Development of New Energy Technology for Improving the Environment

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Recently, global warming caused by carbon dioxide (CO_2) emissions have become more evident. To reduce CO_2 accumulation in the atmosphere, energy decarbonization (i.e., reduced hydrocarbon use), saving energy, and effective use of renewable resources, such as biomass (i.e., scrap wood etc,), must be studied. Our laboratory has diligently developed CO_2-free combustion technology (Figure 1), technology to use wastes effectively, technology to use biomass not suitable for food as fuel (Figure 2), CO_2 immobilization technology (CCS), and lean-burn technology for energy saving (Figure 3).

Keywords: Global warming prevention, advanced combustion technology, energy saving, thermal fluid engineering

(1) Development of combustion technology to eliminate CO_2 emissions (design of a burner to simultaneously achieve high intensity combustion and NOx reduction

Ammonia is considered ideal combustion fuel that does not emit greenhouse gases, such as CO_2. However, the burning velocity of ammonia is below 0.06 m/s, which is much lower than that of conventional hydrocarbon fuels (oil-based fuels), making it difficult to achieve stable combustion of ammonia. If ammonia is forcibly combusted, a large amount of NOx (toxic substance) will be generated. This study aims to develop a turbulent burner that can simultaneously achieve stable combustion and NOx reduction, and size of the heat exchangers can be minimized.

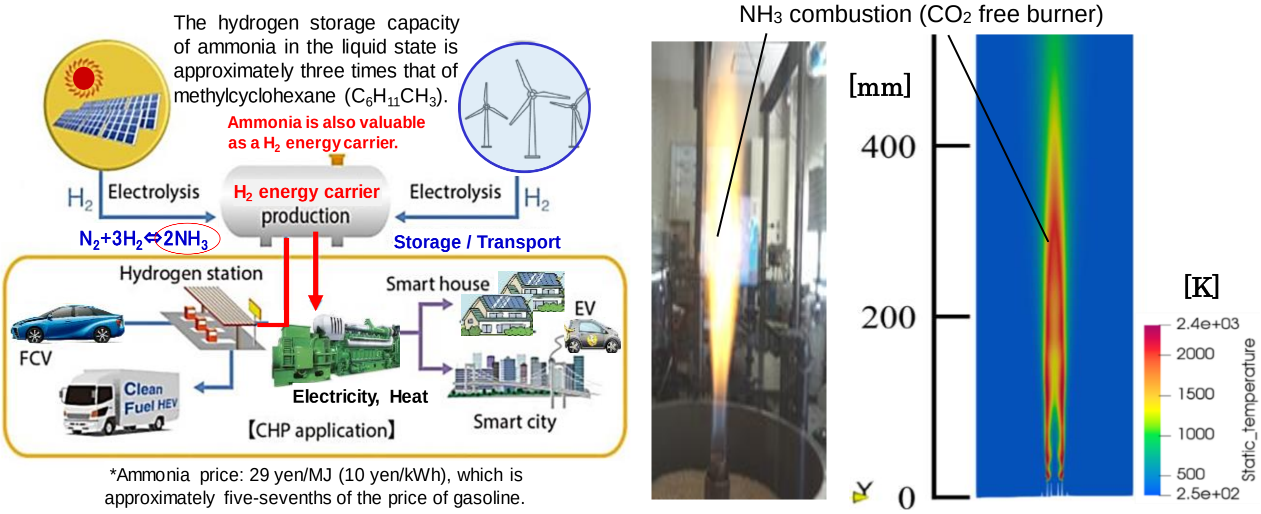

Figure 1 Design and development of an ammonia burner [thermo-hydrodynamic analysis using a supercomputer].

(2) Effective use of renewable biomass resources and development of energy-saving technology

Applicable fields: Gas engines; waste disposal; high-efficiency and energy-saving technology

Wastes/unused biomass resources should be efficiently used. To develop next-generation gasification technology, biomass must be rapidly gasified at approximately 600 ℃ or lower. However, it is difficult to achieve "low temperature" and "rapid gasification" simultaneously, as they are mutually exclusive. In general gasification apparatus, biomass is gasified in the form of partial combustion at high-temperature (1000–1200 ℃). Our laboratory has successfully developed rapid gasification technology, which works at approximately 700 ℃ using a catalyst (gasification rate constant, K_p = 0.1/min). In addition, energy saving can be attained by developing super-lean burn technology, and high-efficiency gas engines can be developed.

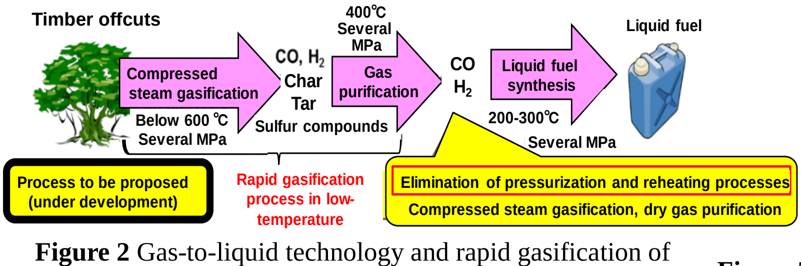

Figure 2 Gas-to-liquid technology and rapid gasification of unused biomass in low-temperature process.

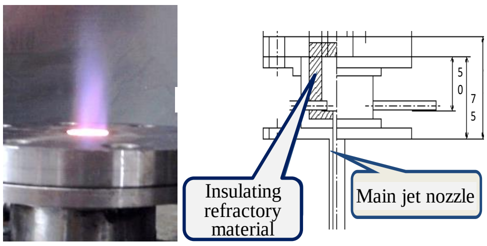

Figure 3 Super-lean burn technology for energy saving.