Development of Large Capacity, Compact MET-MBII Series Axial Flow Turbine Turbochargers and MET-ER Series Radial Flow Turbine Turbochargers

MET-MBII turbocharger

MET-ER turbocharger

Mitsubishi Heavy Industries Marine Machinery & Equipment Co., LTD.

The role of turbochargers, which significantly affect engine performance, is becoming increasingly important in response to the strengthening of regulations on air pollution substances and carbon dioxide discharged from ship engines.

The MET turbochargers are the exhaust gas turbine type, which is one of the global standards for turbochargers intended for marine diesel engines. Axial turbocharger models are mainly used with large 2-stroke engines and radial turbocharger models are used with small 4-stroke engines.

Mitsubishi Heavy Industries Marine Machinery & Equipment Co., Ltd. (MH-MME, our company) developed the MET-MBII series of axial turbochargers and the MET-ER series of radial turbochargers, both of which feature the high performance that satisfies the environmental regulations and high capacity in a compact size characterized by mountability and low cost.

1. New MET-MBII series axial turbochargers

1.1 Concept and characteristics

We started the production of axial turbochargers in 1960. Since 1965, when we launched MET no-water-cooling type turbochargers, we have continued to develop new technologies and release new products in response to the various requests of engine manufacturers. The latest models on the market can be found in the MET-MB series. The concept of the newly-developed MET-MBII series is a reduction of the frame size by achieving higher air flow. **Figure 1** illustrates the relationship between engine output and turbocharger weight. The capacity of the MET-MBII series is 16% larger than that of the conventional MET-MB series. Turbochargers of compact frame sizes, model 1 or 2, can be applied, which leads to a reduction of the initial cost, weight and maintenance cost, when the engine output is the same.

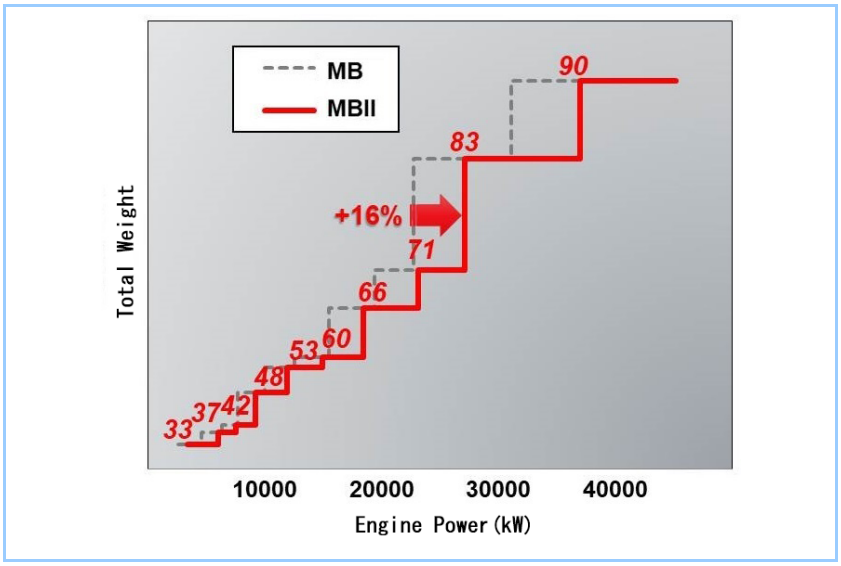

Figure 1 Relationship between engine output and turbocharger weight

A new compressor wheel with the optimum number of blades and blade angle distribution was developed for the MET-MBII series, aiming to increase the capacity while maintaining the high performance. The turbine blade throat distribution was also optimized, as can be seen in **Figure 2**, to develop a new turbine with higher exhaust gas pressure recovery performance in the gas outlet casing.

Meanwhile, the casing, a component excluding the silencer, is the same as the casing used in the conventional MET-MB series, and the high reliability and maintainability are the same as the MET-MB series.

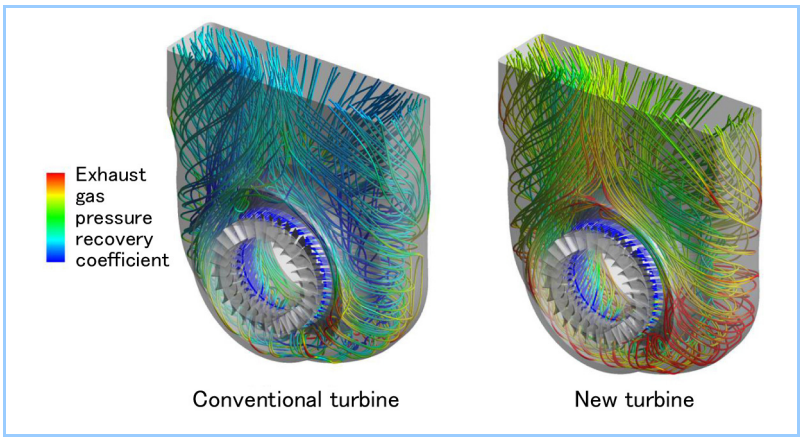

Figure 2 Comparison of new turbine and old turbine in exhaust chamber pressure recovery performance

1.3 Lineup

Figure 3 presents the lineup of the MET-MBII series. The lineup of the MET-MBII series consists of ten models, which is the same as the MET-MB series. The turbochargers cover engine output ranging from approximately 2,500 kW to 32,000 kW, depending on the model.

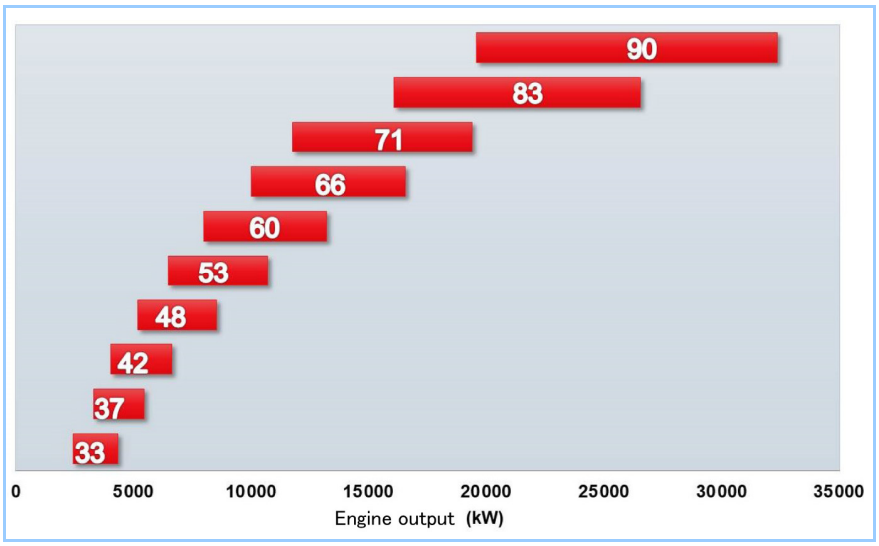

Figure 3 Lineup of the MET-MBII series

2. New radial turbocharger MET-ER series

2.1 Transition in compressor pressure ratio of radial turbocharger

The transition in the compressor pressure ratio of our radial turbochargers is given in **Figure 4**. The Miller cycle, in which the air intake valve is closed earlier, is increasingly used in 4-stroke engines to improve the performance and to respond to the need for NOx emissions reduction. To make up for the decline in the air volume by the early valve closing, the pressure ratio of a turbocharger needs to be high. The pressure ratio of the newly-developed MET-ER series is 1 point higher than the existing MET-SRC series, and they support a compressor pressure ratio of a maximum of 6.0.

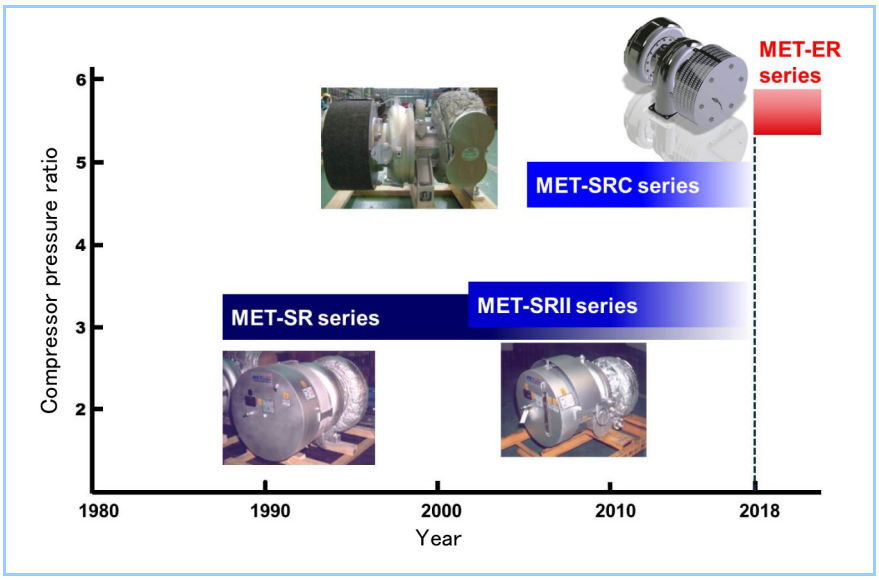

Figure 4 Transition in compressor pressure ratio of our radial turbochargers

2.2 Concept and characteristics

The MET-ER series was developed for use in main and auxiliary marine engines and on-land power generation engines, with the concept of the three "E's," standing for Environment-Friendly, Economy and Excellent Performance.

In terms of environmental friendliness, a high pressure ratio was realized to satisfy environmental regulations, while a new compressor wheel with an optimized blade height and blade angle distribution, which is depicted in **Figure 5**, was developed and used. The new models were also downsized compared with the existing models. External sizes of turbochargers intended for 1,000 kW class engines are compared in **Figure 6**. The new MET16ER model is 40% smaller than the existing MET18SRC model. In terms of economy, the number of parts was reduced by about 30%, while maintaining a structure that is easy to open, to improve the maintainability and reduce the initial cost, as well as improve the functions. In terms of performance, a new smaller turbine wheel was developed while maintaining the flow rate, and the response was improved by 25%.

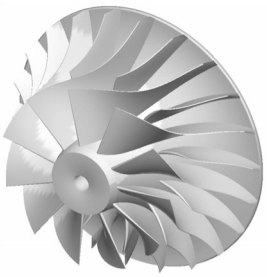

Figure 5 New compressor impeller

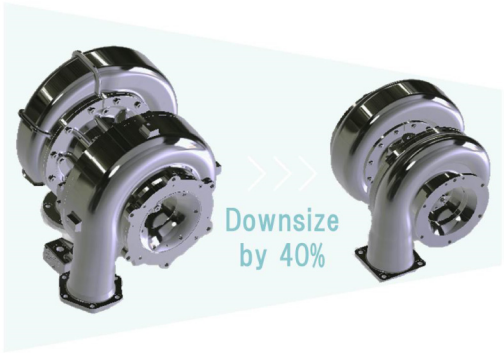

Figure 6 Comparison of outer shape of turbochargers (applied to 1,000 kW class engines)

2.3 Lineup

Figure 7 shows the lineup of the MET-ER series. The lineup of the MET-ER series consists of seven models and each of the turbochargers covers engine output ranging from about 500 kW to 5,200 kW, depending on the model.

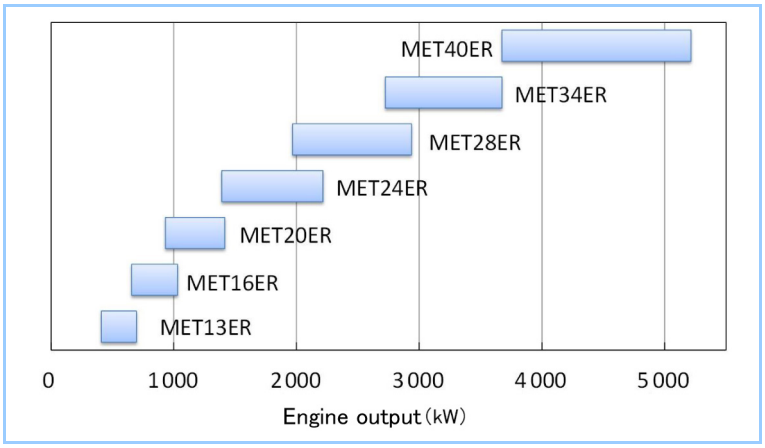

Figure 7 Lineup of the MET-ER series

3. Conclusion

Following the enforcement of SOx controls in general waters in 2020, many ship owners are forced to use comparatively expensive low-sulfur fuels. Fuel costs are expected to remain high for a long period in the future, and ship owners are required to reduce fuel costs. The regulation based on the EEDI (Energy Efficiency Design Index) CO_2 emissions index, which is applied to ships manufactured in or after 2013, will also be further strengthened in phases.

Turbochargers used with diesel engines significantly affect the combustion of fuels, and turbochargers play an important role in solving the aforementioned issues. We will contribute to global environmental conservation through our turbochargers and make efforts for technical innovation and product improvement, aiming to respond to the further diversifying needs of customers in the future.