Research Activities on Gas Turbine in National Institute of Advanced Industrial Science and Technology (AIST)

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1. Introduction

The National Institute of Advanced Industrial Science and Technology (AIST) began operations on April 1, 2001. AIST is a newly formed research organization that is the result of an amalgamation of the 15 research institutes previously under the former Agency of Industrial Science and Technology in the Ministry of International Trade and Industry. AIST is Japan's largest public research organization with many research facilities and around 3,200 employees (2,400 Researchers) in all. The main elements of AIST research are energy and environmental technology, life science, information technology, nanotechnology, materials and manufacturing, measurement standards, and geological survey. The research bases located in Hokkaido, Tohoku, Tsukuba (Fig. 1), Tokyo, Chubu, Kansai, Chugoku, Shikoku, and Kyushu allow AIST to operate a nationwide research and development network. AIST has participated in the national R&D projects of 300kW ceramic gas turbine, hypersonic transportation, world energy network, and so on.

2. Research Activities on Gas Turbine

2.1 CO_2 recovering gas turbine system

As shown in Fig. 2, CO_2 recovering semi-closed gas turbine system has been executed. The characteristics of pollutant formation and its oxidation processes are analyzed from the chemical kinetic calculation. An optimal equivalent ratio for the total system efficiency and emission is also estimated [1]. With regard to high temperature materials, the research on the mechanical properties of carbon/carbon composite [2], high temperature ceramic matrix composite, and ceramic thermal barrier coating [3], is conducted.

2.2 Combustion technology

The burning velocity of hydrogen-oxygen-steam mixture is investigated as basic data for a future electric power plant with a hydrogen combustion turbine [4]. To develop a new ignition method, a series of experiments about the ignition process of H_2-O_2-O_3 mixture with an excimer laser were carried out [5]. The photographs in Fig. 3 show the plane ignition process observed with a high-speed framing camera. The flat part of mixture irradiated with the laser sheet ignited simultaneously.

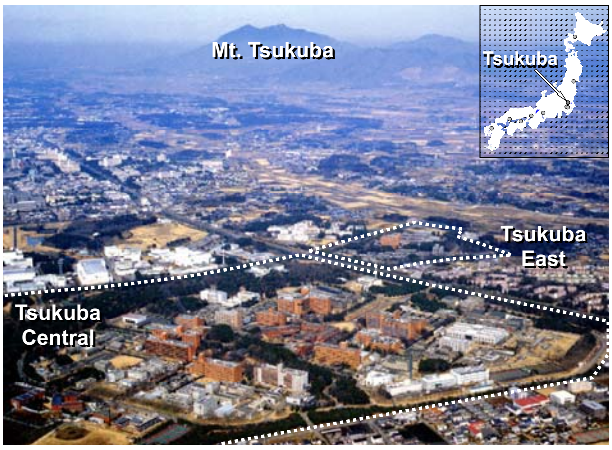

Figure 1 AIST Tsukuba Center

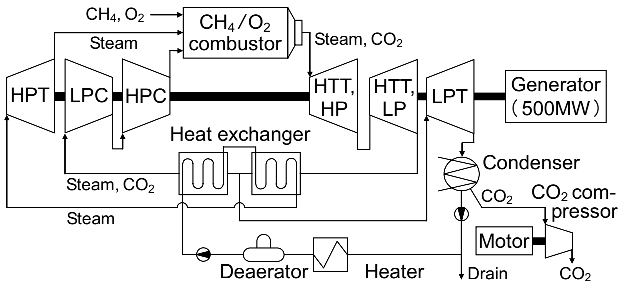

Figure 2 CO_2 recovering closed gas turbine system

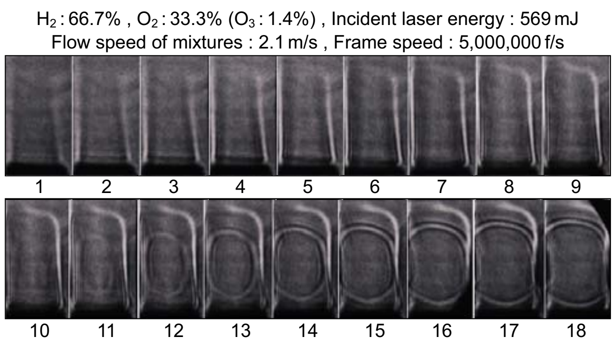

Figure 3 Ignition process of flat ignition with KrF laser

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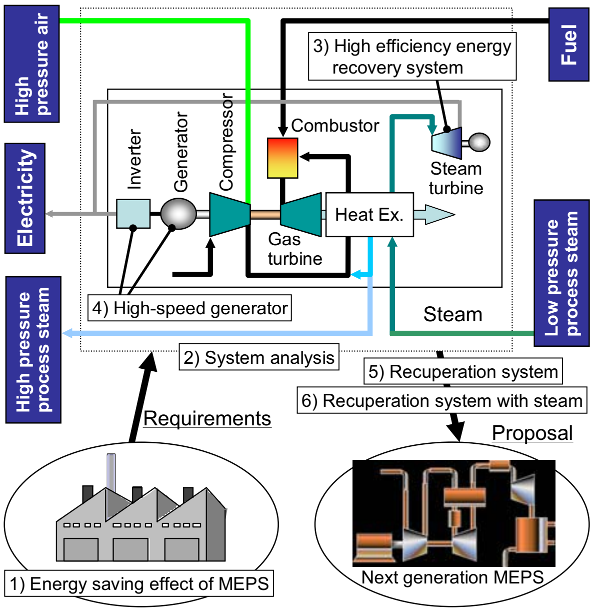

Figure 4 Multi energy production system (MEPS)

2.3 Multi energy production system

With the aim of contribution to energy saving in the industrial and commercial sectors, the first generation flexible turbine system (which is called MEPS, Multi Energy Production System) shown in Fig. 4 has been proposed [6]. This system has features; that the ration of output heat and electricity could be variable, and that low quality thermal energy such as surplus steam and high or middle temperature gas exhausted from industrial process could be efficiently converted to high quality energy such as electricity.

2.4 Micro gas turbine

The application of ceramic materials to small gas turbines is expected to achieve higher thermal efficiency, because the ceramics is well known to have higher heat-resisting properties than usual metals. However, they are brittle to impact forces. Therefore, the impact tests of foreign object damages (FOD) of ceramic turbine blade were carried out [7]. Figure 5 shows the new particle impact system (the ET gun), the ceramic blade, and the damaged blade.

Moreover, the boundary layer on the turbine blade of small gas turbines is dominated by laminar flow and is susceptible to flow separation, which accomplished by increased loss and reduced performance, due to the reduced Reynolds number of the fluid flow. The unsteady flow measurements of a turbine at low Reynolds numbers are experimentally investigated

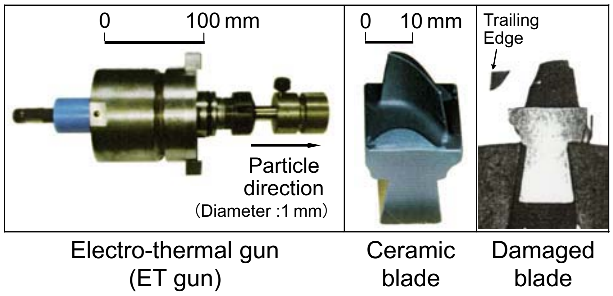

Figure 5 Foreign object damage (FOD) of ceramic turbine blade

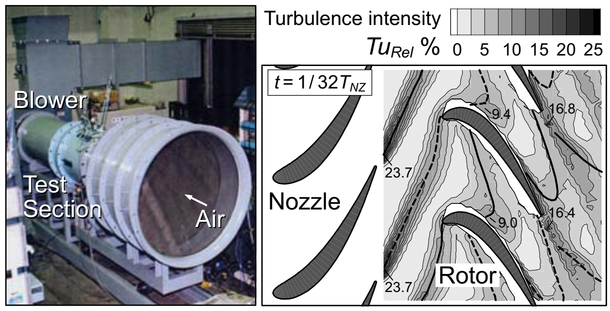

Figure 6 Aerodynamic characteristics of an axial-flow turbine at low Reynolds numbers

using a laser Doppler velocimetry system (Fig. 6) [8].

3. Summary

The research activities on gas turbine in the National Institute of Advanced Industrial Science and Technology (AIST) were briefly introduced in this paper. The details are given in the following references.

References

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