An Algorithm to Estimate Lithium-Ion Battery Lifetime

Park, Andrew (School: The Carol Martin Gatton Academy of Mathematics and Science in Kentucky)

Lithium-ion batteries are a crucial component in many applications. Failure to understand the battery lifetime can lead to rapid degradation, emission of harmful gases, and fatal explosions. Thus, mathematical models were created to estimate the battery lifetime, ensuring the safety and efficiency of these systems. Once a lithium-ion battery is not able to store at least 75% energy capacity compared to a new battery, the battery has reached its end-of-life, where further use may result in catastrophes. When electrical current is discharged, heat is transmitted. Properly functioning batteries maintain a stable temperature throughout its lifetime. However, defective batteries have a temperature anomaly, indicating its near-end-of-life. By gathering data on the parameters of 25 batteries as each was discharged at a constant 50A, equations that generate curves to accurately estimate the battery lifetime were created. One equation estimates lifetime as a function of average discharge voltage while the other as a function of discharge capacity. It was found based on 75% of the 1st cycle discharge capacity that the maximum projected lifetime of the current lithium-ion battery is ~2100-4130 cycles. Furthermore, discharge capacity will limit the battery lifetime before average voltage, but the average voltage the battery can deliver drops off significantly faster after a temperature failure. This algorithm accurately estimates lithium-ion battery lifetime with greater precision than before, ultimately increasing energy sustainability, ensuring safety and efficiency, and reducing economic costs. Further statistical analysis and different battery operating cycles can be modeled to predict the accuracy and practicality of the algorithm.

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