UQTR-040 REAL TIME ADAPTIVE EFFICIENT COLD START METHOD FOR PEMFC FUEL CELLS

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BACKGROUND

The proton exchange membrane fuel cell (PEMFC) is widely regarded as a potential power source for mobile and portable applications owing to its noteworthy features of high efficiency, quick response and zero emission. PEMFCs have reached the commercialization stage due to an impressive worldwide R&D effort. However, further improvements are needed to overcome barriers related to durability, costs, and cold starts. Among these barriers, the cold start is of critical importance for optimal PEMFC performance and durability. The water produced at the cathode through the electrochemical reaction could freeze and lead to ice formation under subfreezing temperatures. The formed ice can prevent the migration of oxygen, increase membrane resistance and decrease the cathodic oxidation reaction. These phenomena cause a significant voltage drop resulting in cold start failure.

TECHNOLOGY

The current invention is based on an adaptive cold start strategy focused on reducing energy requirements and optimizing start-up time by reducing the degradation of the PEMFC. It avoids adding external heating devices by using heat released by the exothermic reaction to warm up the PEMFC. The proposed strategy controls the PEMFC parameters in real time in order to maximize heat flux in the stack depending on the state of the PEMFC. In addition, this strategy avoids complex modeling of PEMFCs and provides a cold start solution adaptable to the state of the PEMFC.

COMPETITIVE ADVANTAGES

- The adaptive cold start strategy is **simple to implement in a real and commercial PEMFC system** and requires minimal user intervention, which minimizes manipulation and parameterization errors.
- The adaptive cold start strategy adapts to the variation of PEMFC degradation. Whether it is a new PEMFC or a degraded one, the strategy automatically changes its parameters to ensure a fast and successful cold start.
- The adaptive cold start strategy greatly reduces the cold start–up time and the energy requirements. **On our tested fuel cell, conventional methods result in a start-up time of about 45s. This invention allows starting the PEMFC in less than 15s.**
- The current start-up techniques are based on a fixed, pre-calculated set of rules. This invention modifies these rules according to measurements carried out on the PEMFC system in real time. It adapts to the cold start conditions (ambient temperature, air humidity, PEMFC degradation, etc).

APPLICATIONS

The invention can be used on vehicular or stationary applications.

TECHNOLOGY DEVELOPMENTAL STAGE

The adaptive cold start strategy was developed and validated experimentally at -20°C on a 500W fuel cell. It is perfectly functional: **until now, 100% of start-ups at -20°C have been successful**. The upcoming work will focus on the portability of the strategy on other fuel cell models (different technologies and different power) and the impact of the strategy on the lifetime of the fuel cell (aging study).

BUSINESS OPPORTUNITY

Technology licensing

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