Thermal Heat Exchange of a Battery Module with 32700 Lithium-ion Cells and Side Cooling Effect Investigation by Numerical Approach

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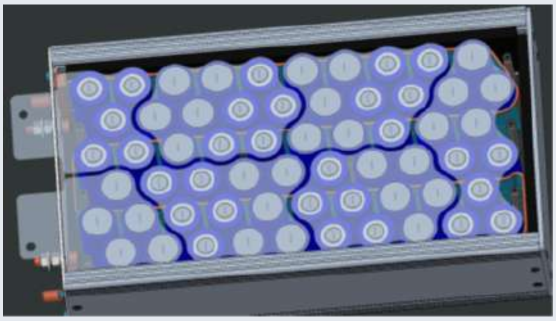
1 Introduction

Electric vehicles have become one of the most popular choices in the automotive industry over the past decade. Climate change and environmental issues are supporting this choice. In terms of capacity performance, energy and power density, lithium-ion batteries are widely used in electric vehicles. On the other hand, safety is the main expectation. Thermal heat exchange of lithium-ion battery is a crucial point to get longer performance, battery health and safety. Therefore, many models have been developed in the literature to predict the thermal characteristics of Li-ion batteries [3,4].

Aim

Accordingly, single lithium-ion cell characterization involves setting up and defining the battery module maximum and minimum charge/discharge processes of the battery module at different ambient temperatures in order to calculate the heat generation for each case. Many parameters need to be controlled and managed, and many aspects need to be optimised [1]. On the other hand, the main output of the research is the addition of a side cooling plate to the battery module to monitor heat dissipation and cooling effects on battery performance.

2 Methods

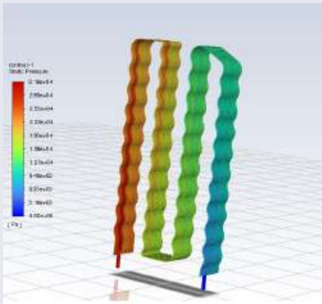


Lithium-ion batteries heat generation

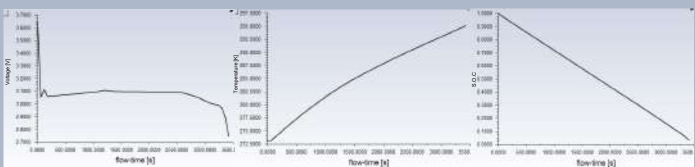
Ansys Fluent software is used to monitor the heat generation. As a solution method, MSMD-Equivalent Circuit Model is chosen to assign model parameters (internal resistance, contact resistances, etc.) and limitations. Measuring temperature differences between walls of the cells which are located each side of the battery module and at the center cells.

Cooling Plate

Liquid cooling system with microchannels is used to cool the battery module. The heat flux calculated from battery module, is applied on the contact surfaces. Liquid (water-glycol) mass flow and inlet tempereature and flow direction are given as boundary conditions. Pressure drop along the cooling plate and outlet temperature are calculated from the simulation. The effect of the flow rates on the heat exchange capability of the battery module is investigated [2].

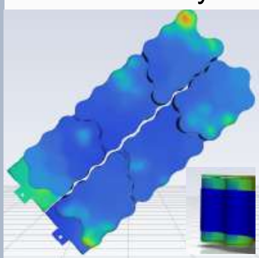


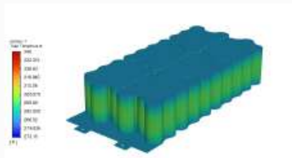
3 Results



Graphics of voltage, temperature and S.O.C vs flow time during full discharge at 1C rate and ambient temperature of 273.15 K.

The above simulation results were implemented with the battery module without cooling plate.





Battery Module simulation of the battery module and images.

4 Conclusions

Voltage and temperature changes can be obtained by using Ansys - Battery Model. Heat generation and temperature distribution in the battery module can be simulated to avoid any unsafe conditions at higher ambient temperatures. It is an ongoing project, and cooling plate effects can be seen after the CFD-CHT studies. This study has been carried out at the University of Polytechnic Valencia, CMT Laboratories.

References

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