Energy Engineering Research Laboratory

Brief Overview

One of the principal aims of the Energy Engineering Research Laboratory is the firm establishment of energy security through the supply of innovative fundamental technologies for the energy industry and society. The EERL also aims at creating new highly efficient, clean and low cost power and energy supply and demand systems and also at assisting the transition to a recycling-oriented society.

Achievements by Research Theme

Operation and Maintenance Technology for Thermal Power Generation

[Objectives]

To understand the basic combustion characteristics of alternative or new types of liquid fuels and to develop a reliability assessment tool for the equipment used in a high temperature environment at existing thermal power plants for the purpose of advancing operation and maintenance technologies for thermal power generation; to develop an innovative numerical simulator for thermal power generation equipment.

[Principal Results]

- Using a small burner, the combustion performance of modified oil from oil sand which is a new type of liquid fuel (Table 4) was clarified as a step for the assessment of its adaptability to gas turbines. [M08014]
- For the purpose of developing a numerical simulator for thermal power generation equipment, a gas-phase reaction model was developed for the simulation of the reacting flow with phase changes. The effectiveness of this model was confirmed through comparison with existing verified data.

Fuel Reforming and Environmental Protection Technology

[Objectives]

To develop base technologies relating to the reforming of low grade fuels, utilisation of coal ash and decomposition of volatile trace substances for the purpose of contributing to the diversification of fuel and environmental protection.

[Principal Results]

- Research efforts were made to expand the application scope of dehydration and de-oiling technologies using liquefied DME and it was discovered that the moisture in low grade coal with a high moisture level can be reduced to the level of bituminous coal and that the hypergolicity was reduced for dehydrated coal.
- It was discovered that a volatile organic compound (VOC) decomposing system using ceria as the catalyst has a high deodorisation performance level and joint research commenced to develop a practical system.

High Efficiency Energy Conversion Technology

[Objectives]

To conduct the research and assessment of fuel cell technologies, clean fuel technologies, heat transfer technologies for the refrigerant for heat pumps, heat storage technologies and various energy systems with a view to contributing to the development of highly efficient energy conversion technologies in the future.

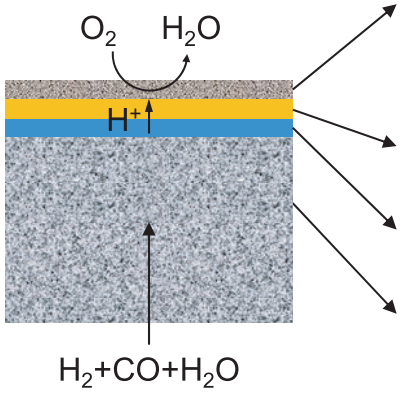
[Principal Results]

- A new method was developed to assess the performance of polymer electrolyte fuel cell (PEFC) and the deterioration mechanism, including factors accelerating deterioration, was further investigated.
- Research on the highly efficient utilisation of energy in the future progressed. The relevant work included study of the temperature dependence of fuel cells and estimation of the power generation efficiency of a fuel cell systems [M08021], feasibility assessment of the middle temperature operation type of fuel cell with a proton conductor (Fig. 1) [M08023], evaluation of the basic heat transfer performance of CO_2 refrigerant to improve the heat pump efficiency and evaluation of the performance of an AHAT (advanced humid air turbine) system.

Table 1 Summary of Fuel Analyses

			Oil_Sand Refined(Light) :OSA(NC)	Oil_Sand Refined(Light) :OSA	Oil_Sand Refined(Midium)	Oil_Sand Diluted Bitumen	NO.2 Diesel Oil
Density	@30℃	g/cm^3	0.8952	0.8496	0.8847	0.9193	0.8252
Kinematic Viscosity	@30℃	mm^2/s	16.77	4.24	11.29	71.4	3.292
	@50℃	mm^2/s	8.20	3.10	6.09	28.7	
	@75℃	mm^2/s	4.26	1.86	3.62	13.4	
Higher Heating Value		J/g	45,270	45,160	45,230	43,520	45,990
Lower Heating Value		J/g	42,660	42,450	42,400	41,110	43,100
Flash Point		℃	116.0	< 20	Lower than R.T.	Lower than R.T.	62.5
C/H Ratio			7.122	6.736	7.000	7.296	6.400
Nitrogen Content		ppmw	630	530	720	2700	5
Sulfur Content		ppmw	2,100	1,700	2,300	39,900	6

- Refined oil sand OSA, which has a feature of less sulfur content and suitable kinematics viscosity, is considered one of the most promising fuel for the gas turbine.
- A naphtha fraction removed OSA is used as a specimen fuel for more safety and easier handling.



Porous intermediate active cathode

- Cathode is baked at low temperature in the last step because this material has the lowest allowable temperature limit.

$BaCeO_3$ thin electrolyte film

- Studied this time
- Film must be formed on Pd.

Metal Pd thin film

- Pd film can be formed by existing technology.

Porous support substrate: ex. Al_2O_3, etc.

- Substrate maintains cell strength and diffusion zone for reformed fuel gas.

Fig.1 Basic structure of the intermediate temperature-type fuel cell using proton conducting electrolyte

New processing method of proton conducting electrolyte ($BaCeO_3$) thin film on the metal Pd was developed for establishing above basic structure of the intermediate temperature-type fuel cell.