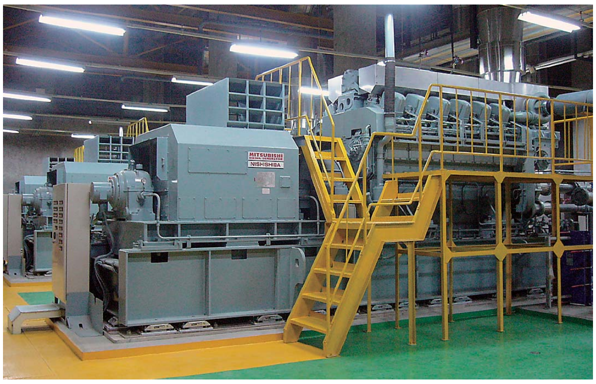

High Efficiency and Low Emission Diesel Engine Co-generation System

TAKASHI KADO*1
TAKUYA KUMAGAI*1
KOUMEI SHIMOMURA*2
HIROSHI KOMUKAI*1
MOTOYUKI NINOMIYA*1
MAKOTO KANEHIRA*3

1. Introduction

Because of the environmental problems of global warming, CO_2 emissions and innovative changes such as the deregulation of electric power supplies, attention has currently been turned from conventional large-scale integrated power supply systems to a distributed power generation system that closely fits local demand and makes simultaneous and effective use of both heat and electrical power. The distributed power supply uses new energy systems such as gas turbines, gas engines, diesel engines, and fuel cells. Of these, diesel engines need less installation space, can be operated (start/stop) according to the power demand, allow easy adjustment of load, have a high power generation rate and overall efficiency including the effective use of electricity and exhaust heat. The diesel engine has therefore become widespread in industrial and commercial use and among small and medium scale consumers.

This paper describes a co-generation power system which uses SU3 engines ranging from the 1.4 to 4 MW classes with improved thermal efficiency and environmental requirements while keeping nitrogen oxide (NOx) emissions to the levels of conventional engines.

2. SU3 engine

Compared with a conventional SU engine, the SU3 engine simultaneously improves its power and efficiency because of its enhanced maximum cylinder pressure and fuel injection pressure, the longer stroke design, and its high pressure-ratio turbocharger, as shown in **Fig. 1**. **Table 1** shows the main specifications of SU3.

(1) Basic structure of engine

Various up-to-date technologies have been introduced to ensure that the engine has substantial resistance against maximum cylinder pressure and high heat load brought about by the high efficiency of the engine, and has also improved durability. The appearance of the engine is shown in **Fig. 2**. The cylinder head adopts a material which excellently balances strength and heat transfer coefficient, and the bore is

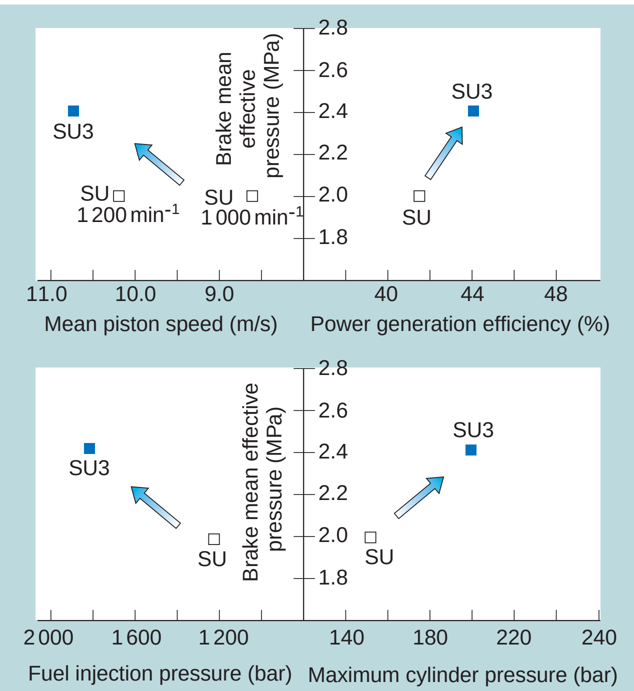

Fig. 1 Representative performance values of SU3

Table 1 Main specifications of SU3

Cylinder diameter x stroke (mm)	240 x 320			
Engine speed (min^{-1})	900/1 000			
Frequency (Hz)	60/50			
Number of cylinders	L6	V8	V12	V16
Generator output (kW)	1 350/ 1 500	1 800/ 2 000	2 700/ 3 000	3 600/ 4 000

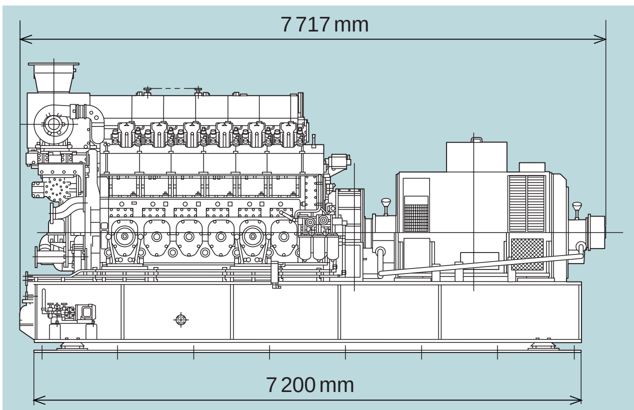

Fig. 2 Appearance of SU3 (V12) generator set

*1 General Machinery & Special Vehicle Headquarters
*2 Kobe Shipyard & Machinery Works
*3 MHI Sagami High-Tech Ltd.

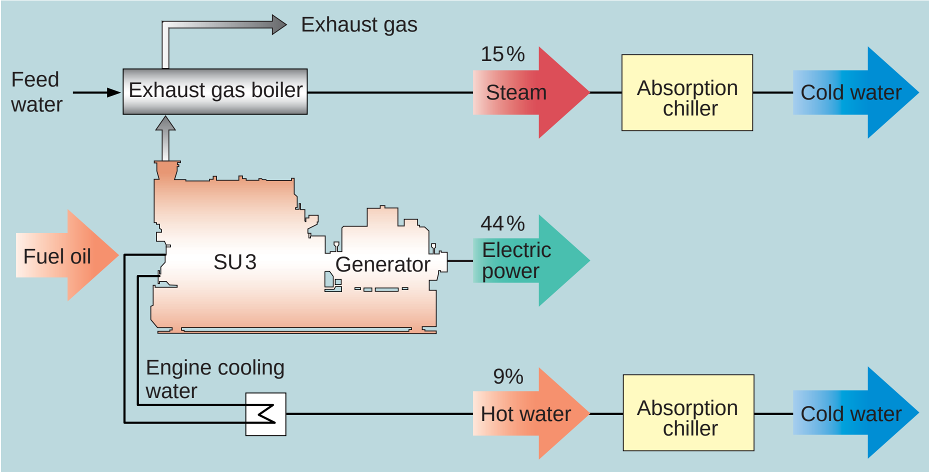

Fig. 3 Example of SU3 exhaust heat recovery system

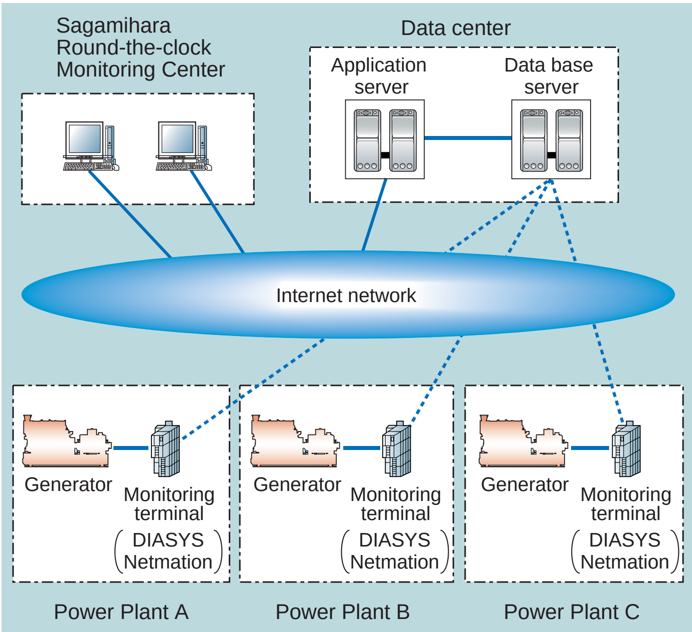

Fig. 4 Remote monitoring system

Fig. 5 Round-the-clock monitoring center

cooled in the space between the intake and exhaust valves, where the temperature is the highest, in order to provide sufficient strength for cylinder pressure and to reduce the temperature of the combustion chamber. Further, the cylinder liner is normally equipped with an anti-polish ring to prevent carbon polishing by restraining the carbon from adhering to the piston top land, to reduce the consumption of lubricating oil. The piston ring unit, comprises three rings including the oil ring, and the ring faces are coated with chromium ceramic with excellent wear resistance to ensure excellent sliding performance and wear resistance even under maximum cylinder pressure.

All these designs are based on the basic design of the SU engines, of which more than 800 units have been produced, and have high reliability and excellent durability and optimum design using diverse simulations. In order to ensure higher reliability and higher durability, the engines are subjected to continuous endurance tests in our power plant.

(2) Auxiliary component units

The auxiliary components of the lubricating oil and cooling water systems (such as pumps, filters and coolers) are built in modules and mounted onto the engine in order to reduce the external piping. Thus the design allows the maintenance inspection and exchange of components simply by detaching the components. Further, because these components are mounted on the engine the pipes connecting to the plant equipment can be reduced, contributing to easy installation of the engine and to the simplification of the equipment.

3. Exhaust heat recovery system

Fig. 3 shows an example of the SU3 exhaust heat recovery system.

The SU3 co-generation system not only supplies power to the user's equipment, but also recovers exhaust heat from the exhaust gas and cooling water, and the recovered heat sources (steam and hot water) are then fed to the steam-driven and hot-water driven absorption chillers as heat energy for the user's cooling load.

The exhaust heat recovery allows the user's air-conditioning power using the existing electric chiller to be reduced, making a large contribution to reducing the user's total energy cost.

4. Remote monitoring system

In order to minimize the power supply stoppage caused by distributed power generation system problems, we have developed a remote monitoring system for the operation, control and maintenance of the system, with the real-time monitoring of the operational status of more than 500 power generation systems supplied to supermarkets, hospitals, hotels, and factories etc. Further, Mitsubishi Heavy Industries, Ltd. (MHI) has launched the operation of a high-function remote monitoring system using the MHI DIASYS Netmation control system. **Fig. 4** shows the remote monitoring system.

The DIASYS Netmation controller installed in the power generation system is connected to a server in the data center by means of an internet connection to carry out the round-the-clock, real-time monitoring of the operational status of the power generation system. (See **Fig. 5**.) Further, when an alarm occurs, it is transmitted to the cellular phones of service personnel by e-mail, while the history of the alarm and its operational data are managed at the data center.

The DIASYS Netmation controller constantly carries out 100 ms data sampling, which is effective for a detailed analysis of the cause of the problem. The controller is further equipped with a problem diagnosis logic and allows the remote change of the logic from the round- the-clock monitoring center, thus ensuring detailed control depending on the operational status.

The monitoring center is developing manuals for analyzing the cause of problems, troubleshooting measures, drafting maintenance schedules based on cumulative operating time and developing problem diagnosis and prediction functions to avert major accidents.

5. Conclusion

MHI has manufactured a lineup of diesel engines with a wide output range and has supplied them to a large number of users for stationary power generation. The new SU3 model, developed by feeding back extensive experience and records, boasts high heat efficiency and reliability, and combined with the exhaust heat recovery system and the remote monitoring system, the new SU3 model is expected to play an important part in co-generation power generation.

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Takashi Kado


Hiroshi Komukai


Takuya Kumagai


Motoyuki Ninomiya


Koumei Shimomura


Makoto Kanehira