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, saving energy, reduced hydrocarbon use, carbon-free 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 burner (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 single NH_3 firing for carbon-free technology (Figure 3).

Keywords: Advanced combustion technology, Thermal-fluid engineering, Heat and mass transfer

(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.

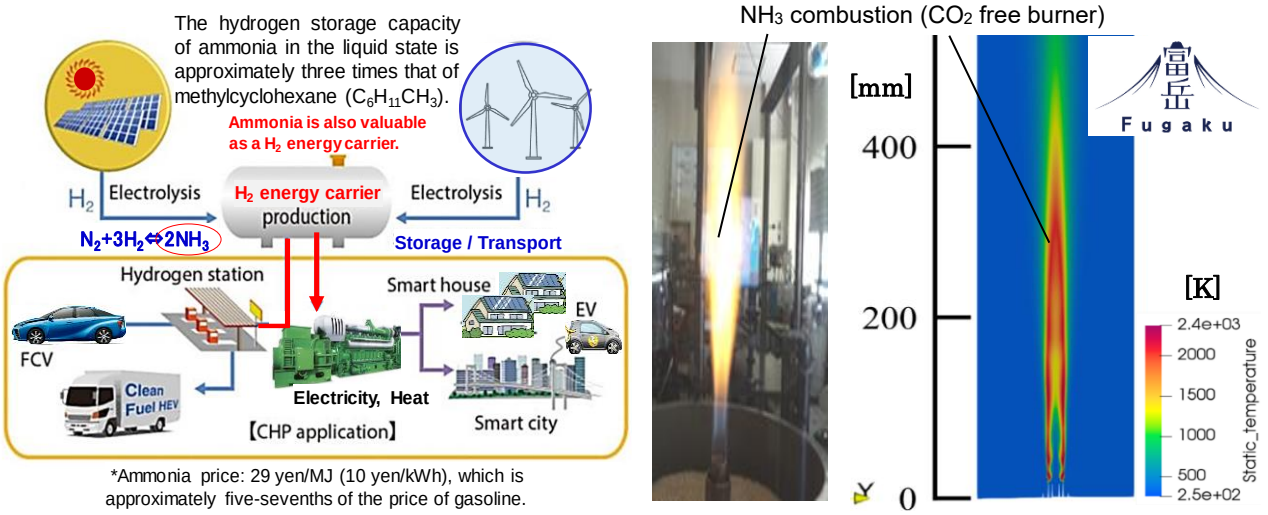

Figure 1 Design and development of an ammonia burner [Thermo-hydrodynamic simulation using a supercomputer].

(2) Effective use of renewable biomass resources and development of gas engine

Applicable fields: Gas engines; Waste disposal; Energy conversion technology; Carbon-free energy

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) and high-efficiency gas engines can be developed. In addition, single NH_3 firing have been attained by special design. (Figure 3)

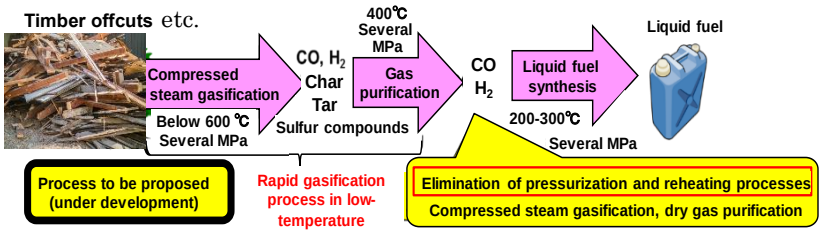

Figure 2 Gas-to-liquid technology and rapid gasification of unused biomass in low-temperature process.

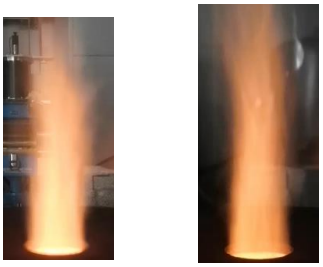

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Figure 3 Single NH_3 firing for carbon-free technology.