TSUTSUMI LAB.

[Innovative Energy Efficient Utilization Technology]

Exergy Recuperation & Co-production

Collaborative Research Center for Energy Engineering

Dept. of Mechanical and Biofunctional Systems

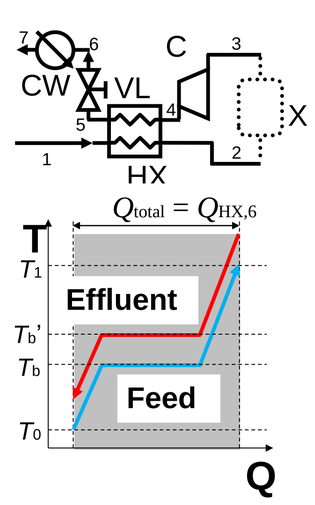
http://www.energy.iis.u-tokyo.ac.jp/tsutsumi/

Energy Process Engineering

Department of Mechanical Engineering

Energy and Material Co-production Systems for Minimizing the Exergy Loss and CO_2 Emission

We have proposed “co-production of energy and materials” and “self-heat recuperation” processes to minimize exergy loss in energy and material production systems. By applying “self-heat recuperation technology” to several separation and chemical processes, we found that energy consumption can be drastically reduced. In addition, a novel process synthesis methodology “process module architecture” was developed instead of the conventional “unit operation” to reconstruct and optimize the present industrial processes.

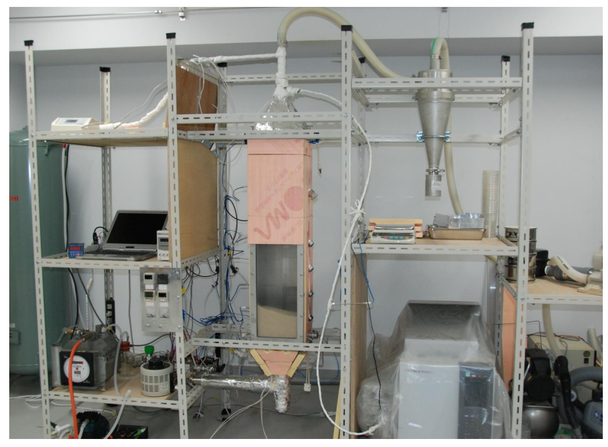


Self-heat recuperation（left）, Pilot distillation process（right）

Nippon Steel Engineering
Kitakyushu Environmental Technology Center

Energy-Efficient Biomass Drying Process based on Self-Heat Recuperation Technology

Biomass contains a large amount of moisture which deteriorates the heating value of biomass. Conventional biomass drying technologies require a large amount of energy, especially oil. Thus, an innovative biomass drying process by using self-heat recuperation technology is proposed and developed. The heat from biomass is recuperated and circulated in the system to reduce the energy consumption of the system.



Fluidized bed dryer

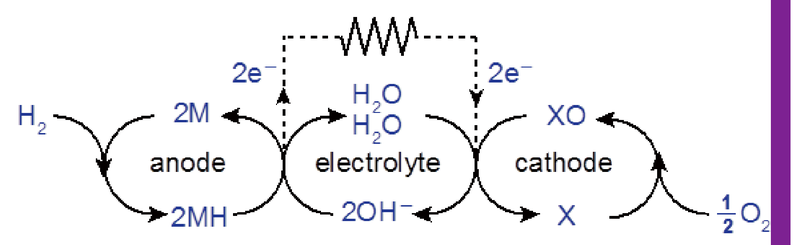
Advanced-Integrated coal Gasification Combined Cycle/Integrated coal Gasification Fuel Cell Combined Cycle with Exergy Recuperation

Advanced Integrated Coal Gasification Combined Cycle (A-IGCC) and Integrated Coal Gasification Fuel Cell Combined Cycle (A-IGFC) is proposed to make a highly efficient power generation system by exergy recuperation. In this power generation system, coal gasification is carried at low temperatures and the heat required in the gasification is provided by the steam from exhausted heat of a high temperature gas turbine or a fuel cell. To complete these cycles, 1) an integration methodology of gasification furnace and gas turbine 2) a flux and density solids circulation system in cold model are investigated.

Large scale circulating fluidized bed cold model in Chiba Experimental Station (h: 16 m, d: 0.10 m)

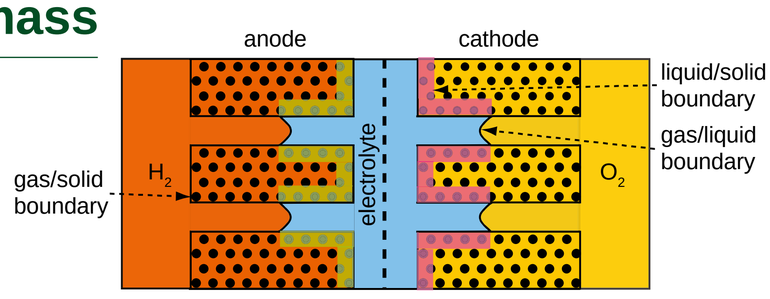
Novel Type of Electrochemical Energy Production/Storage System

We have developed a Fuel Cell/Battery (FCB) system by a hybridization of secondary batteries with fuel cells. This FCB system can function as both fuel cell and secondary battery such that electric power is produced as in a secondary battery when the cells are fully charged. Furthermore, it can also produce electric power by consuming hydrogen and oxygen in a similar way to a fuel cell system when it is completely discharged. This system has several advantages such as 1) improved energy density per weight and 2) flexible response to load change.



Hydrogen Production by Energy Recuperative Gasification of Biomass

We proposed an energy recuperation technology. The system design of energy-recuperative biomass gasification process was conducted based on the integration of energy recuperation for high efficiency co-production of power and hydrogen. We have investigated the reaction mechanisms of biomass in steam gasification and a novel gasifer.



Schematic image of Fuel Cell/Battery System