World Academy of Science, Engineering and Technology
International Journal of Transport and Vehicle Engineering
Vol:16, No:09, 2022

Experimental investigation on the lithium-Ion Battery Thermal Management System Based on Micro Heat Pipe Array in High Temperature Environment

Authors : Ruyang Ren, Yaohua Zhao, Yanhua Diao

Abstract : The intermittent and unstable characteristics of renewable energy such as solar energy can be effectively solved through battery energy storage system. Lithium-ion battery is widely used in battery energy storage system because of its advantages of high energy density, small internal resistance, low self-discharge rate, no memory effect and long service life. However, the performance and service life of lithium-ion battery is seriously affected by its operating temperature. Thus, the safety operation of the lithium-ion battery module is inseparable from an effective thermal management system (TMS). In this study, a new type of TMS based on micro heat pipe array (MHPA) for lithium-ion battery is established, and the TMS is applied to a battery energy storage box that needs to operate at a high temperature environment of 40 °C all year round. MHPA is a flat shape metal body with high thermal conductivity and excellent temperature uniformity. The battery energy storage box is composed of four battery modules, with a nominal voltage of 51.2 V, a nominal capacity of 400 Ah. Through the excellent heat transfer characteristics of the MHPA, the heat generated by the charge and discharge process can be quickly transferred out of the battery module. In addition, if only the MHPA cannot meet the heat dissipation requirements of the battery module, the TMS can automatically control the opening of the external fan outside the battery module according to the temperature of the battery, so as to further enhance the heat dissipation of the battery module. The thermal management performance of lithium-ion battery TMS based on MHPA is studied experimentally under different ambient temperatures and the condition to turn on the fan or not. Results show that when the ambient temperature is 40 °C and the fan is not turned on in the whole charge and discharge process, the maximum temperature of the battery in the energy storage box is 53.1 °C and the maximum temperature difference in the battery module is 2.4 °C. After the fan is turned on in the whole charge and discharge process, the maximum temperature is reduced to 50.1 °C, and the maximum temperature difference is reduced to 1.7 °C. Obviously, the lithium-ion battery TMS based on MHPA not only could control the maximum temperature of the battery below 55 °C, but also ensure the excellent temperature uniformity of the battery module. In conclusion, the lithium-ion battery TMS based on MHPA can ensure the safe and stable operation of the battery energy storage box in high temperature environment.

Keywords : heat dissipation, lithium-ion battery thermal management, micro heat pipe array, temperature uniformity
Conference Title : ICATMT 2022 : International Conference on Automotive Thermal Management and Technology
Conference Location : San Francisco, United States
Conference Dates : September 27-28, 2022

Open Science Index, Transport and Vehicle Engineering Vol:16, No:09, 2022 publications.waset.org/abstracts/148328.pdf