7A1. Co-generation Systems

Technology overview

1. Definition of co-generation

A co-generation system is a system using a common energy source to produce both electricity and thermal energy for other uses, resulting in increased fuel efficiency.

2. Co-generation systems

Co-generation systems are roughly divided into two types. One is a type that powers a diesel engine, gas engine, gas turbine, or other motor to generate power while recovering the waste heat from the motor as hot water or steam through a thermal exchange at a boiler. The other type involves generating power by rotating a steam turbine with steam produced by boilers and removing steam of a desired pressure as process steam.

The former generally uses liquid or gas fuel and is often small-scale for hotels, supermarkets, and hospitals.

As for the latter, every type of fuel, including coal, is used as fuel for boilers and many are found as relatively large-scale industrial-use thermal power plants. Systems are further grouped into ones that mainly supply electricity (condensing turbines) versus those that mainly provide steam (back-pressure turbines).

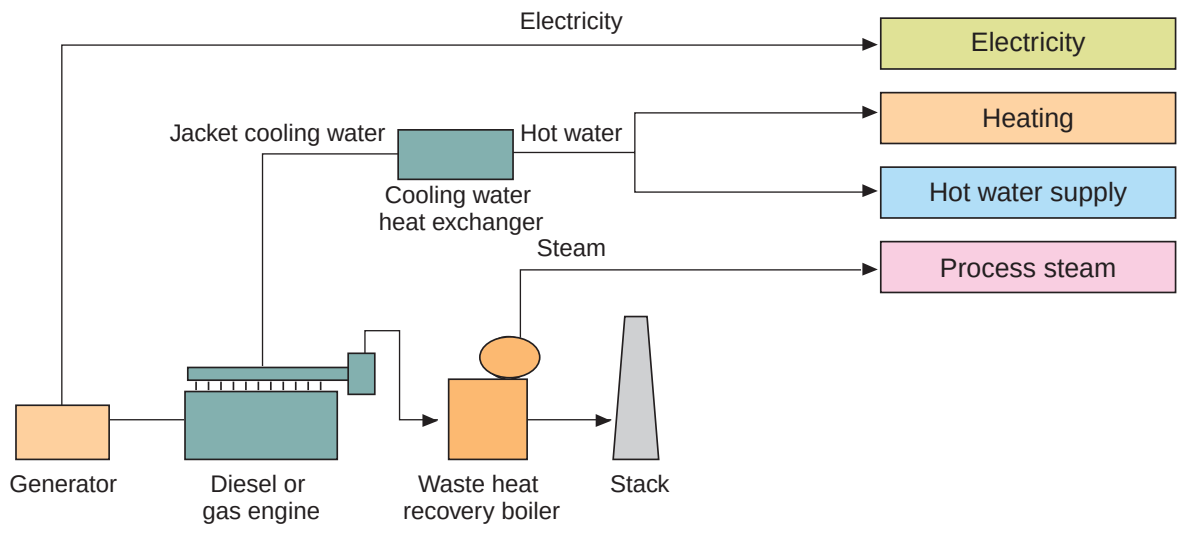

Fig. 1 Overview of a typical diesel/gas co-generation system

3. Efficiency

In general, the power generation efficiency of a coal thermal power generation plant producing only electricity is around 40%. On the other hand, the overall thermal efficiency of a cogeneration system, which combines power generation efficiency and heat recovery efficiency, depends upon whether its main purpose is to supply electricity or to supply heat. Co-generation systems that primarily supply heat can reach efficiency levels as high as 80%.

(1) Co-generation at a large-capacity coal thermal power plant

Kobe Steel's Shinko Kobe Power Station, a 1,400MW (700MW x 2 generators), large-scale coal thermal power plant, wholesales/supplies electricity as an independent power producer (IPP). Electricity generated from the No. 1 unit, which began operating in April 2002, and the No. 2 unit, which began operating in April 2004, are all being delivered to The Kansai Electric Power, Inc.

(2) Regional supply of heat

A portion of the steam from the Kobe plant to be used for power generation is extracted in order to supply up to a maximum of 40 tons/hr to four nearby sake-breweries. This amount, accounting for approximately 2% of the steam generated in the boilers, indicates that the share of heat supplied is small. Previously, each

brewery had produced its own steam. Now, however, the power plant's secondary steam is extracted at the steam header and directly supplied to the breweries. By using steam extracted from the power plant, regional energy conservation efforts are realized.

(3) Heat supply conditions

Steam extracted from the turbine of the power plant contains trace amounts of a rust inhibitor called hydrazine and, therefore, cannot be directly supplied to breweries since the steam used in the breweries comes into direct contact with rice. Secondary steam, produced indirectly using a steam generator powered by turbine extraction steam (primary steam), is therefore supplied to breweries. An overview of Kobe Steel's Shinko Kobe Power Station is shown in Photo 1.

Photo 1 View of Kobe Steel's Shinko Kobe Power Station

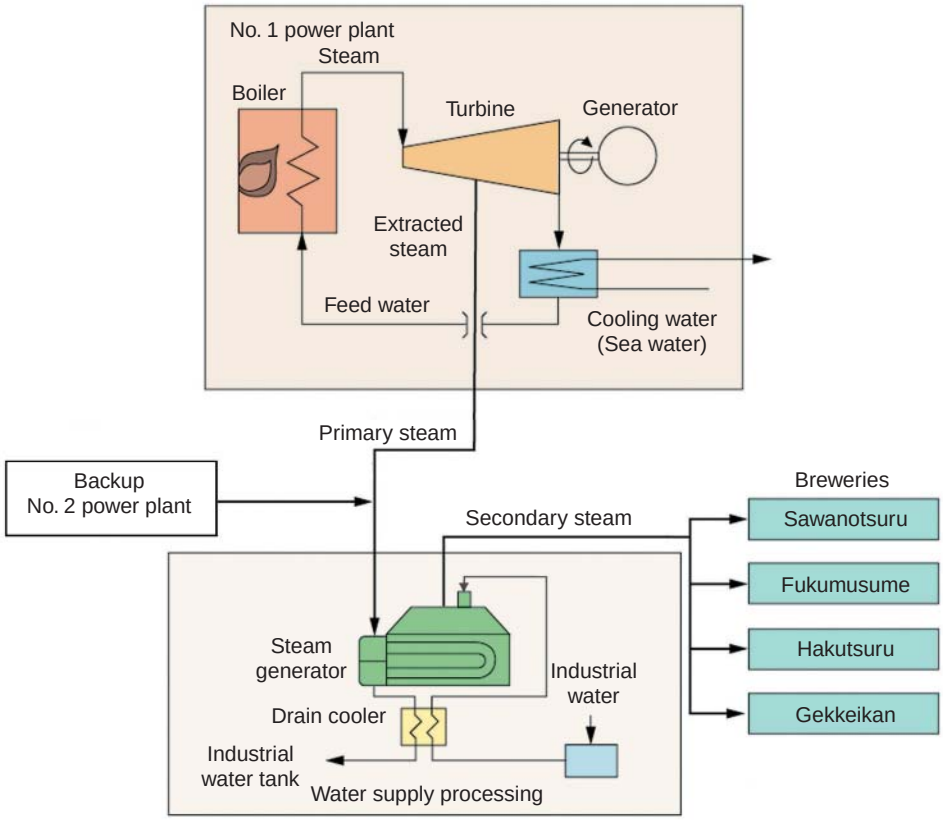

Fig. 2 Process flow of heat supply facility

References

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2) The Thermal and Nuclear Power Engineering Society: Introductory Course IV. Industrial-Use Thermal Power Facilities, Etc., pp. 1539-1546 Vol. 54, No. 567, Thermal/Nuclear Power Generation, Dec. 2003.

3) Kida et al., Outline of Power Generation Facilities at Kobe Steel's Shinko Kobe Power Station, pp. 2-7, Vol. 53, No. 2, Kobe Steel Technical Report, Sept. 2003.

4) Miyabe et al., Kobe Steel's Shinko Kobe Power Station Surplus Steam-Based Heat Supply Facility, pp. 14-18, Vol. 53, No. 2, Kobe Steel Technical Report, Sept. 2003.