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Electric Vehicle Lithium-Ion Battery Cooling

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Introduction

Lithium-ion battery is the preferred energy storage system for Electric vehicles due to its high specific energy, high specific power and low self-discharge rate.

However, during a discharge time battery pack reduces its capacity due to temperature distribution increased between the cells. In order to control temperature range and heat generated inside the battery pack it requires a significant cooling system.

Aim of the project

To investigate temperature distribution for a lithium-ion battery during a discharge period by experimental test and thermal model (Ansys Fluent).

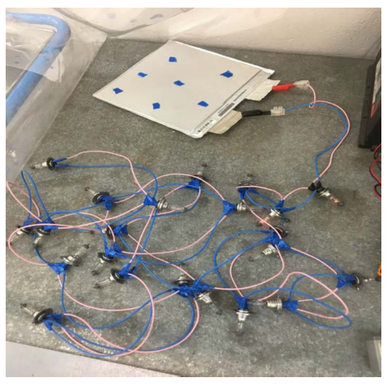
To design an efficient cooling plate and reduce the temperature gradient in the battery pack. To ensure the pack operates in the desired temperature range for optimum performance and working life.

Thermal model

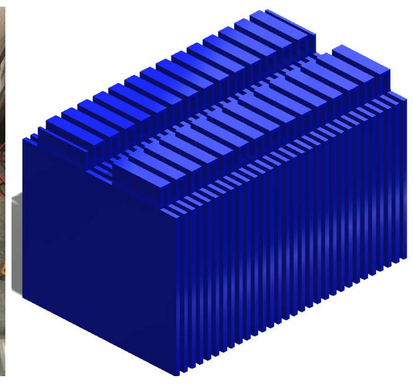
The analysis is made for pouch cell, $LiNiMnCoO_2$, with its recommended discharge rate 10C. Experiment test was applied during a discharge rates 1C, 3C, 5C and 10C using automotive light bulbs 12V*55W.

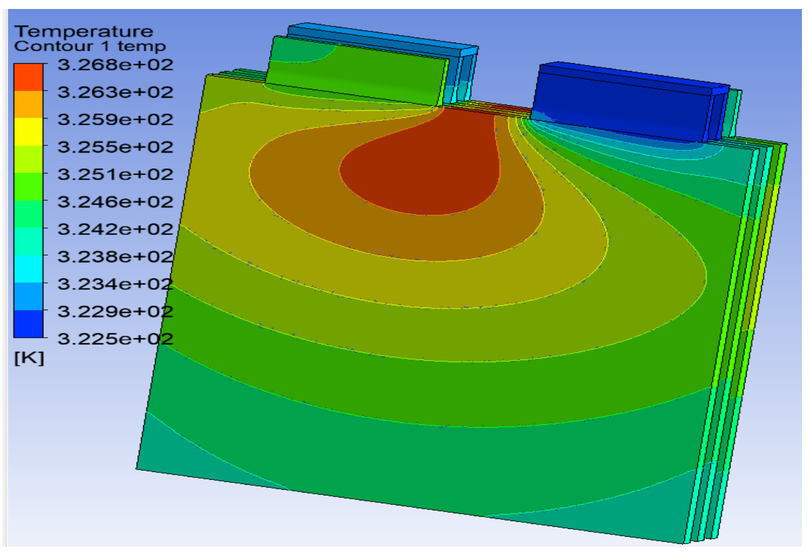
CFD model was made over single cell, cell group and battery module during a discharge rate from 1C to 10C without cooling at a stream temperature 300K (26.85°C). To study temperature distribution over surface of cell and voltage drop.

10C discharge rate experiment temperature distribution and voltage drop over the cell

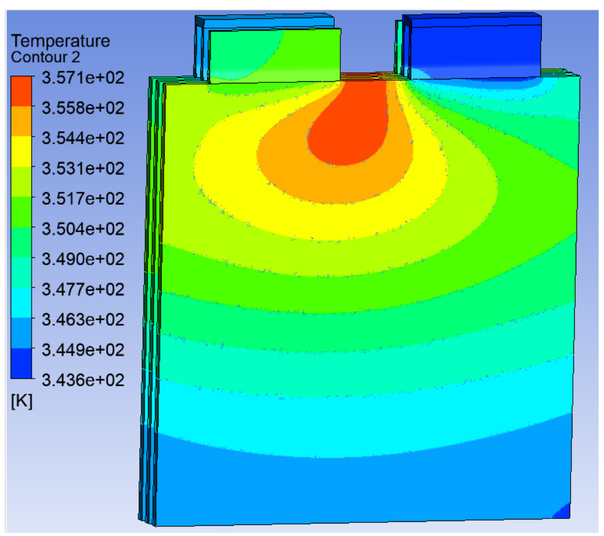


Battery module 3D Solid geometry, 30 cells of battery connected in a series with 29 busbars.

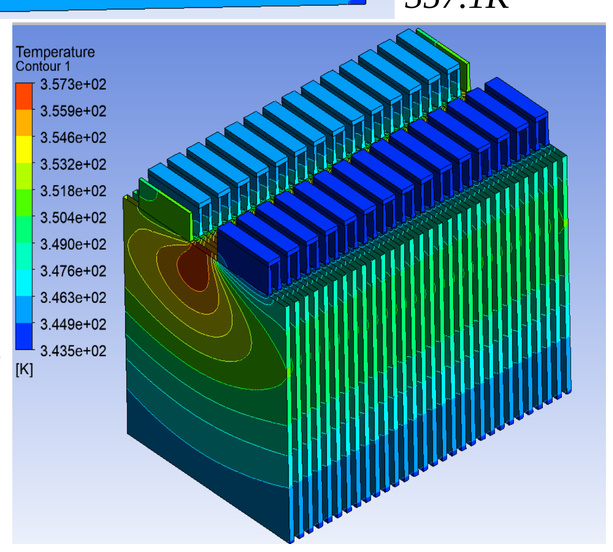




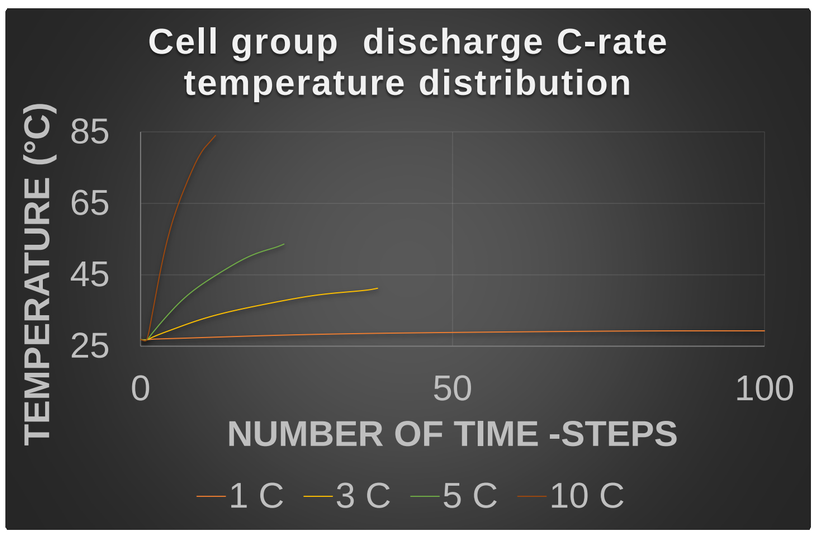
5C discharge rate for cell group battery temperature contour, increased from 300K. CFD thermal model.

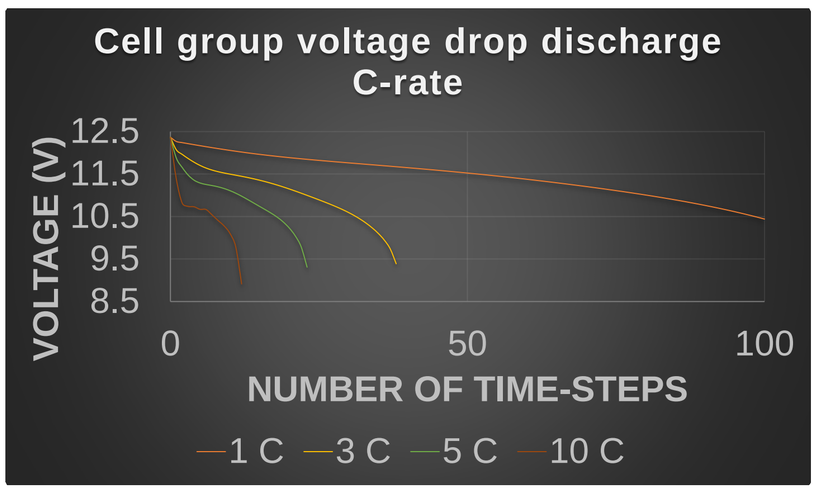


10C cell group discharge temperature distribution over cells from 300K stream temperature to a range 343.6 to 357.1K



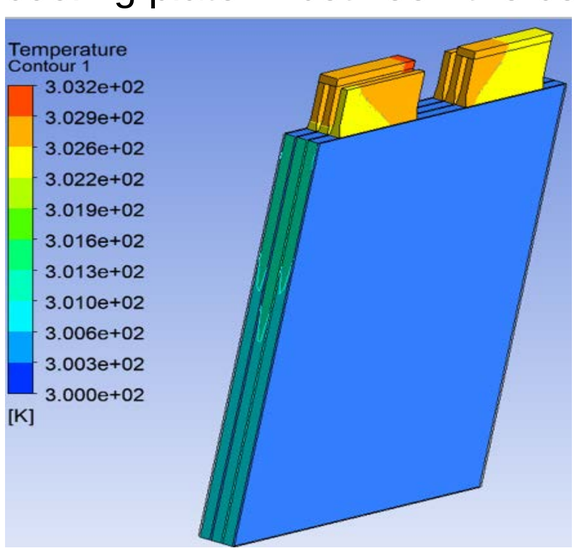
10C battery module discharge Temperature distribution. Temperature increase from 300K to maximum 357.3 without cooling





CFD model for cell group Battery cooling plate

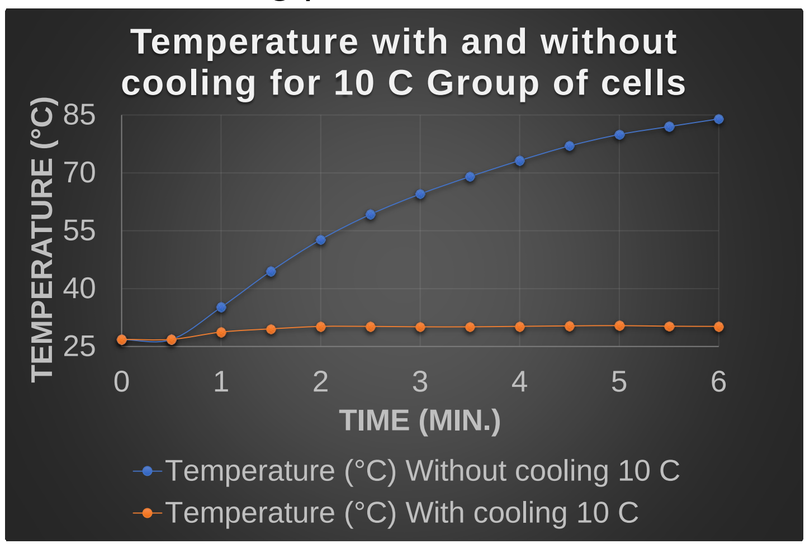
CFD is applied to study battery cooling plate in a discharge time for cell group battery section. A liquid cooling system was applied to dissipate the heat generated inside the cells, with 1mm Aluminium cooling plate in between the cells.



10C discharge rate of a cell group with a single channel cooling plate. Temperature range is 3.2K among the cells.

Results

The results are correlated CFD model for cell group without and with cooling plate. In order to figure out the optimum working temperature and range of temperature to keep the current density performance. The range of temperature with outcooling is 13.5°C, but after cooling it was 3.2°C very efficient cooling plate.



Conclusion

Range of the temperature for the cell group after a cooling was 3.2°C and maximum temperature 30.05°C. The values were represented an effective thermal cooling system.

References

Liu et al., (2019). Transient Temperature Distributions on Lithium-Ion Polymer SLI Battery. *Vehicles*, pp.127-137.

Kim et al., (2009). Modelling for Scale up of a Lithium-ion Polymer Battery. *Journal of Power Sources*, 189, pp. 841-846.

ANSYS

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