Backward Powertrain Optimization Analysis and Hardware-in-the-Loop Design of Fuel Cell Motorcycle

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ABSTRACT

This study explored the backward powertrain optimization analysis and Hardware in-the-Loop (HIL) design of PEM hydrogen fuel cell motorcycle. This study used the hybrid power system and pure fuel cell power system to simulate and analyze the backward powertrain of fuel cell motorcycle under the European Community Normalized (ECN) driving cycle. The fuzzy logic controller and mode logic controller based were adapted to simulate and analyze the hydrogen flow control in backward powertrain of fuel cell motorcycle. The fuel cell simulation model development in this study had been tested and verified with fuel cell experiment test machine. PEM fuel cell output voltage and transient data were observed the 8W single cell under different load current and fuel inlet temperature. The fuel cell optimized simulation model parameters were searched by using fractional factorial analysis of Experimental Design Method (DOE). HIL approach was established to simulate and analyze the dynamic response and control of fuel cell inlet temperature control real-time environment. The fuzzy logic controller parameters were optimized by using the desirability approach to find the proper type of membership functions of the fuzzy controller so that fuel cell output power be maximized while maintained the minimum consumption of the hydrogen fuel. The simulating model was proved to be effectively simulating the fuel cell output voltage and transient characteristic of the single cell. The hybrid power system energy management of fuel cell motorcycles were also optimized to find proper distribution from battery and fuel cell. The simulation result showed optimum fuzzy logic controller had better performance than original baseline controller. The simulation result showed optimum fuzzy logic controller had better performance than original fuzzy logic controller and mode logic controller. This study also compared the performance of Hybrid power system and pure power system of fuel cell motorcycle performance. The hydrogen consumption of different fuel cell motorcycle was estimated, from the simulation result, the hybrid power system was proved to have less hydrogen consumption. The methodologies developed can be used to reduce the trial and error development schedule and expanses for fuel cell and fuel cell motorcycle hydrogen fuel controller.

Keywords : Hydrogen Fuel Cell Motorcycle Dynamic Control、Optimization of Fuzzy Logic Controller Parameters、Fuel Inlet Temperature control of PEMFC

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