Key take-aways from each article

**Article 1.0:** Analysis of Charging and Discharging Behavior of **Li-(SCiB).** Relation Between Capacity Degradation Rate and CE (**Jul/2019**).

1. The authors show the relation between the capacity degradation (SOH’s degradation) and CE with respect to the cycle number. The experiment was carried out with **constant C/2 and C/10 rates and at 45 °C and 25 °C.** Although SOH decreases as the battery gets more cycled, an increase in the number of cycles, **CE = Qd / Qc keeps very close to 1, always**.

**What could be done for ME754**: remove eta from our model.

**Article 1.1**: The relationship between coulombic efficiency and capacity degradation of commercial **lithium-ion (LiFePO4 and Li(NiMnCo)O2)** batteries (**Jan/2018**).

1. The authors explain that CE is a measure of the magnitude of side reactions.
2. **Their cycling used only 1C rate currents and was performed at 45 C**.
3. **CE** of their LiFePO4 cells did not decreased significantly after more than 2000 cycles **and ranged from 0.996 to 1.001**.

**What could be done for ME754**: remove eta from our model.

**Article 1.2.1**: Combined state of charge estimator for electric vehicle battery pack **(2007)**

1. The authors defended that CE is always smaller than 1 for different c-rates. However, their battery’s chemistry is **NiMH**, and, in top of that, it is a paper from 2007.

**What could be done for ME754**: remove eta from our model.

**Article 1.2.2**: A High Precision Study of the Coulombic Efficiency of Li-Ion Batteries (2010).

1. The authors explain that CE is a measure of the magnitude of side reactions.
2. Although they varied the temperature and C-rate, the C-rate was always very small (C/22 at least).
3. Figure 5 shows a plot of CE vs. C-rate. For temperatures lower than 40C, CE >= 0.995.

**What could be done for ME754**: remove eta from our model.

**Article 3.0: Estimation for Battery SOC Based on Temperature Effect and Fractional EKF. (Nov/2020)**

1. The authors measured the decrease of in the charging or discharging capacity of a LiFePO4 battery of 20Ah rated capacity.

**What was done for ME754**: used it in our model.

**Article 4.0:** An Improved Ah method (*AKA: Coulomb Counting*) for battery SOC estimation based on Temperature, Efficiency Model and Capacity Loss**. (Sept/2010)**

1. The authors carried out the measurements at different temperatures and C rates. However, it was done with a **NiMH** battery.
2. One interesting aspect though is that they used the discharge efficiency as 1 and proposed an equation for the CE charging efficiency that is based on the current and temperature.

**What could be done for ME754:** use their idea (figure 2) to have an equation that we can have the exact CE for each specific c-rate and temperature + invert our definition as well: CE discharging = 1 and CE charging = our proposed equation.

**Article 4.1:** Performance Evaluation of Lithium Polymer Batteries for Use in Electric Vehicles**. (Sept/2008)**

1. The authors investigated the performance of 100 Ah LiPoly batteries when they were still being studied as an option to be used in EV.
2. They submitted the batteries to CC/CV protocol from -20 up to +40 °C and verified that the CE was practically 1.00 from 0 to 40 °C.

**What could be done for ME754:** paper too old to be considered.

**Conclusion**

1. It seems that there are not many available studies in the literature that have measured the battery’s charge and discharge capacities varying both the temperature and c-rate.
2. Usually, the CE is defined simply as Qd/Qc for a constant, low c-rate (C/3, C/2 max). However, there are authors that defined CE slightly different, such as in 1.2.1 and 3.0. Either way, we should change our approach, so we do not have CE bigger than 1 and should try making the charging
3. The magnitude of the results observed for NiMH cannot be considered at all for LiFePO4. So, the minimum efficiency that we should have is 90%