Improved Competitiveness of 1,000 kW class CHP systems

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Abstract

OSAKA GAS CO., LTD and MITSUBISHI HEAVY INDUSTRIES, LTD. jointly work on the development of new 1,200 kW engine with high electric power and high generating efficiency natural gas CHP systems by using high efficiency turbocharger and optimized the combustion chamber configuration. We aim to increase electric power by 20% and improve the generating efficiency by 1.8pt%. In addition, we developed the system which is combined use of the cooling tower and the radiator to cool the gas engine. This system has high generating efficiency and power output with the cooling tower and the radiator at ordinary time, and can generate electricity even at the time of water failure with the radiator.

Introduction

Until now, OSAKA GAS CO., LTD and MITSUBISHI HEAVY INDUSTRIES, LTD. have jointly developed high-efficiency natural gas CHP systems. We have already installed approximately 250 units of the Miller cycle gas engine CHP systems (300kW ~ 1,000kW class) and the total capacity of these systems have reached about 150MW.

Natural gas CHP systems become widely used due to the high total efficiency, the efficacy of CO2 emission reduction, the functionality as distributed energy systems applicable to various demands and the advantage of the clean exhaust emission.

This time, OSAKA GAS CO., LTD and MITSUBISHI HEAVY INDUSTRIES, LTD. are jointly successful in developing of natural gas CHP systems for water supply failure, and are just developing new natural gas CHP system that electric power is over 1,000kW with high generating efficiency.

CHP system for water supply failure

In Japan, water cooling is popular for the natural gas CHP systems because the atmosphere temperature is high in the summer season and water supply infrastructure is maintained. However, there was problem not to be able to operate at the time of water failure because a cooling tower needs water supply.

Since the Great East Japan Earthquake, the function as the power supply at the time of the emergency is regarded as important to natural gas CHP systems more than before. Therefore we constructed the system that can supply electricity at the time of water supply failure by adding the radiator to the CHP system. A cooling with a radiator causes a drop in generating efficiency and deterioration in electric power generation, because it has lower ability for cooling than a cooling tower. Therefore we developed the system which is combined use of the cooling tower and the radiator.

Figure 1 shows the cooling water channel structure of CHP systems for water supply failure. The big characteristic of this system is changing only cooling water of intercooler which affects the engine output and generating efficiency. This characteristic contributed to the downsizing of the cooling tower. It minimized the cost gap between this system and only cooling tower systems. Additionally, addition of the radiator contributes to cutting down user's water bills at ordinary time, because cooling water of jacket is always cooled by the radiator. When a water supply failure occurs, the cooling water channel is turned into a cooling with a radiator system by switching valves.

A cooling with a radiator causes a drop in generating efficiency and deterioration in electric power generation. Table 1 shows the relationship between the engine output and the cooling water temperature of intercooler (engine inlet) and knocking characteristics. The merchandise specification is detected in consideration of engine output and the cost of the radiator. The cooling water temperature of intercooler (engine inlet) is 55 degrees C, and engine output is 80%.

By the examination mentioned above, this system has high generating efficiency and electric power with the cooling tower and the radiator at ordinary time, and can generate electricity even at the time of water failure with the radiator.

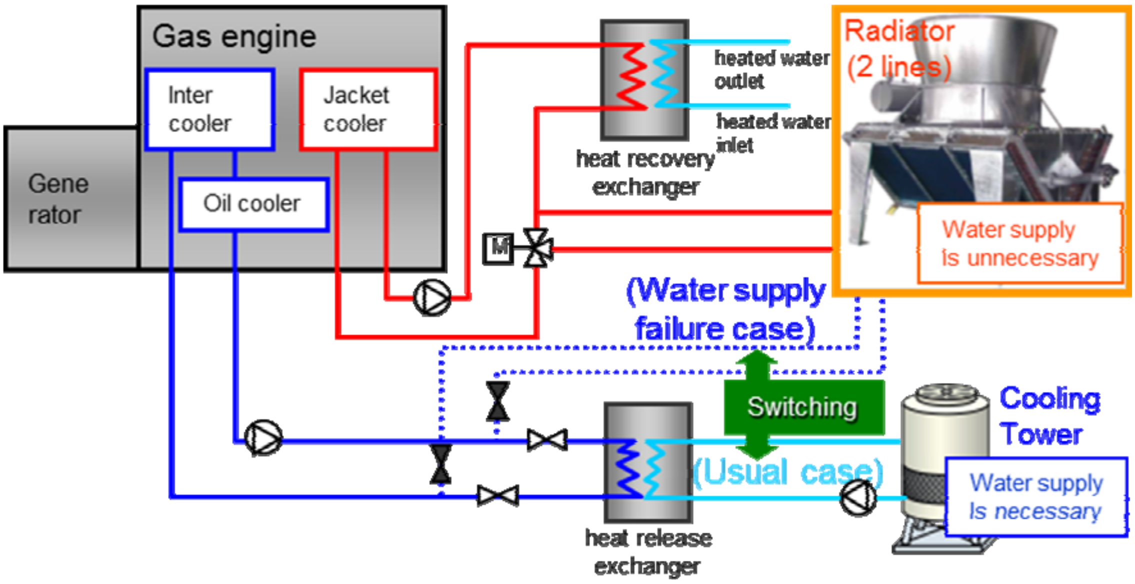

Fig.1 The cooling water channel structure of CHP systems for water supply failure

Table 1 The relationship between the engine output and the cooling water temperature of intercooler (engine inlet)

Cooling water temperature of intercooler (engine inlet) [degrees C]	Output[%]				
	100	90	80	75	70
35	○	○	○	○	○
40	○	○	○	○	○
45	×	○	○	○	○
50	×	×	○	○	○
55	×	×	◎	○	○
60	×	×	×	○	○
65	×	×	×	×	○

× : Margin of Knocking < 3°

○ : Margin of Knocking ≧ 3°

◎ : Selection point

Development of power up and high efficiency generating CHP

In addition, OSAKA GAS CO., LTD and MITSUBISHI HEAVY INDUSTRIES, LTD are now work on not only the enhancement of emergency power supply functions, but also the developing the new 1,200kW high generating efficiency natural gas CHP systems to practical use in the spring of 2015. Table 2 and Figures 2 show the performance improving items for power up and high generating efficiency. The big modification point from existing 1,000kW model is raising the Brake Mean Effective Pressure (BMEP:1.31MPa→1.75MPa) by using the high efficiency turbocharger and optimizing the combustion chamber configuration. Furthermore, we are now planning to use the waste gate valve control systems to increase exhaust gas temperature to achieve high steam recovery.

By adopting these items, we aim to improve 1.8pt% generating efficiency improving from the existing 1,000kW model. This efficiency will reach to the best-in-class generating efficiency 43.5% in spite of the same size as existing 1,000kW model.

Table 2　The list of performance improving items for 1,200kW new CHP

No	Items	Purpose
①	High efficiency turbocharger	Efficiency gain for lean combustion
②	Optimizing the combustion chamber configuration (Expansion ratio, Piston, Prechamber)	Efficiency gain by optimizing the firing
③	Adoption of waste gate valve control systems	Reduce exhaust loss Increase exhaust temperature
④	Optimizing the miller cycle	Increase in the work of engine
⑤	High efficiency steam boiler	Increase steam recovery efficiency

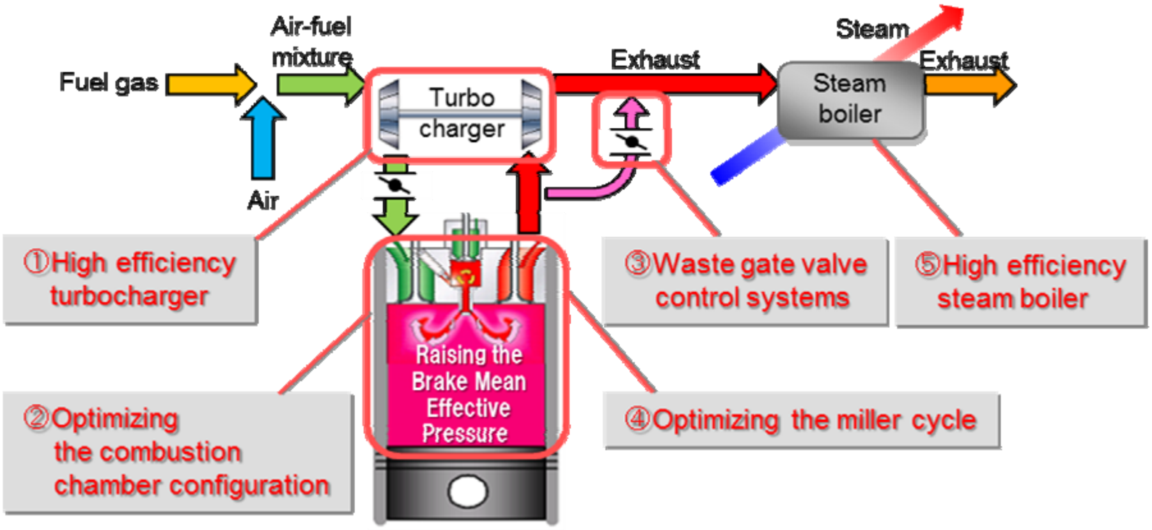

Fig.2 Performance improving items for power up and high generating efficiency

Conclusion

CHP system for water failure is developed at a low price to raise cooling water temperature of intercooler (engine inlet) from 35 degrees C to 55 degrees C and lower the output to 80%.
OSAKA GAS CO., LTD and MITSUBISHI HEAVY INDUSTRIES, LTD are developing the new 1,200kW engine with the best-in-class generating efficiency by high efficiency turbocharger and optimizing the combustion chamber configuration.

Closing

Customers' expectations for natural gas CHP systems demanding multiple functions such as operation as an emergency power source and effective equipment for CO2 emission reduction are becoming high. Further performance improvements will be addressed focusing on generating and total efficiency of CHP systems and adding greater values as energy saving equipment and emergency power source.