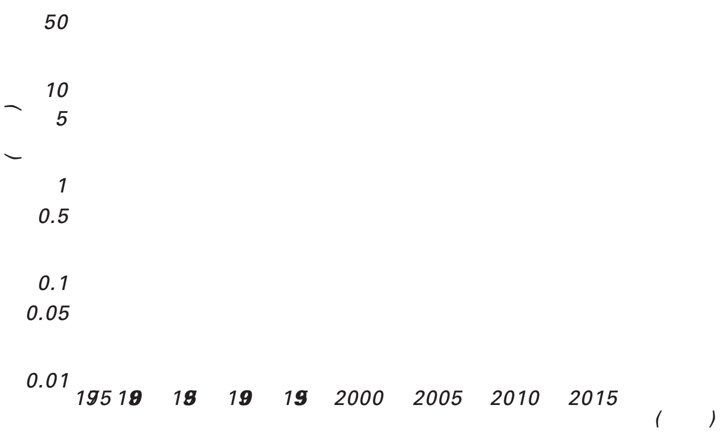
1.7 MW class high efficiency and low emission gas turbine, M1A-17

Preface

Recently, the importance of distributed power sources has increased from the viewpoint of ensuring power supply against the loss of power and power service interruptions in disasters. In addition, regulations on exhaust gas are increasingly stricter from the viewpoint of global environment preservation. A reduction in NOx emissions from power generation-use gas turbines is also demanded.

Since successfully developing Japan's first domestically built industrial gas turbine in 1972, we have put various models of gas turbines on the market. Fig. 1 shows the lineup of our industrial gas turbines. The M1A-13, developed in the latter half of the 1980s, boasts a track record of deliveries of about 400 units for continuous generating power use both in Japan and overseas.

Developed on the base of the proven M1A-13, the M1A-17[1] not only integrates the development history and basic technologies of Kawasaki but also is endowed with a substantial improvement in efficiency and exhaust gas performance while still preserving the reliability of the M1A-13. The M1A-17 has exhibited a generating-end efficiency of 26.0% and an overall thermal efficiency of 80% with the boiler included, achieving the top-level performance indexes of this class.



1 Overview of the M1A-17

The M1A-17 is composed of a two-stage centrifugal compressor, a three-stage axial flow turbine, and a single can-type combustor as its main components. The model can be equipped with a diffusion combustor or a dry low emission (DLE) combustor; the model equipped with a DLE combustor is distinguished as the M1A-17D. Fig. 2 shows a cut model of the M1A-17D and Table 1 the main characteristics and cogeneration performance data. The features of the M1A-17 are described below.

(1) High efficiency

(2) Turbine

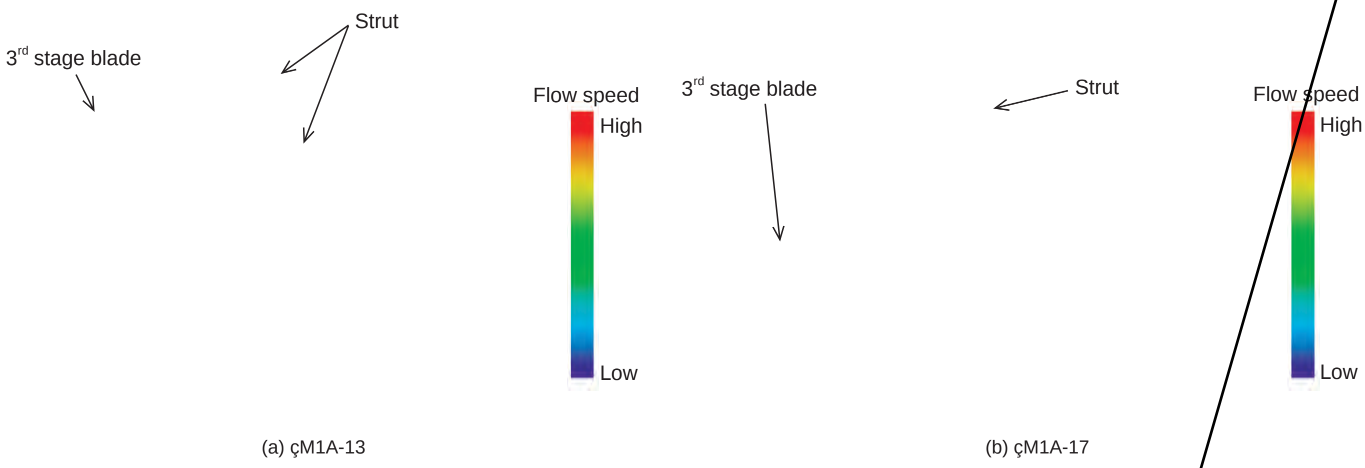


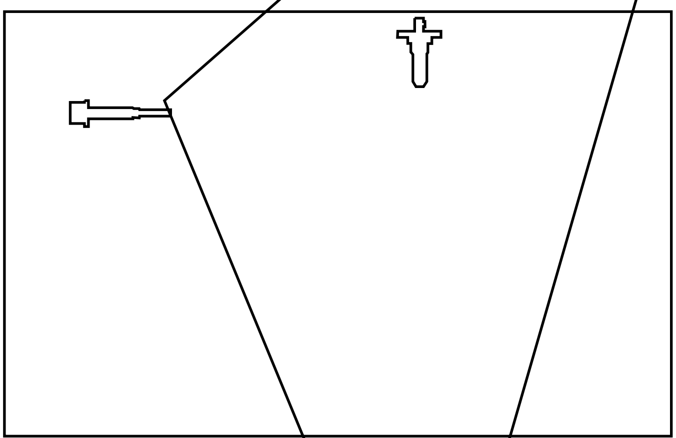
Fig. 6 CFD results of exhaust diffuser

(3) Exhaust diffuser

The exhaust diffuser is used to discharge exhaust gas while expanding the flow passage to reduce the flow speed and recover static pressure. Struts are provided in the flow passage to hold bearing parts and others arrayed on the inside diameter side. Since the struts are provided in the exhaust gas passage, their shape, number, and arrangement affect the performance of the exhaust diffuser greatly. In the M1A-17, CFD-based flow analysis was used to study the arrangement and shape of the struts, while the pressure loss was reduced by minimizing the reverse flow domain. Fig. 6 shows examples from the CFD-based analysis of the exhaust diffuser used in the M1A-13 and M1A-17. The illustration shows a smaller separation of flow and areas of reverse flow in the M1A-17 than in the M1A-13, which comes as a result of reducing the number of struts and other measures.

(4) DLE combustor

The combustor is based on lean premixed and a supplemental combustion method, both of which have been proven with our products. The combustor has three burners: a pilot burner, a main burner, and supplemental burners (Fig. 7). The pilot burner is used mostly for ignition and low load, while the main burner and the supplemental burners are used at low NOx operation. Keeping the fuel concentration distribution as homogeneous as possible in the combustion zone is effective towards reducing



emissions. For this purpose, CFD analysis was used to optimize the shape of the burner and flow passage so that air and fuel are mixed efficiently in the burner section. In

4 Mass-production units

The M1A-17 was put on the market in April 2010. Since the first mass-produced unit was commissioned in April 2012, 10 units have been shipped as of June 2012. Table 2 shows the track record of deliveries, and Fig. 10 the package of the first mass-produced unit destined for Switzerland.

Concluding remarks

Carrying on the reliability proven in its predecessor machines, the M1A-17 incorporates state-of-the-art performance-enhancing technologies and substantially

Reference

1) Y. Hosokawa, M. Gouda, Y. Yamasaki, and A. Norimoto: "Development of 1.7 MW Class High Efficiency Gas Turbine, M1A-17," Asian Congress on Gas Turbines, 2012.