceramics filter.

in **Fig. 3**, it consists of a dryer for sewage sludge (steam-type), circulating fluidized bed incinerator, air preheater, waste heat boiler, cyclone to treat exhaust gas, and ceramic filter.

The advantages of this facility in reducing greenhouse gases are as follows.

(1) The N_2O generated from sludge is reduced through the adoption of high temperature stable combustion (constant combustion at 850°C) and an in-furnace SOx reduction system (limestone, oxidation catalyst).

(2) In addition to reducing the electric power consumption of the combustion air blower through the two-stage combustion method of the circulating fluidized bed incinerator, electric power consumption is further reduced through the use of the steam drying system.

(3) The facility uses carbon neutral digested gas as the assisting fuel (100% free of fossil fuels when the incinerators are replaced).

(4) From the above, the facility achieves a CO_2 reduction of about 23,000 tons per year just for the old incinerators, which will soon be replaced.

4. Conclusion

The current status of MHI's carbonization and gasification technology in the field of biomass utilization is described in this report. MHI's intention is to work continuously on our developments in this field and promote our efforts toward reducing greenhouse gases.


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