Coulombic efficiency vs energy

a coulomb is a unit of charge. Equal to lots of electrons.a battery has a fixed amount of chemicals which react and need a fixed amount of electrons to complete reactions between empty and full.therefore an ideal battery needs a fixed number of coulombs

an amp is a coulomb per secondso, charge at 100 amps for 2 hours is 200Ah which is 720000 coulombsdischarge at 50 amps for 4 hours is 200Ah which is 720000 coulombs.

An ideal battery has the capability of driving a certain amount of charge around a circuit that being 200 Ah or 720 kC in your example. This represents 12 $times$ 720,000 = 8.64 MJ of energy stored in the battery.That is about it for an ideal battery other than actually giving it an infinite capacity, a constant terminal potential difference independent of the current though it and its temperature which implies zero internal resistance.

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In our water bottle example, the equivalent Coulombic efficiency would be 99% -- total (100%) minus percent lost (1%). 99% may sound like really good retention, but when you think about this happening many times in succession, the effect quickly adds up. For example, if you continue to pour the water back and forth between the two bottles 100 times, losing 1% of the water in each pour, you''ll end up with ~37% of the original volume, or 370 mL -- and that loss will be very noticeable.

This is similar to what happens in batteries. Lithium ions in a battery are like the water in our analogy, with each bottle pour representing another battery charge/discharge cycle. As lithium ions move between the anode and cathode during charge and discharge, some are lost to side reactions. No physical system is ever perfectly efficient, and although 99% efficiency may sound excellent, the following chart demonstrates how the energy storage capability of a lithium-ion battery with a Coulombic efficiency of 99% decays dramatically after only a few dozen cycles.[1]

Electric vehicle batteries must have excellent Coulombic efficiency, but that is not enough on its own. Battery cells can face a lot of challenges over a lifetime of hundreds of charge/discharge cycles, such as resistance growth or dendrite formation. A cell"s Coulombic efficiency represents the maximum limit of its cycle life performance, assuming these other problems don"t get in the way.

[3] This is because the loss of lithium is compensated for by the extra lithium available in the foil. However, resistance growth due to side reactions will reduce the accessible capacity, reducing the battery’s capability to store energy.

QuantumScape"s planned first commercial product, QSE-5, is a ~5 amp-hour cell designed to meet the requirements of automotive applications. Here, we"ll walk through the various elements of the cell specifications and explain some of the complexities behind the seemingly simple metric of energy density.