

Development of high-accuracy large-scale CFD analysis of unsteady fluid forces on turbine blades

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Abstract

World's power generation systems that use steam turbines produce more than half of the world's electricity. By 2035, the worldwide generation of electricity is projected to increase about 180 % of the current demand. Consequently, in order to supply the necessary electricity while curbing and reducing global greenhouse gas emissions, the focus should be on the development and practical realization of efficiency enhancement technologies for steam turbines used in power generation.

The aim of the project is to increase steam turbine efficiency with the development and introduction of high-accuracy large-scale CFD analysis of unsteady aerodynamic forces on turbine blades.

Main components of steam turbines are turbine stages that consist with stator blades and rotor blades. Aerodynamic optimum designs of stator blades are already introduced in many designs of actual operating commercial steam turbine units. However, aerodynamic optimum designs of rotor blades are still difficult due to high centrifugal force and vibration stress on rotor blades. The current project focuses on rotor blades and exhaust diffusers that affect the flow field just downstream of last stage long blades.

The high-accuracy large-scale CFD analysis of unsteady aerodynamic forces of turbine blades has been successfully introduced using the Earth Simulator of Japan Agency for Marine-Earth Science and Technology. This analysis has been also introduced for simulations of low pressure exhaust diffusers and has been proved with the measured data in an actual operating steam turbine.

Keywords: large-scale simulation, steam turbine, power generation, efficiency, blade, unsteady aerodynamic force