Thermal Analysis of a Latent Heat Storage Based Battery Thermal Cooling Wrap

Chiew Hay King Joel[1]

[1]Temasek Polytechnic, Singapore

Abstract

The most common cause of lithium ion battery failure is high temperature. Improper thermal management strategies can contribute to the temperature related premature battery failure. Excessive heat significantly impacts the performance, safety and cycle lifetime of the lithium ion battery. Therefore, maintaining a lithium-ion battery cell within a safe operating temperature range is crucial for safe and reliable operation.

In this study, a latent heat storage based thermal cooling wrap is proposed as a thermal management solution for a single cell battery. The selected battery cell is the A123 26650 LiFePO4 with an optimal operating temperature range is 20 - 40 °C. Hence, a phase change material (PCM) of melting temperature of 28°C was selected to keep the battery cell within that specified temperature range.

The cooling wrap consist of a phase change material (PCM) embedded within an absorbent material and wrapped around the battery cell. A thermocouple is placed on the surface of the battery cell to monitor the temperature of the cell. The ambient temperature is also measured and controlled.

Due to the cylindrical shape of the battery cell, a 2D axis-symmetrical model was designed and analysed in COMSOL Multiphysics. COMSOL Multiphysics was used to simulate the heat generation of the lithium ion battery cells via the lithium-ion battery model. The heat transfer module was also used to simulate the heat transfer between the battery cell surface and the phase change material. The phase change module was used to demonstrate the melting interface of the phase change material. The ambient temperature is assumed to be constant.

The battery cell was discharged at 5 ampere (2C) and the model maintained at a constant temperature of approximately 28°C over the total melting duration of the phase change material. The peak surface temperature was measured to be just over 30°C, which is still within optimal operating temperature range.

The results presented in the simulation indicates that the latent heat storage based battery thermal cooling wrap is capable of absorbing sufficient thermal energy and keeping the cell cool. The battery cell successfully operated within the optimal temperature range. The accuracy of the simulation is verified by a similarly set up experiment.

Figures used in the abstract

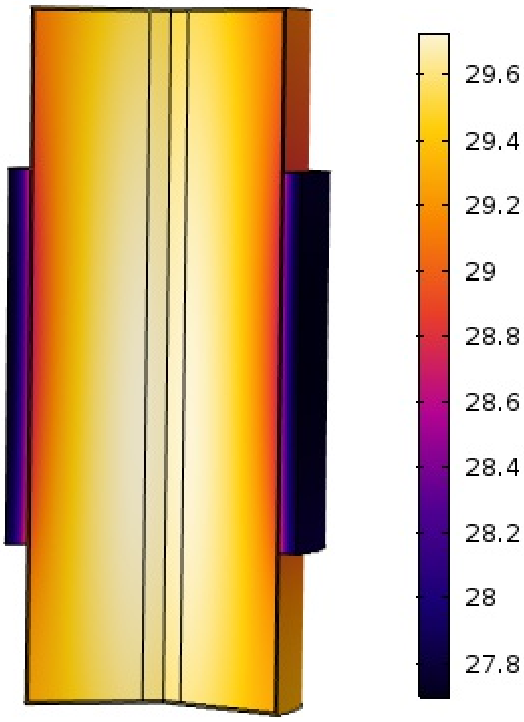

Figure 1: 2-dimensional axis-symmetrical view of the lithium-ion battery cell and the latent heat storage based battery thermal cooling wrap.