Environmental and Innovative Technologies
− Sustainable Use of Fossil Fuels and New Energy −

Brief Overview

To contribute to mitigation of climate change, we promoted researches of global warming projection, effective utilization of biomass energy, and high efficiency thermal power generating technology.

For global warming projection, we introduced a carbon cycle model into the global climate model to investigate future changes of CO_2 absorption in marine and land ecosystem. We also developed a simplified climate system model for easy study of climate change at various CO_2 emission scenarios.

For utilization of biomass energy, we developed a supporting tool available for assessment of business profitability from fuel production to power generation to clarify spontaneous heating mechanism during biomass storage.

For high accuracy prediction of thermal hydraulics phenomenon inside the gasifier which is important to establish high efficiency and stable operation of the Integrated coal Gasification Combined Cycle (IGCC), we verified adaptability of numerical simulation method developed by CRIEPI by comparing with experimental data to sample coal for the demonstration plant.

Achievements by Research Theme

Global warming mitigation research

●Projection and adaptation of global warming
- Introduced the carbon cycle model into the global climate model, and developed a simplified climate system model to investigate relationship between CO_2 concentration and climate changes. [V08022]
- Constructed a statistical prediction method of atmospheric temperature, precipitation, and frequency of heavy rain at various regions in Japan using seasonal weather forecasting results and re-analysis data. [V08037; V08057]

○CO_2 underground storage
- Proposed the assessment method for possibility and possible quantity of ground storage at geological structures much located near CO_2 mass emission source in Japan. [N07]
- Confirmed adaptability of analysis method developed by CRIEPI on CO_2 ground transfer behavior by simulation analysis to injection tests of CO_2 gas into in-situ fracture system rocks. [N08037]

●High efficiency utilization of biomass energy
- Developed support tools to assess profitability in various projects from fuel production of biomass to power generation. [Y08032]
- Clarified spontaneous heating mechanism during biomass storage contributing to safe management guides for solid fuel storage such as biomass at power plants. [M08022]
- Clarified the fact that much existing process residuary biomass (squeezed oil residuum of palm and jatropha, etc.) has promise as gasified fuel. [M08018]

Innovative environment technology

○Innovative environment measurement
- Commercialized film type PCB biosensor to apply for contamination screening. [V08053]
- Developed an easy and low cost biological analysis kit for cadmium and lead in the soil. [V08007]

○Coal ash environment countermeasures
- Presented the empirical result that cement if added to landfill ash at low compounding ratio can be used as light civil engineering material, which is effective for leaching countermeasure of trace elements. [V08031]
- Demonstrated usability of soil cleaning material, developed using desulfurization gypsum and sewage sludge as main materials, in actual contaminated soil. [V08015]

Next generation thermal power plant technology

○Integrated operation and evaluation system for pulverized coal combustion power generation
- Invented the ash properties estimation method to introduce into coal adaptability assessment method for power generation.
- Clarified corrosion speed and influence factors under high corrosive environment for sulfidation corrosion.

○Coal gasifier
- In comparison with experimental results, we verified validity of numerical simulation results on thermal hydraulics phenomena in gasifier to sample coal for IGCC demonstration plant.
- Clarified influence of oxygen concentration in gasifying agent to gasification performance using 3 ton/day coal gasifier. [M08019]
- As a result of trial calculation of production cost of super-light weight slag foam, we presented its superiority to market price of expanded obsidian. [M08016]

○Trace element control
- Constructed optimum sampling method of gaseous boron and selenium in exhaust gas and proposed gaseous boron measurement method for ISO standardization. [NEDO Mid-Term Report FY 2008]

○Low cost MCFC power generating system
- Developed 1 kW class MCFC stack with low cost materials to evaluate its output performance and behavior as a power generation system. [M09001]

○Next generation IGCC system with CO_2 capture
- Proposal of gasification reaction rate formula under high CO_2 concentration at high temperature and high pressure and clarification of the effect of CO_2 partial pressure to gasification reaction.
- Evaluation of desulfurization performance of zinc ferrite desulfurization sorbent at high CO partial pressure condition.
- Investigation of the improving effect (about 2% up for the fundamental system: absolute value) for the gross thermal efficiency by optimizing the system and operating conditions of combined cycle power block. [M08006]

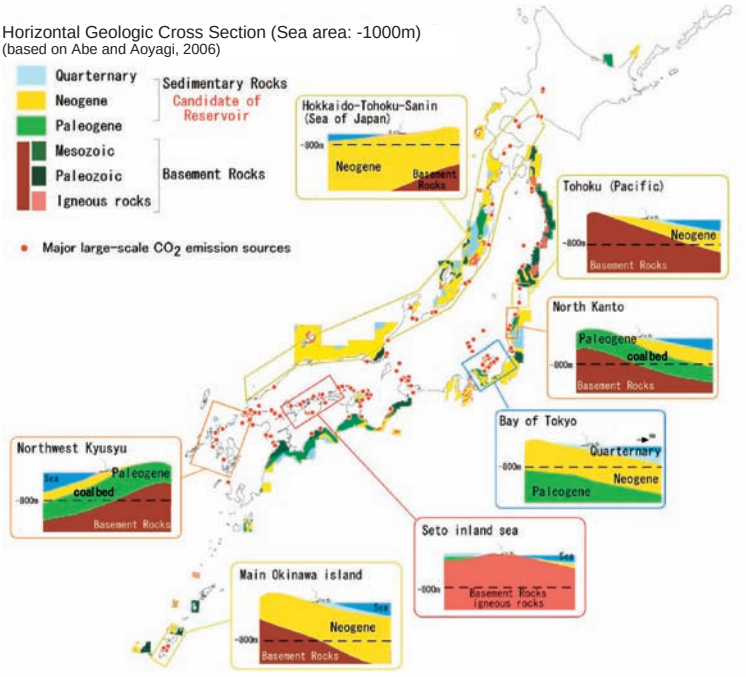


Fig.1 Distributions of large-scale CO_2 emission sources, horizontal geologic cross section of -1000m in the sea area, and schematic geological sections of coastal area. It is thought that the aquifer which inclined generously is widely distributed over the coastal area.

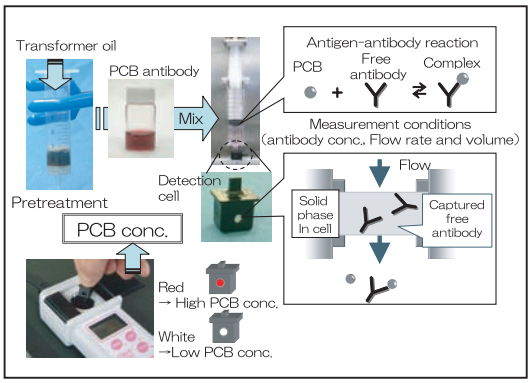
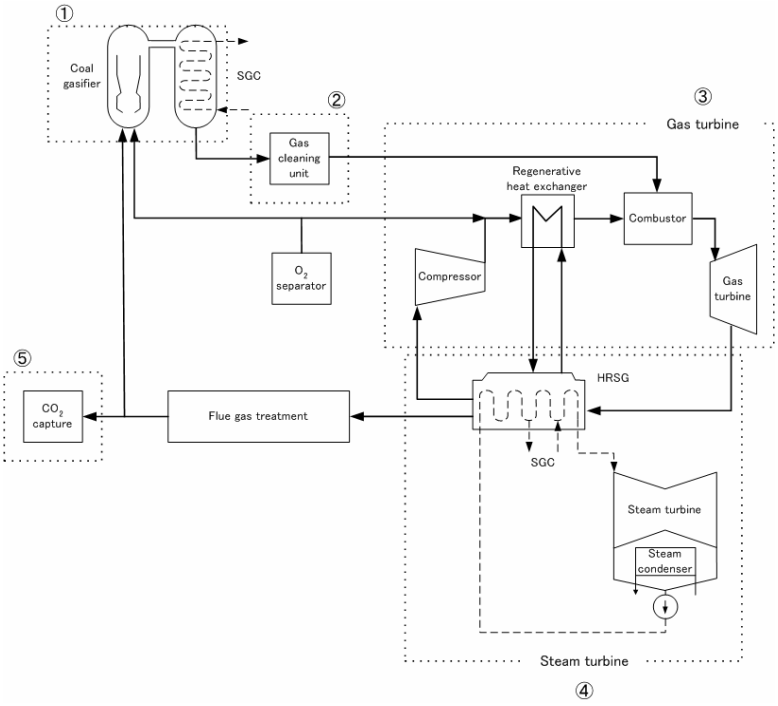


Fig.2 Measurement procedure of PCB biosensor



Advantages of the system

Gasifier

Gasification performance is improved by installation of O_2-CO_2 blown gasifier (①).

Gas Cleanup Unit

Heat loss in hot gas cleanup unit (②) is very small compared with wet gas cleanup unit.

Combined Cycle System

Thermal efficiency of combined cycle part is improved by installation of 1300degC-class regenerative gas turbine system (③) and triple-pressure steam turbine system (④).

CO_2 Capture Unit (⑤)

CO_2 separation and recovery unit becomes unnecessary.

These advantages lead to higher efficiency of our proposed system.

Fig.3 Process of proposed IGCC system with CO_2 capture