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Reference: Fuel Cell
Controls



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Control System for Improved Efficiency of PEM Fuel Cells

Auburn University is seeking a licensee or development partner for a control system that improves the efficiency and reduces the size of fuel cell systems.

Overview: Fuel cells are highly reliable alternate energy sources that can be used in mobile or remote locations such as automobiles, ships and farms, as well as for on-grid applications. This highly sensitive control system has the potential to improve the overall efficiency of fuel cells and provide safer and more reliable operations. This technology has potential applications in the following economic sectors: Automotive industry, other transportation areas including marine and space, as well as heat and power generators for commercial, residential or utility (back-up) use.

Advantages:

- **EFFICIENT** — Increases overall efficiency by improving fuel cell performance; reduces total power consumption in components (7%) accomplished by controlling air blower (2%) and bypass valve (5%)
- **RELIABLE** — Improves temperature and heat management, increasing safety, reliability
- **SMALLER** — Reduces size of fuel cell system, potentially lowering costs and improving portability
- **IMPROVED SENSITIVITY** — Provides an improved dynamic response to sudden load changes, improving sensitivity

Description: A proton exchange membrane (PEM) fuel cell is an electrochemical device that produces “clean” electricity from a chemical reaction between hydrogen and oxygen, with only water and heat as byproducts. Mismanagement of the heat generated in the cells drops performance and jeopardizes reliable and safe operations.

In a classic system, the coolant controls for a PEM fuel cell stack use a feedback system that is based on the actual temperature value measured at the outlet of the coolant channel. This is known as a “bang-bang” or proportional-integral (PI) controller. However, such controls cannot completely reject the heat generated. The Auburn control system employs an extra three-way valve and control strategies based on state feedback controls. These controls follow variations in the current load and can effectively reject the generated heat.

Simulations show that this invention suppresses temperature rise in the stack at sudden high load by achieving three-times faster recovery time and four-times faster supply of coolant than that attainable through existing classic PI controls. As a result, the ideal oxygen excess ratio using better feedback control was sustained at a set value, and the volume of certain thermal management components (such as heat exchangers) can be reduced.

Status:

- U.S. Patent [8,691,456](#) and South Korean Patent 10-0911591
- A dynamic model that includes stack and components has been verified via simulation
- This technology was co-invented and is co-owned with Hyundai Motor Company
- This technology is available for exclusive or non-exclusive licensing
- Further development opportunity areas include controls, real time dynamic models, Hardware-in-the-Loop simulations, and advanced testing (diagnostics and prognostics)