Parameters Optimization for a Physics-Based Model of LTO Battery Cell

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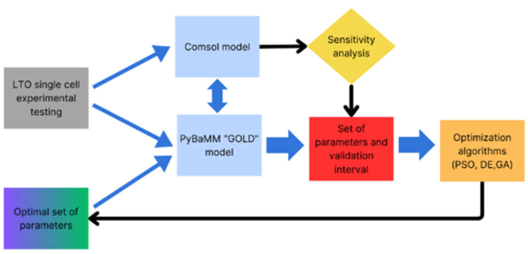
In the rapidly evolving landscape of energy storage technologies, optimizing battery performance is crucial for applications in electric vehicles, grid storage, and industrial power systems. This project, conducted in collaboration with ABB, focuses on the parameters optimization of LTO batteries to make a meaningfull physics-based battery model framework.

Objective of this Thesis

The primary objectives of this thesis are to:
1. restrict the variables for model parametrization based on a sensitivity analysis performed on a previous project, focusing on those that significantly influence battery performance
2. develop a comprehensive battery model using PyBaMM (Python Battery Mathematical Modelling)
3. implement optimization algorithms to identify the optimal set of parameters
4. validate the optimized parameters through testing and comparison with baseline models

Methodology

The methodology involves an approach combining theoretical modeling and experimental testing:
- **model development**: Tuning the DFN Battery Model in Comsol to match the measured data and then compare it to the model tuned in PyBaMM and use Python to build the complete model framework
- **sensitivity analysis**: Done in the semester project as a prerequisite for focusing on a smaller set of parameters that have most influence on battery response
- **optimization**: Applying optimization techniques to create a solid modeling framework to see which algorithm will minimize the error in respect to the initial model that should reflect the measured data
- **validation**: Conducting comparison with a model that is representative of the measured data(‚'gold model'')



Project Overview

Overview

This project is a continuation of a semester project done in collaboration with ABB, aimed at optimizing battery parameters.
The initial model was developed in Comsol, refined to match experimental data from the BFH Battery Center, with the OCV curve as the main reference. Once the model's response was satisfactory, it served as the „gold model" for further analysis.

Results

Tuning the new model in PyBaMM involved interpolating OCV curves for the two electrodes using MATLAB-fitted stoichiometry values. These were used in PyBaMM to calculate voltage at each SOC value. Additional parameter adjustments and modifications to the DFN model's kinetic functions were made to achieve a robust model ready for optimization.
After identifying the most sensitive parameters during the semester project, these parameters were left free to vary in acceptable ranges and optimization was performed to find parameter combinations in boundaries that closely match the ‚gold model''. PyBaMM was chosen for its extensive modeling capabilities and integration with Python-based optimization algorithms and options for battery modeling.

The project achieved promising initial results, showing good correlation with experimental data and paving the way for further refinements and applications for ABB battery systems.

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