An Innovative thermal management system for Lithium-ion battery under a real driving condition

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ABSTRACT

A hybrid thermal management system (TMS) for high power lithium-ion battery modules of EVs is introduced with low energy consumption and reliability in a real state driving condition. An experimental investigation was performed to compare the hybrid TMS with an active air-cooling and a passive TMSs. We employed all three TMSs in standard weather condition of 24 °C. Although in the active TMS, the average temperature of the cell and module surface reached a steady state under safety temperature of 60 °C and 40 ºC respectively, the surface temperature non-uniformity was a chief problem. Consequently, the heat accumulation in PCMs caused by low thermal conductivity resulted in the failure of passive TMS. Our experiment reveals that while the airspeed (vehicle speed) was an only 3.2 km/h (2.0 mph), the hybrid TMS could entirely keep the module surface temperature under 40 °C. For dynamic mode, a study of driving cycle in comparison with US, Europe, and Japan driving cycle data was conducted to perform a dynamic model based on the Tehran traffic to challenge our TMSs in a real driving state including high and standard discharge rate and a stop mode in which there was no air convection. The results showed that just in the hybrid TMS, the cell surface could reach a steady state under 60 °C while the active TMS could keep temperature only for three cycles. Furthermore, our test proved that the proposed hybrid TMS maintains outstanding reliability and efficiency in the hot weather condition of 40 °C.

Keywords: TMS; PCM; Hot weather condition; High power LIB; Energy consumption