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Student Carl Spångberg (LTH)
Supervisors Richard Pates (LTH), Dimitrios Papageorgiou (DTU), Zoltan Mark Pinter (DTU), Chunyang Zhao (DTU)
Examiner Björn Olofsson (LTH)

State of Health estimation of battery systems

Popular science summary, Carl Spångberg

Estimating the state of health (SoH) of a lithium iron phosphate (LFP) battery system, is crucial for assessing the value and lifespan of new or used batteries in energy storage, grid support, and electric vehicle applications.

The use of batteries is increasing. New usage of batteries is being thought of, such as storing household electricity. The purpose of the battery investigated in this thesis is to support the electrical grid by supplying power to electric vehicles when no electricity is being produced. These batteries might come from used batteries to save resources and money. These used batteries could be from a used electric vehicle. A battery of an electric vehicle is used up when it no longer meets its capacity requirements. Even though the battery does not meet the capacity requirements, it can still be used for second-hand applications. If the batteries are acquired from second-hand applications, then it is essential to know what state the battery is in to determine the capacity of the battery.

A measure of the battery capacity compared to the initial battery capacity is considered the state of health of the battery. The state of health can indicate how long the battery will last. The battery's capacity can decrease in two ways: calendar aging, which is the decrease in capacity over time, and cycle aging, which is the decrease in capacity from the number of charges and discharges performed on the battery. This thesis has focused on the cycle aging of a battery and attempted to degrade a battery by charging and discharging the battery and, in turn, find a method to determine the state of health.

In order to see if the capacity decreases with cycle aging, the battery was charged and discharged two hundred times. One charge and battery discharge take approximately five hours to complete.

Models of the battery were created. The idea of the model was to simulate how the battery's voltage behaved during a charge and discharge. Two different types of models were created; one model was to simulate the voltage of the battery, knowing the current of the battery as it is being charged and discharged, and the other model's purpose was to simulate how a degraded battery voltage behaves during a charge and discharge.

This study could not fully determine the state of health of the battery. One reason for this is that the battery's original state was unknown. The lack of knowledge of the original state of the battery was because of not knowing previous usage before testing and the actual state of the battery from production.

One method to estimate the capacity in the battery showed that the battery capacity did not change significantly, even with two hundred charges and discharges. A lot of data have been generated during the charging and discharging of the battery. The data can be used to study the battery and employ other techniques to determine the state of health and increase the general knowledge of how batteries behave and degrade. Knowing how the battery behaves will allow controllers to run it to optimize its performance, maximize lifetime and increase the number of applications. The full thesis can be downloaded from https://lup.lub.lu.se/student-papers/