Parameterization Of A Simplified Physical Battery Model

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Abstract

The importance of batteries is increasing, especially in the field of the high power requirement systems like electric driven vehicles. Mobile energy storage makes it possible to accelerate with incredible torque, without any accruing air pollution. Due to the high costs of real components, it is of great use to simulate battery driven systems before building them. Transient processes within a cell are highly dependent on the operating point of the complete system, which makes it difficult to create equations and model parameterizations. This paper shows which data is important for cell modeling and how to parameterize simplified physical cell models.
Keywords: simplified battery model, battery parameterization, physical battery model

1 Introduction

The main target of the master student's project was to get a method to generate a simplified model of a lithium ion cell. In general the physical models of batteries are generated with electronic elements like resistors, capacitors, or inductances.
The complexity of battery models can go up to infinity, so it is necessary to simplify the structure as much as possible. The simpler models contain a resistor, which represents the inner resistance of the cell and a resistor connected in parallel with a capacitor, which represents the capacitive behavior. Because of that, this model can only recreate the real battery behavior in a few situations and is also the least accurate one. To generate a more precise simulation, it is necessary to use more RC-elements (resistance connected in parallel with a capacitance). With more of these elements, it is possible to fit the Nyquist plot of batteries much more accurately.

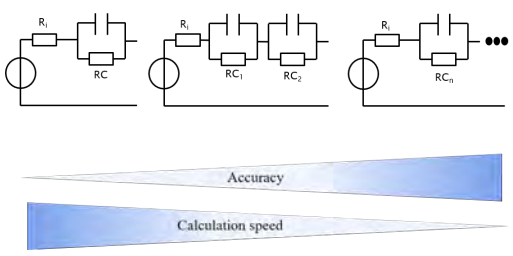

Figure 1. Rising calculation speed versus higher complexity

For high frequencies the impedance goes even inductive, so therefore a inductance should also be considered.
The disadvantage of more elements in the equivalent circuit is that more information about the cell is needed for parameterization and the CPU time for calculations is increased.
The most accurate models are completely numeric models in which all Elements are parametrized with interpolated tables, which are depending on temperature, SOC (state of charge) and flowing current. These models need much more measurement data than the ones with simple concentrated elements. All the parameters have to be recalculated in every state of the battery, which causes an extreme rise of the calculation time for the simulation. The measurements are very time consuming and expensive, so not many institutions have access to the necessary information and data for this kind of simulation models. That is the reason why in this paper no such model is discussed and presented.

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