Kawasaki-MAN 48/60 4-stroke diesel engine for stationary power generating plant

In 2011, we delivered land-use generator sets to the Ishigaki Daini Power Station of the Okinawa Electric Power Company. The facility is composed of a new model Kawasaki-MAN 18V48/60 diesel engine as the main engine, which boasts an output of 18 MW, the first ever in Japan and ranking one of the world's largest. (The largest output in Japan in the past was 10 MW.) The facility is in operation and performing well.

This paper introduces the Kawasaki-MAN 48/46 diesel engine.

Preface

Since 1955 when its first emergency power generation set was delivered to Kawasaki Steel Corporation (currently JFE Steel Corporation), we have been delivering diesel generator sets for normal and emergency uses for about 60 years. The total number of diesel generator sets delivered is 111, with a total output amounting to 226.1 MW. In the past 20 years or so, we have delivered 10 land-use diesel generator sets to Japan's electric power utilities.

The current market of reciprocal engine generator sets demands higher output, higher efficiency, and higher environmental performance, with gas engine generator sets of low environment loading attracting attention. However, isolated islands where infrastructure for gas facilities has not been developed still need diesel power generation.

In 2011, we delivered to the Okinawa Electric Power Company a land-use power generation set powered by a new type of diesel engine, which is also of the world's largest class with a power generation output of 18 MW, in the Kawasaki-MAN 18V48/60.

Table 1 Main specifications

The 18V48/60 are highly reliable engines with which MAN has registered a solid track record. By constantly raising engine performance, MAN has responded to the market requirements of high efficiency and high environment performance.

Table 1 shows the major characteristics of the Kawasaki-MAN 48/60 diesel engines.

1 Construction

Figure 1 shows an outline of the Kawasaki-MAN 48/60 diesel engines.

Air supply is pressurized in an axial flow turbine type exhaust gas turbocharger, passes through the A train and B train air coolers (controlled to the optimum air supply temperature through two-stage cooling of warm water and

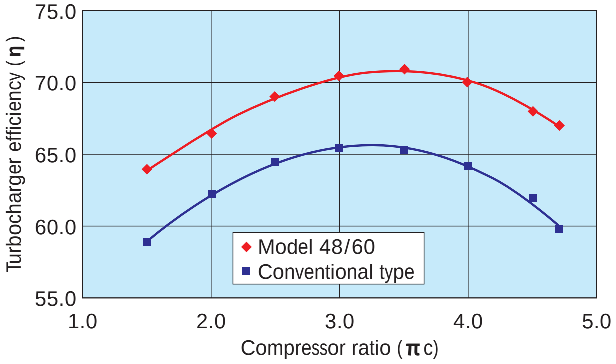

Fig. 2 Turbocharger efficiency

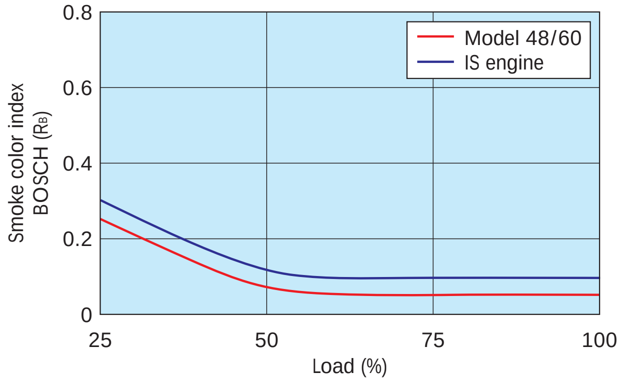

Fig. 3 Smoke index

cold water), and are supplied to individual cylinders. The fuel oil, injected into the cylinder combustion chamber at high pressure under the control of the electric speed governor, is diffused and burned in the combustion chamber. The exhaust gas from the fuel is discharged into a single exhaust pipe, passes through the turbocharger turbine chamber, and is discharged into the atmosphere.

The main features of the component parts of the Vee are as follows.

(i) Cylinder head

The shape of the intake duct and exhaust duct have been optimized and the combustion surface smoothed to improve air flow, which improves the mixture of fuel and air, and the combustion efficiency, and reduces fuel residue.

(ii) Fuel injection system

With the aim of improving combustion conditions, the fuel injection timing has been optimized and the maximum fuel injection pressure increased from the conventional value of 80 MPa to 160 MPa.

(iii) Turbocharger

A high-efficiency large-scale turbocharger has replaced two turbochargers used on conventional models. Fig. 2 compares efficiency against a conventional turbocharger.

2 Features

This engine is provided with the following features owing to an optimized design.

(i) Higher output

In terms of the average effective pressure used in comparing per-cylinder output values, this engine exhibits a 47% higher output than conventional 10 MW class engines, achieving the target of an increase in output. An increase in output accompanies an increase in cylinder internal pressure, however the optimized design of the cylinder head ensures safety and reliability.

(ii) Higher efficiency

The optimized design of the combustion chamber, fuel injection and turbocharger has made it possible to increase the thermal efficiency of this engine to 48.2% from the 45.5% of conventional 10 MW class engines.

(iii) Improvement in smoke

The improvement in combustion conditions and the installation of a high-efficiency turbocharger have resulted in an improvement in smoke. Fig. 3 shows the smoke color index for smoke from engines.

When the smoke color index is $0.3R_B$ (Bosch index) or smaller, the smoke reflects good exhaust emissions that cannot be confirmed visually. MAN-type engines have shown satisfactory exhaust emissions under 25% or higher loading as Invisible Smoke (IS) engines; the engine presented here exhibits a further improvement in this respect. In addition, intake air temperature control raises the intake air temperature under low loading, reducing black smoke that accompanies low loading operation.

(iv) Easy maintenance and servicing workability

The cylinder head, intake pipe, and control lever casing are assembled in an integrated structure on each cylinder, while a spherical bearing of a new structure is adopted in the control lever device. Both measures contribute to a reduction in servicing time.

Postscript

The future will bring a variety of needs such as further enhanced efficiency and fuel diversification. To respond to such needs, we will make an effort to improve MAN-type engines and contribute to society through the supply of diesel power generation of higher efficiency and less environmental loading.

Seiichi Ohsaki / Michio Fukushima

Contact information
Power Generation Project Department,
Machinery Division,
Gas Turbine & Machinery Company
Tel: +81-78-682-5344   Fax: +81-78-682-5530