平板热管–PCM 复合动力电池散热系统性能研究

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摘 要 电池在运行过程中产生大量热，对其性能和寿命均造成影响，本文针对多个并联电池组进行散热研究，在保证高散热功率的同时兼顾对电池组温差的控制。文中基于平板热管设计了两种热管理系统：平板热管散热系统，平板热管与相变材料 (PCM) 复合的散热系统。在 3 C 高工作电流下，平板热管散热系统可以保证电池组内最高温度为 308.99 K，最大温差为 4.01 K，但存在单块电池上温差过大的问题，占到并联电池组总温差的 72% 以上。而平板热管–PCM 复合散热系统内相变材料发生相变时吸热但温度不发生变化，可以解决单块电池温差过大的问题，相较于平板热管散热系统，平板热管–PCM 复合散热系统使得电池平均温度和最大温差分别降低 3.65 K 和 0.56 K，且复合散热系统相较于平板热管散热系统在低温工作环境下具有更好的工作性能。

关键词 电池热管理系统；平板热管；相变材料；电池均温性
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Study on a Composite Power Battery Thermal Management System Based on Flat Heat Pipe-PCM

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Abstract Batteries will produce a lot of heat during working, which affects its performance and life span. In this paper heat dissipation of multiple parallel battery packs is studied. High heat dissipation power is ensured while temperature difference of the battery pack is controlled. In this paper, two kinds of battery thermal management system based on flat heat pipe are designed: Flat heat pipe cooling system, flat heat pipe-phase change material (PCM) composite cooling system. Under the high operating current of 3 C, the flat heat pipe cooling system can control the maximum temperature in the battery pack to 308.99 K and the maximum temperature difference to 4.01 K. However, there is still a large temperature difference on a single battery, accounting for more than 72% of the total temperature difference of the parallel battery pack. The phase change material in the flat heat pipe-PCM composite cooling system absorbs heat while the temperature does not change, so the composite cooling system can solve the above problem. Comparing with the flat heat pipe cooling system, the average temperature and the maximum temperature difference of the flat heat pipe-PCM composite cooling system are reduced by 3.65 K and 0.56 K respectively. Moreover, the composite cooling system has better performance in low temperature working environment comparing with the flat heat pipe cooling system.

Key words battery thermal management system; flat heat pipe; phase change material; battery temperature uniformity

0 引 言

锂电池具有能量密度大、功率高、低自放电率、寿命长等优点，是电动汽车较理想的动力源 [1]，然而锂电池在工作过程中会放出大量热。如果温度得不到有效控制，则会导致电池内 SEI 膜和电解质分解 [2]，降低工作性能及循环寿命 [3]，甚至引发火灾。因此，无论是从经济还是安全方面考虑，开发一种

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