Heat Generation Modeling of a Lithium Battery: from the Cell, to the Pack on COMSOL Multiphysics

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Introduction: Lithium Ion batteries are increasingly used. The improvement of the energetic density allows a **bigger autonomy for a lower weight**. Lithium batteries are even used in aviation with the Efan (Fully powered by electricity airplane). The performance and life of a battery pack is related to its temperature.

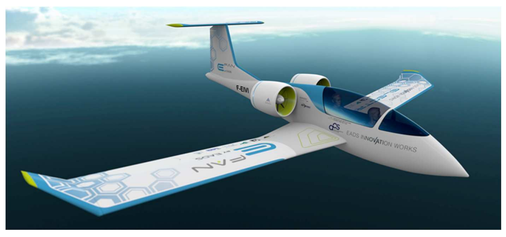


Figure 1. Efan

Figure 2. Battery Cell

Figure 3. Cal Poly Electric Race Car

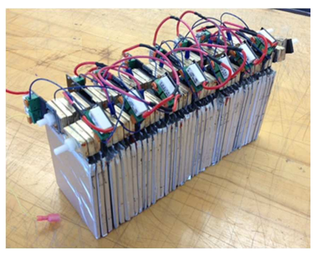


Figure 4. Battery Pack

OBJECTIVE 1: Model the electrochemical reaction to figure out the heat generation

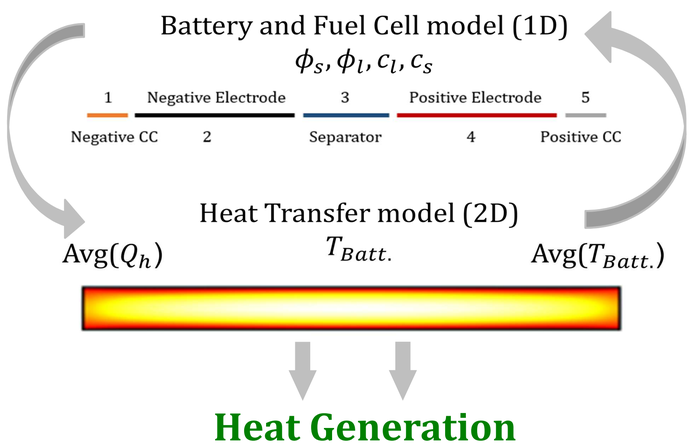
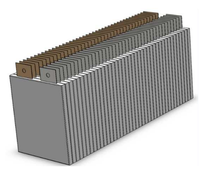


Figure 5. The heat generation process

OBJECTIVE 2: Use the generated heat as the source term in the Heat Transfer in Solids model of the battery pack.



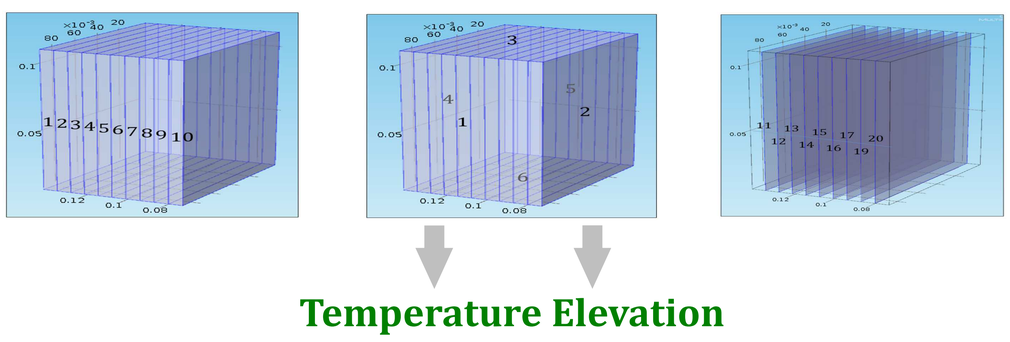
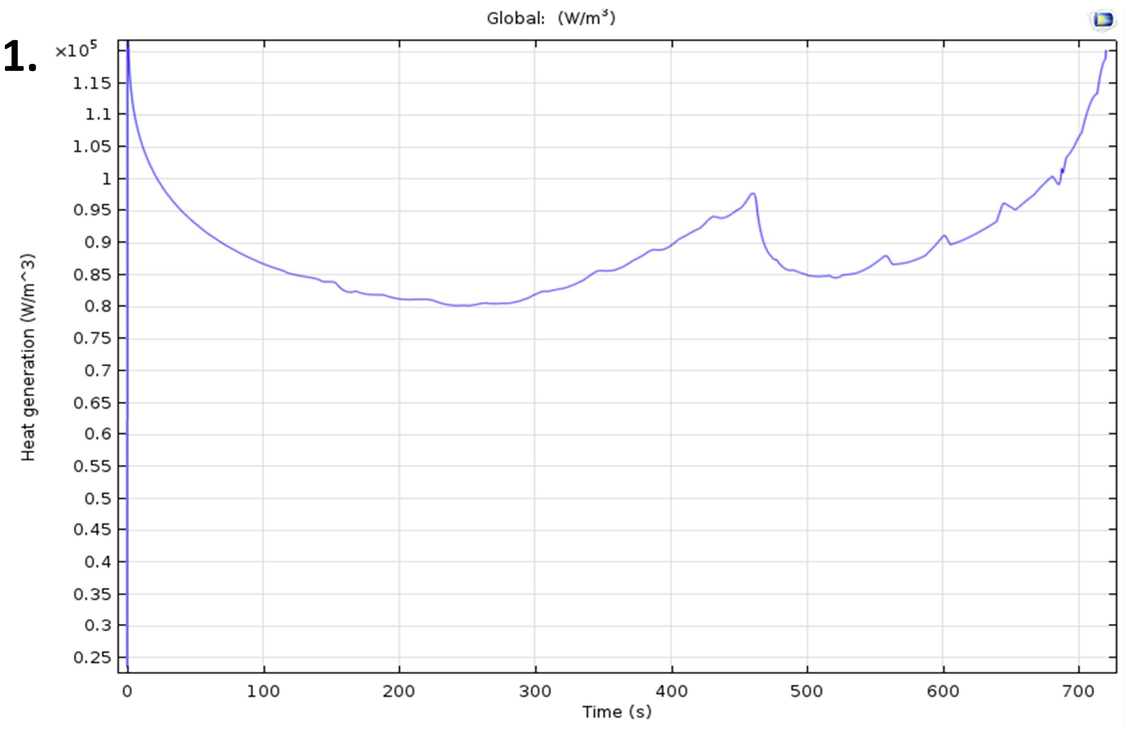


Figure 6. The Battery Pack Heat Transfer Model

Results :

1.



2.

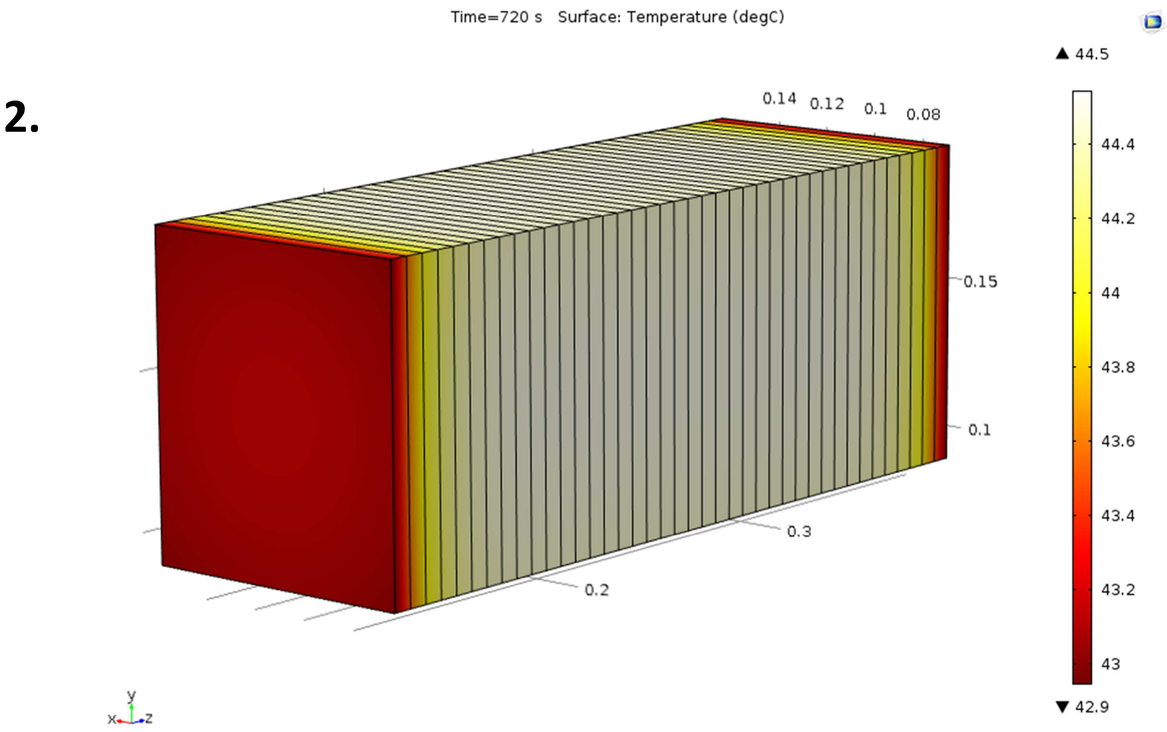


Figure 7. a. Computed heat power density; b. Computed temperature distribution in the battery pack

Conclusion: The model predicts successfully the temperature elevation of the battery pack with an error of 9.1% based on experimental comparisons.

References:

1. Long Cai, Ralph E. White, Mathematical Modeling of a Lithium ion Battery with Thermal Effects in Comsol Inc. Multiphysics (MP) software, *Journal of Power Sources*, **196**, 5985-5989 (2011).
2. Doyle, M., Newman, J.,Gozdz, A.S., Schmutz, C.N.,& Tarascon, J.M., Comparison of Modeling Predictions with Experimental Data from Plastic Lithium Ion Cells, *Journal of the Electrochemical Society*, **143 (6)**, 1890-1903 (1996).

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