Energy Engineering Research Laboratory

Brief Overview

Providing innovative fundamental technologies to the electric industry and the society, the Energy Engineering Research Laboratory (EERL) is engaged in the creation of highly efficient, clean and low cost electric energy supply/demand systems, which lead to the renewable and energy secured society.

Achievements by Research Theme

High Efficiency Power Generation

【Objectives】

The evaluation and maintenance technology for the hot gas path parts of gas turbines and combustion technology for new type liquid fuels will be developed to advance the further efficiency increase and improvement of operability of thermal power plants.

【Principal Results】

- For developing a highly efficient cooling technique for gas turbine blades, effects of internal ribs of first stage blade on external film cooling effectiveness were experimentally investigated using a scaled up test rig. From computational simulations, essential mechanisms for improvement of film effectiveness by the rib geometry were clarified [M10010].
- LCO (Light Cycle Oil) is produced as a by-product of petroleum refinery, and one of the surplus energy resources. Atomization and atmospheric combustion test of LCO were conducted. The test results showed that LCO will be promising for a non-conventional and alternative resource for gas turbine fuel, although there are some problems such as reducing soot formation [M10011].

Advanced Fuel Utilization

【Objectives】

For the diversification of energy resources and improvement of environmental friendliness of coal fired power plants, diverse fuel types and measurement methods for trace elements are under development. The catalytic decomposition of volatile organic compounds (VOC) is also studied aiming at extension of its application and verification for practical use.

【Principal Results】

- Using dimethyl ether (DME) as an extractant, bio-oil was directly extracted from high-moisture microalgae at considerable extraction rate.
- For the measurement of gaseous selenium in combustion flue gases, the mechanism of selenium loss during sampling was clarified and a reliable sampling method was developed.
- In collaboration with a manufacturer, a ceria catalyst VOC decomposition technology was applied to field deodorization tests at demonstration scale to verify its performance and characteristics.

Heat Pump and Thermal Storage

【Objectives】

As for heat pump and thermal storage technology, research and analysis will be conducted for responding appropriately to the needs of electric power industry.

【Principal Results】

- We conducted a survey of the latest development trends of stationary heat pump using low-GWP (Global

Warming Potential) refrigerants. At the moment, there is no refrigerant that satisfies all needs for low GWP, non-flammability and high cooling capacity.

・Cooperating with the development of a large capacity chiller using water as a refrigerant conducted by the maker and the electric power companies, we contributed to its commercialization.

Energy Conversion Engineering

【Objectives】

System analysis for energy/CO_2 saving system and extremely high efficiency power generation system, and the innovative technology development relating to fuel cells, etc. will be performed.

【Principal Results】

・Basic evaluation program was developed and its usefulness for energy and CO_2 saving in several kinds of energy system on demand side was verified [M10009].

・The performance of Advanced Humid Air Turbine (AHAT) system was evaluated and development issues for several hundred MW class were clarified., based on the operation results of the 3MW verification plant and the system analysis with “EnergyWin” [M10004].

・Gas clean-up and tar cracking basic technology with molten salt for biomass gasification gas [M100006],a new proton conducting thin layer electrolyte for medium temperature fuel cell [M10007] and quantitative analysis method on the acceleration tests for Polymer Electrolyte Fuel Cell (PEFC) lifetime evaluation [M10018] were developed.

Numerical Analysis of Turbulent Heat Transfer and Reacting Flows

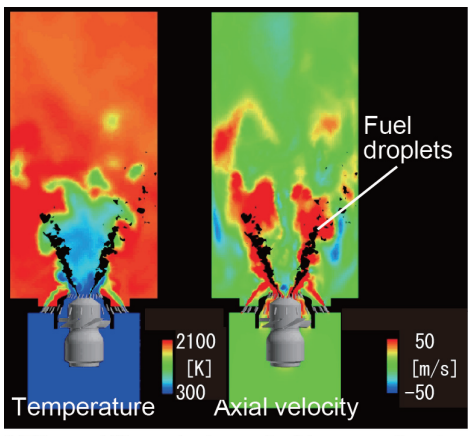
【Objectives】

We aim to establish a comprehensive numerical simulation technology for thermal power generation plants to logically and efficiently evaluate and optimize their high-temperature equipments, e.g., pulverized coal combustion boilers, gasifiers and gas turbines by integrating and enhancing computational fluid dynamics of thermal and reacting fluid flows.

【Principal Results】

・To enhance the evaluation technique of three-dimensional temperature distribution on gas turbine blade surfaces, the convective heat transfer model which was developed in 2009 was modified in order to take effects of roughness on gas turbine blade surfaces into account.

・A turbulent combustion model which can be appropriately applied to multiphase turbulent combustion fields was developed and introduced into the comprehensive and high-accurate large-eddy simulation code. The model was validated on the half-scaled practical gas turbine combustor (Fig. 1).



LES on 1/2-scaled gas turbine combustor

Fig. 1　Highly accurate large-eddy simulation of multiphase combustion