Safety and diagnostics of aged commercial Li-ion batteries cycled at low temperature

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The degradation and ageing of Li-ion batteries will in many cases contribute to reduced thermal stability which potentially affects the safety performance of the batteries. The fact that aging of lithium-ion cells leads to a reduced capacity and cell life, is extensively covered in the literature by several research groups, e.g. Vetter[1]. The safety effects of ageing are far less studied, with only a handful of empirical studies published, e.g. [2-4].

This poster presents safety and in-situ diagnostics data of aged large (20 – 40 Ah) commercial Li-ion batteries. The cells have been aged and cycled at 5, 25 and 45 °C. The ageing mechanisms are however different and will affect the thermal stability of the aged cells. Diagnostic data through entropy spectroscopy, incremental capacity analysis and impedance spectroscopy was recorded and will be compared to post-mortem data. The thermal stability of cells which have been aged with different ageing mechanisms was characterized with an Accelerated Rate Calorimeter (ARC). This is illustrated in Figure 1 below where a cell cycled at 5 °C for 3000 cycles and 70% State-of-Health showed a reduced thermal runaway limit from 240 to 150 °C.

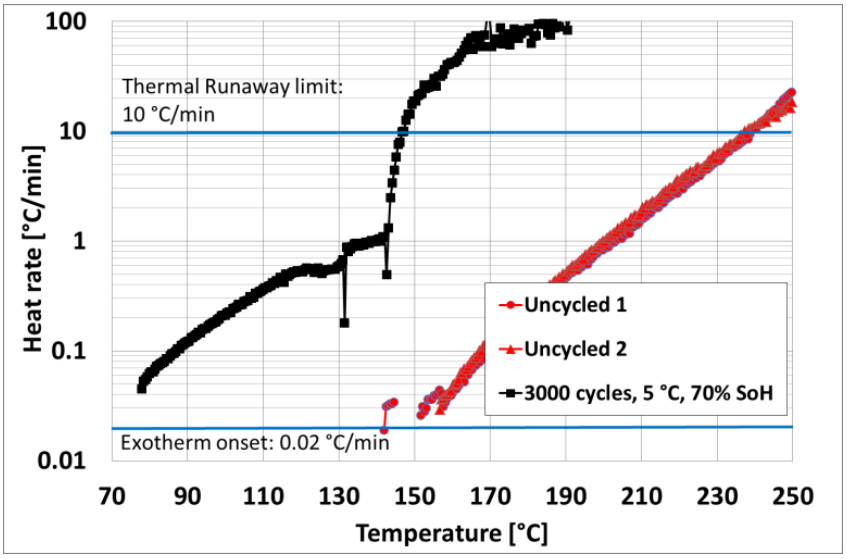

Figure 1. Comparison of ARC results for uncycled cells and an aged cell at 5 °C.

References:

1. Vetter, J., et al., *Ageing mechanisms in lithium-ion batteries.* Journal of Power Sources, 2005. **147**(1-2): p. 269-281.
2. Fleischhammer, M., et al., *Interaction of cyclic ageing at high-rate and low temperatures and safety in lithium-ion batteries.* Journal of Power Sources, 2015. **274**: p. 432-439.
3. Gilljam, M., et al., *7E. Effect of electrical energy and aging on cell safety,* in *Safety of Lithium Batteries*, J. Garche and K. Brandt, Editors. 2017, Elsevier.
4. Friesen, A., et al., *Influence of temperature on the aging behavior of 18650-type lithium ion cells: A comprehensive approach combining electrochemical characterization and post-mortem analysis.* Journal of Power Sources, 2017. **342**: p. 88-97.