Design and Performance Evaluation of a PEM Fuel Cell – Lithium Battery–Supercapacitor Hybrid Power Source for Electric Forklifts

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In this study, we developed a hybrid power source with a direct current (DC) supply system for electric forklifts. Its designs were based on harsh operating conditions, in line with the requirements for the truck. The power source consists of a fuel cell (FC) system, lithium ion batteries, and supercapacitor modules. This system supplies the pallet truck with the power needed for lifting and moving. In the experiments, three kinds of power source modules were designed, and their performance was tested individually. The modules were then combined and tested using machines to simulate load conditions. The test parameters examined were the rate of the supercapacitor and charging and discharging properties. A final simulation of the overall power output performance was also performed. The power output may be divided into power for lifting and power for moving. The FC is the power source for the traveling motor, while the lithium ion battery is the supply for maximum instantaneous power for the pallet truck. The super capacitors protect the FC and batteries and ensure high power output. It can also offset the insufficiency and instability of the power provided by the first two power sources and provides a stable 24 V DC power supply for the traveling motor when connected to a DC power converter. The lithium ion battery and supercapacitor modules are able to power the lifting motors, which require high power output, providing a maximum instantaneous power of 3.2 kW for several cycles of lifting. The power source proposed here therefore has potential use in hybrid systems.

Keywords: hybrid systems, proton-exchange membrane fuel cells, lithium ion battery, supercapacitor circuits, power management

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