BTMS Testing Section

Contributors: INL, SNL, NREL

Background

Cell testing is an important part of understanding the performance and life capabilities of state-of-the art energy storage technologies, particularly with respect to the distinct technical and functional requirements posed by the BTMS program. The baseline requirements for BTMS are loosely defined as a 1MWh BTMS system supporting six 350kW DC fast charging stations with no load profile defined. In order to test energy storage components and systems against these requirements, test procedures must be created that begin to address fundamental questions concerning the balance between cell performance and lifetime to minimize BTMS station cost and maximize station life. System usage scenarios are concurrently being developed with testing of baseline cells intended to illustrate their capabilities relative to a broad set of initial system assumptions. The results from these early performance tests and aging procedures will produce both slow and accelerated cycle-life aging information through a mix of empirical observations and modeling.

Results

Three parameters temperature, rate, and state of charge window were varied to accelerate aging/degradation mechanisms and support modeling to estimate cycle life capabilities. These parameters were chosen because they will each exacerbate theorized performance degradation mechanisms. Calendar aging at 55°C was also added as an accelerated calendar aging condition, compared to the expected system operating conditions closer to room temperature. An outline of the testing conditions is shown in the figure below.

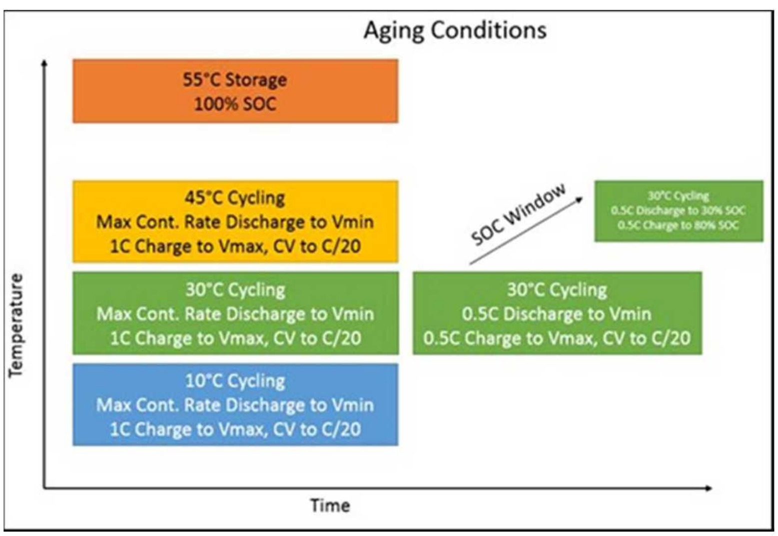

Figure 1. Test matrix for cells under baseline scenario

The 2-hr discharge capacity and pulse-power capability of each cell will be measured monthly in a reference performance test. Every third performance test will include a set of 20-hr charge and discharge cycles which can be analyzed to understand differences in aging mechanisms among test conditions, in addition to the characterization of performance loss through time and cycling.

Performance and life testing has commenced in Q2 for three baseline lithium-ion chemistries at INL and SNL. NMC-LTO cells from XALT energy, NMC-Graphite cells from LG Chem, and LFP-Graphite cells from K2 Energy were put into testing using the methodology described. The figures below show test setups within a thermal chamber. These large cells are resource intensive to test, so resource sharing was carefully planned for available tester channels and chambers.

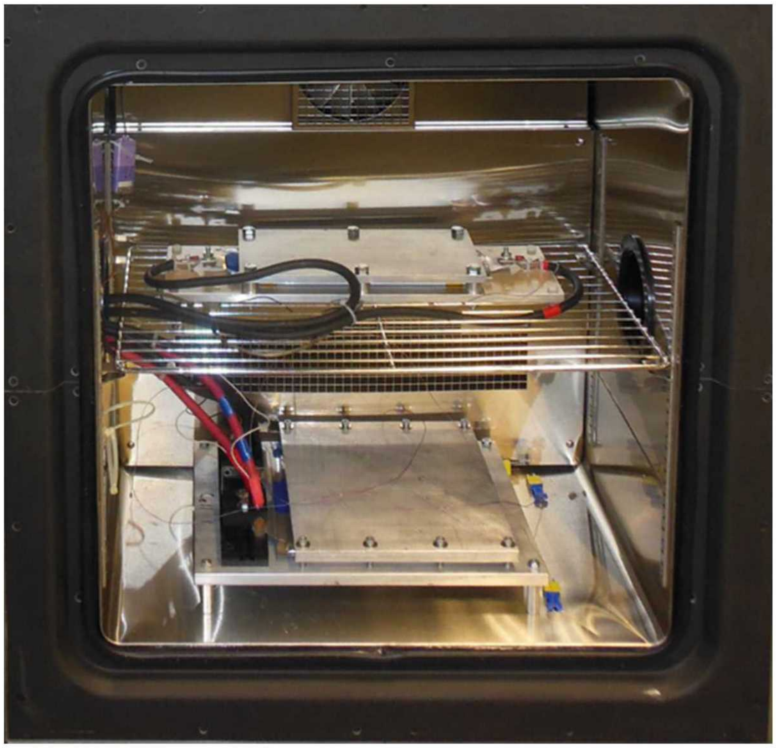

Figure 2. LG Chem cell (top) and XALT cell (bottom) sharing 45°C test chamber.

Figure 3. K2 Power cells sharing in a30°C test chamber

With these few baseline chemistries testing under an early baseline scenario, most data analysis will be forthcoming. The figure below is an example of beginning of life data as well as representative cycle data

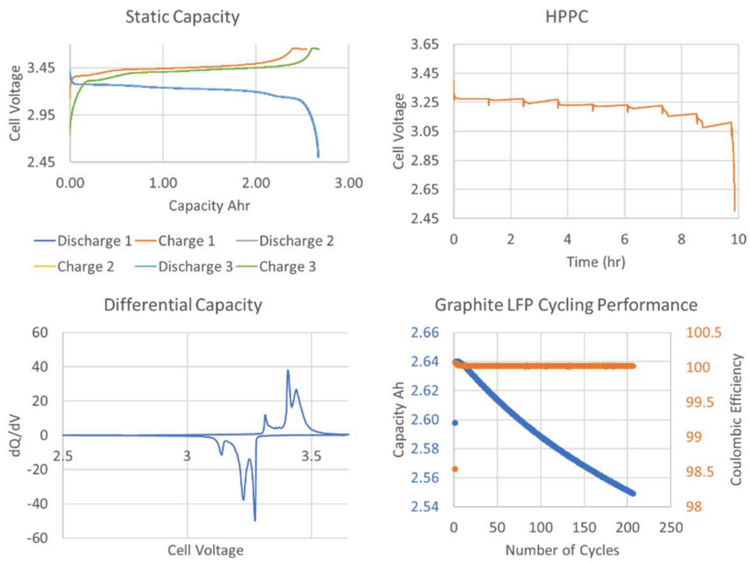

Figure 4. Beginning of life data and cycling of K2 Power cell

The beginning-of-life performance characterization tests yield some early information on cell-only volumetric energy density. This information is not useful by itself, because the balance-of-plant of an energy storage system will certainly be substantial. This does, however, allow us to picture the relative impact of footprint among systems of widely varying energy density, as shown in the figure below.

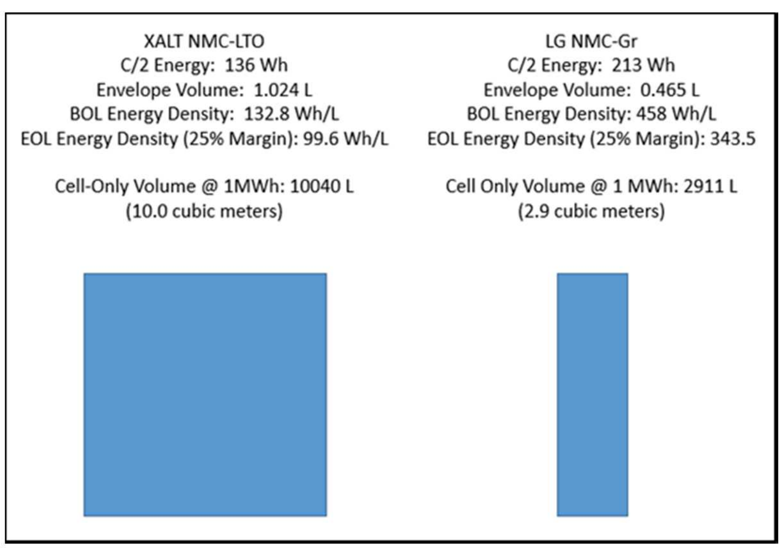

Figure 5. Comparison of energy density of two cell technologies being tested.

The size of the boxes can be adjusted by applying different currents, however this will also have impacts on cell lifetime and must reflect our cell testing protocols. The testing protocols will change and adapt as the BTMS use cases refine.

Summary

Results from the testing discussed above will help to refine methods used for forthcoming testing of articles that are more closely aligned with BTMS goals, particularly the critical materials free mandate. As system modeling progresses, a clearer set of goals will be established and test procedures will be developed to emulate the operation of such a system. These procedures, alongside tests designed to yield accelerated aging, will provide data allowing prediction of technologies' abilities to meet the long cycle and calendar life goals of the program.

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