Thermal And Heat Transfer Modelling Of Lithium Ion Battery Module During Discharge Cycle

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Abstract

Climate change and concerns over the reliable supplies of hydrocarbons are aiding in the focus on Electric Vehicles (EVs) and Hybrid Electric Vehicles (HEVs). The Lithium-ion battery as a better solution for energy storage in automobile applications is briefly introduced. Adverse effects of uneven temperature including thermal runaway, low-temperature performance, and performance degradation are described in detail. Furthermore, the progress on existing battery thermal management systems including both active and passive cooling methods are also described. Mainly, this paper investigates the temperature distribution and the heat generation characteristics of a cylindrical Li-ion battery cell and a battery module. Three ways of heat generation sources, including Ohmic heat, the reaction heat, and the polarization heat were considered in the modeling. The battery cell consists of a spiral wounded cathode, anode, a current collector, and a separator. The material properties are those of a typical lithium-ion battery. Transient and thermoelectric finite element analysis (FEA) of the cylindrical lithium-ion battery is presented. The model was simplified by adopting the cylindrical coordinates and lumped modeling theories. The FEA was performed using COMSOL Multiphysics® and the association of the Battery and Fuel Cells Module. 1 D Lithium-ion isothermal model was also used from COMSOL® application libraries to identify the exact amount of heat generation from the battery cell. The 1 D model coupled with a 3 D model for the cell temperature distribution. The cell simulation model was then expanded for the battery module temperature profile simulation and the battery module consists of 59 cylindrical battery cells. Based on results, it can be confirmed that the temperature profile from the analytical model had a similar tendency with the simulation model. In addition to that, the temperature distribution change based on five different cell arrangements is also discussed and presented.

Figures used in the abstract

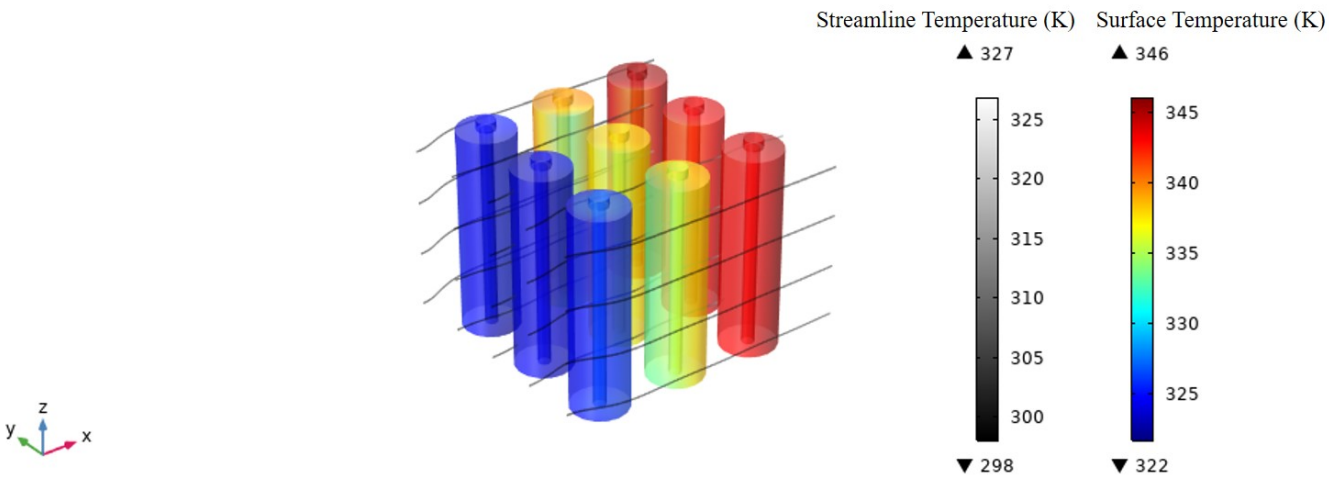

Figure 1 : Temperature Profile for a Battery Matrix with 9 Cells

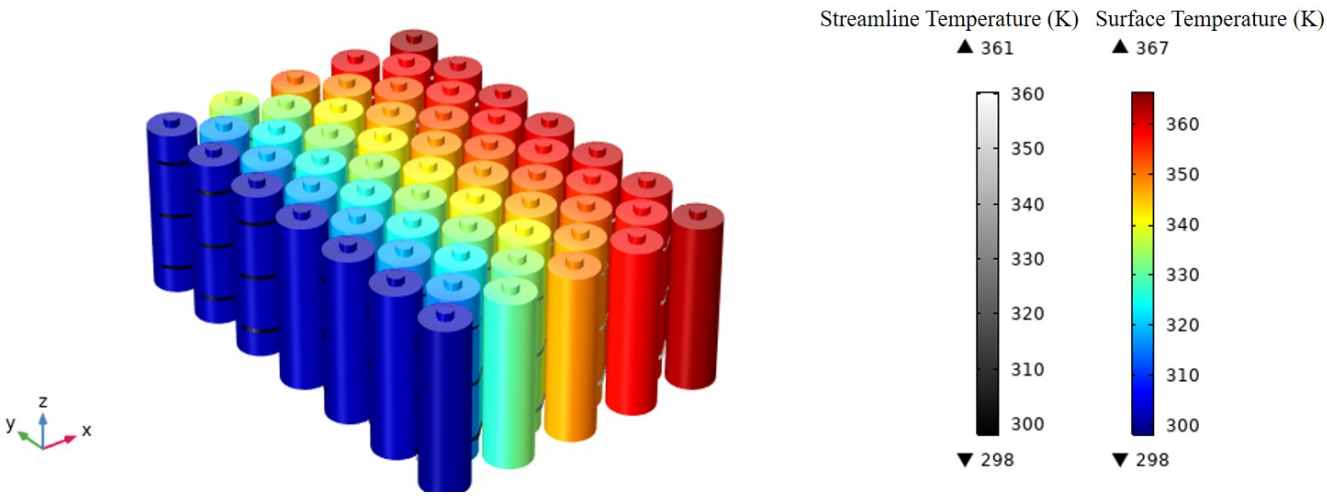

Figure 2 : Temperature Profile for a Battery Module with 59 Cells