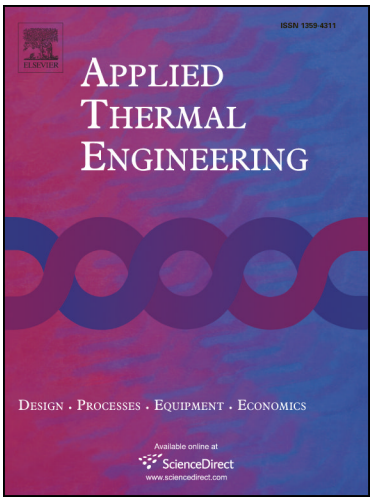

Three-dimensional electro-thermal model of li-ion pouch cell: Analysis and comparison of cell design factors and model assumptions

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Three-dimensional electro-thermal model of li-ion pouch cell: Analysis and comparison of cell design factors and model assumptions.

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Abstract

Thermal modeling is a powerful tool in optimizing design of battery thermal management systems. Among different modelling methods, parallel electrode based 2D electro-thermal model has been used in the prediction of the complex spatial non-uniformity of battery cell temperature. Here, an electro-thermal model of 20 Ah nickel-manganese-cobalt oxide pouch type lithium-ion battery cell is presented, where an advanced 2D-potential distribution model based on overpotential is bi-directionally coupled with a 3D-temperature distribution model. For state of charge estimation during input parameter determination and simulation, Coulomb counting with Extended Kalman filtering method is used. The model is capable of predicting temperature distribution under constant current and dynamic current accurately. Through simulation, the influence of heat transfer through the tabs and the extended pouch seam on the temperature distribution is analyzed. These design factors are found to increase the overall heat transfer rate and influence the spatial distribution pattern of temperature. Several models with analytical and empirical simplification of potential distribution model, 2D geometrical simplification, and uniform heat generation assumption are demonstrated and compared in terms of accuracy and simulation time. It is illustrated that a 3D model geometry of the battery cell is essential to reproduce spatial temperature non-uniformity with high accuracy. Different simplifications can reduce the simulation time with reasonable accuracy. By comparing the results obtained from different simplifications, the present study depicts a broad scenario of modelling method to serve the purpose of implementation in thermal modeling of large battery packs.

Keywords

Multiphysics model, thermal model, li-ion pouch, potential distribution, spatial non-uniformity, thermal management.