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Development of Energy Management System based on a Power Sharing Strategy for a Fuel Cell-Battery-Supercapacitor Hybrid Tramway

Qi Li[*a], Weirong Chen[a], Zhixiang Liu[a], Ming Li[b], Lei Ma[a]

a. *School of Electrical Engineering, Southwest Jiaotong University, Chengdu 610031, Sichuan Province, China*
b. *Tangshan Railway Vehicle Co. Ltd, Tangshan 063000, Hebei Province, China*

*Corresponding author. Address: School of Electrical Engineering, Southwest Jiaotong University, Chengdu 610031, Sichuan Province, China. Tel.: +862887603332; fax: +862887605114.
E-mail address: liqi0800@163.com (Qi Li)

***Abstract*: A hybrid powertrain configuration based on a proton exchange membrane (PEMFC), a battery and a supercapacitor (SC) is designed without grid connection for the LF-LRV tramway. In order to avoid rapid changes of power demand and achieve high efficiency without degrading the mechanism performance, a power sharing strategy based on a combination of fuzzy logic control (FLC) and Haar wavelet transform (Haar-WT) is proposed for an energy management system of the hybrid tramway. The results demonstrate that the proposed energy management system is able to ensure the major positive portion of the low frequency components of power demand can be deals with the PEMFC. The battery can help provide a portion of the positive low frequency components of power demand to reduce the PEMFC burden while the SC bank can supply all the high frequency components which could damage the PEMFC membrane. Therefore, the energy management system of high-power hybrid tramway is able to guarantee a safe operating condition with transient free for the PEMFC and extend the lifetime of each power source. Finally, the comparisons with other control strategies verify that the proposed energy management system can achieve better energy efficiency of the overall hybrid tramway.**

***Keywords*: proton exchange membrane fuel cell, hybrid tramway, energy management system, power sharing strategy, fuzzy logic control, Haar wavelet transform.**

1. Introduction

As a promising technology fuel cells that convert chemical energy of the fuel into electricity without combustion are expected to become a viable solution for transportation applications. They could be used as predominantly renewable energy supplies instead of imported oil to help meet one of our most pressing energy needs. Although there are various fuel cell technologies available for use in vehicular systems, a proton exchange membrane fuel cell (PEMFC) has been found to be a prime candidate, since the PEMFC has lower operating temperatures and higher power density while compared to the other types of fuel cells