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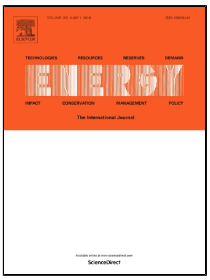

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Performance analysis of a novel thermal management system with composite phase change material for a lithium-ion battery pack

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Abstract

A novel passive thermal management system (TMS) based on copper foam and paraffin composite phase change material (PCM) was designed for a lithium-ion battery pack in this work, where the phase change storage energy unit (PCSEU) was indirectly in contact with the cell. A combined experimental and numerical study was performed to investigate the thermal performance of the battery pack with the novel TMS and air cooling system (ACS). The effects of the PCSEU casing, composite PCM effective thermal conductivity, geometric structure parameters of the TMS, charge/discharge rate and ambient temperature were systematically evaluated, as well as the battery thermal behaviors during charge and discharge cycles. Results showed that the passive TMS could keep the battery temperature in a desirable range even under 4C discharge rate at 42 ^{o}C and the PCSEU casing could remarkably improve its heat absorption efficiency. The thickness of the heat conducting sheet demonstrated the greatest impact on the battery temperature. Pure ACS with an air flow rate ≤200 m^3/h could not meet the battery cooling demands. The passive TMS could achieve up to 3 cycles of 4C charge and discharge at 35 ^{o}C while keeping the maximum temperature of the battery pack below 52 ^{o}C.

Keywords: Lithium-ion battery; thermal management system; phase change material; metal foam; charge and discharge cycle

Nomenclature

a	Constant
A	Heat exchange area, m^2