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Energy Management of Fuel Cell/ Supercapacitor Hybrid Source Based on linear and sliding mode control

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Abstract

This paper, presents the modelling and control strategy based on linear proportional-integral (PI) and nonlinear sliding mode-based controllers of hybrid fuel cell/supercapacitor power system. This source is composed of a Polymer Electrolyte Membrane Fuel Cell (PEMFC 500 W) and a supercapacitor module (800W) as a main and an auxiliary sources respectively to satisfy the load requirements in the transient and steady states. Due to the weak request on the FC, a classical PI controller has been adapted to control it through an interleaved boost converter. However, because of the fast response in the transient state and its ability to work with a constant or variable frequency, a sliding mode controller has been used to manage the SCs power variation through a DC-DC bidirectional converter. The simulation results under Matlab/Simulink showed that the proposed control strategies had managed and had controlled successfully the hybrid system which satisfied the load requirements with a stable and robust performances.

Keywords: IBC converter, PI Controller, Sliding mode control, Energy conversion, Hybrid system, Fuel Cell, Supercapacitor;

1. Introduction

Nowadays, the appearance prototype replacing part of the battery by a fuel cell generator pack, made the advanced vehicle technology research turned to the FCs. However, their uses in the EV field remains at the prototype stage, due to many obstacles such as hydrogen storage, and complexity of their annexes component (compressors, radiators,...etc) [1]. The main FC vehicle drawback is its slowest dynamic behavior specially during the transient load variations. Thus, to utilize an FC in dynamic applications, its current or power slope must be limited to circumvent the fuel-starvation problem [2]. As a result, the vehicle electrical system must have at least an auxiliary power source (an energy storage device), such as a battery or SCs to improve the system performance when electrical loads at a DC bus demand high power in a short time (e.g., vehicle acceleration and deceleration) [3]. The SC has an unusually high energy density, but its main disadvantage is its lower specific energy, which limits the

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