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Professor Sanggyu Kang's research team found an optimal system for cascade solid oxide fuel cells

□ GIST (Gwangju Institute of Science and Technology) School of Mechanical Engineering Professor Sanggyu Kang's research team developed a cascade solid oxide fuel cell system with high system electrical efficiency and investigated the effects of current density, external reforming rate, and steam/carbon ratio, which are the main operating conditions, on the electrical efficiency of stacks and systems.

* cascade solid oxide fuel cell system: By connecting two solid oxide fuel cell stacks in series, the unreacted fuel in the first stack is used as the fuel in the second stack to maximize the system fuel utilization rate.

□ The solid oxide fuel cell system is attracting attention as a fuel cell system for power generation because it has advantages such as high system electrical efficiency and waste heat utilization compared to other fuel cells.

◦ To increase the electrical efficiency of the system, it is necessary to increase the fuel utilization rate of the stack, but there is a limit due to the durability problem of the core material. Although an anode recirculation solid oxide fuel cell system* has been developed to increase the system fuel utilization

rate, the blower or ejector** used to implement it causes an increase in the cost of the system, delaying the commercialization of the fuel cell system.

* anode off-gas recirculation solid oxide fuel cell system: A fuel cell system with improved system fuel utilization and system electrical efficiency by recycling some of the unreacted fuel in the stack and using it again as fuel.

** ejector: As a type of pump, a mechanical device that sucks and transports suction fluid using the pressure energy of high-pressure fluid.

□ To quantitatively compare and analyze the superiority of cascade fuel cell systems, the research team developed a numerical analysis-based single-stage system, anode exhaust gas recirculation system, and thermodynamic model of the cascade system. The electrical efficiency of each system according to the change in density, external reforming rate, and steam/carbon ratio was identified.

◦ As a result, under the operating conditions of current density of 100 mA/cm^2, external reforming rate of 50%, and steam/carbon ratio of 2.5, the electrical efficiency of the cascade solid oxide fuel cell system was 66.97%, which was higher than other system configurations. This result was analyzed as the effect of maximizing the system fuel utilization that can be achieved with the cascade system configuration. Under the same conditions, the anode exhaust gas recirculation system showed the second highest electrical efficiency at 65.84%.

□ Professor Sanggyu Kang said, "This research result has the greatest significance in that it can achieve maximization of the efficiency of the solid oxide fuel cell system and can contribute to the distribution of fuel cells in Korea according to the domestic hydrogen economy revitalization policy to take the lead in achieving the 2050 carbon neutrality goal by conducting additional research that can maximize the power generation efficiency of the cascade solid oxide fuel cell system in the future."

□ This research was led by GIST Professor Sanggyu Kang and conducted by master's students Donghwan Shin and Taebeen Kim with support from the National Research Foundation of Korea's 'Technology Development Program to

Solve Climate Changes' and was published online on June 12, 2021, in *Applied Thermal Engineering*, an international academic journal with global authority in the field of energy and thermal management.

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