Distributed Generation and Fuel Cells

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The use of fuel cells for on-site power production should decrease environmental loads and primary energy consumption since fuel cells are clean, quiet, and efficient. However, fuel reforming units, which supply hydrogen-rich gas to fuel cells, are comparatively inefficient for partial load power and, therefore, lower the overall efficiency of the power system. In addition, the units perform poorly in following fluctuating power loads.

Consequently, we are investigating the effectiveness of relatively small energy buffers in improving the overall efficiency and load-following capability of stand-alone power generators. We are focusing on a metal hydride intermediate-buffer method that is a much simpler way of refining hydrogen from reformed gas than conventional methods employing pressure swing adsorption or membrane separation. This buffer method provides a storage capability, allowing immediate power generation by using previously charged hydrogen and, therefore, circumventing the necessity of waiting for reformers to warm up.

In addition, we have proposed and are studying the optimization of local energy networks that employ fuel cells, emphasizing effective utilization of thermal output, load leveling, and the introduction of renewable energy systems. To achieve effective and efficient distributed power generation, the power generators need to perform in general somewhat independently of the power grid but still be capable of quickly utilizing the grid to both acquire and supply emergency power. Therefore, the emphasis is on improving the electrical efficiency of the distributed power generators during partial loading and on improving the flexibility of the system to accommodate changing loads rather than increasing the rated power of the individual generators.

Keywords:

Cogeneration: Combining the generation of electric power with the simultaneous utilization of heat to reduce the overall emission of CO_2.

PEFC: A type of fuel cell with a polymer electrolyte membrane operating at a low temperature (less than 100 degrees Celsius), allowing faster start-ups and immediate responses to changes in demand for power. In addition, it is essentially maintenance-free because no liquid electrolyte is used.

Reforming process: Steam reforming is the most commonly used method for producing hydrogen-rich gas to operate fuel cells from hydrocarbon-based fuels supplied by a supporting infrastructure. This process is not highly flexible with regard to load changes and has more heat loss for partial loads than for full loads due to the high temperature of the chemical reactions.

Metal hydride: Metal hydrides are chemical compounds formed when hydrogen gas reacts with metals. Metal hydrides are certainly the safest way to store flammable hydrogen gas and are also useful for compressing and purifying hydrogen.