ABSTRACT

Operating Condition Optimization of Fuel Cell System For Minimum Hydrogen Fuel Consumption

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In a fuel cell electric vehicle, a polymer electrolyte membrane fuel cell stack and balance of plant are widely used for its propulsion system. The fuel cell system must produce traction motor request power and ensure high fuel economy. The efficiency of the fuel cell system is dominated by the operating condition adjusted by BOP. The purpose of this study aims at developing a fuel cell system operating condition optimization methodology to reduce hydrogen fuel consumption.

There are many published fuel cell system operating condition optimization methodologies with fixed current input or request power. In a vehicle application, however, system operating condition needs to be optimized considering a wide range of motor request power. In addition, the durability of the fuel cell stack decreases when the fuel cell system operates dynamically across a wide load range. Therefore, the fuel cell lifetime

must be investigated in operating condition optimization.

This paper use multi-domain system simulation to integrate the electrochemical fuel cell stack model, thermo-fluid dynamic balance of plant model, and vehicle dynamic model. The hydrogen consumption is estimated by the vehicle level simulation. The design variables are oxygen stoichiometric ratio, stack temperature and power split parameter. The objective function is hydrogen fuel consumption during the WLTC driving cycle. The objective function is approximated by surrogate models to reduce computational cost and find a global minimum. The water content of membrane is constrained to prevent fuel cell degradation. The results verify that optimal operating conditions can reduce 4.6% the hydrogen fuel consumption of FCEV by comparing initial operating conditions.