A study of parallel $LiFePO_4$ batteries cycle aging by using derivation curve

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Keywords: *derivationcurve, capacity fading, parallel, single*

Abstract

According to the practical engineering problems of battery energy storage system(BESS) and electric vehicles(EV),an accurate on-line estimation of the battery capacity is important for forecasting the EV driving range and BESS power dispatching. In practical engineering, because of the capacity limitation of single battery, the battery is paralleled to enlarge the capacity, but the characteristics is different between single and parallel battery, so it's necessary to analyze the characteristics between them. But because of the different driving environment, operation condition and the property of the battery, it is hard to estimate the capacity of the battery. Additionally, the capacity estimation iscalculated using coulomb counting equation usually, which in turn, will lead to a further capacity estimation error because of accumulative error.

This paper presents a new method, using the derivationcurvetoestimate the capacity of LiFePO4 battery by analyzing the charge/discharge data. Firstly, different alternative techniques for estimating the capacity are analyzed, a comparison of the incremental capacityanalysis(ICA) and differential voltage analysis(DVA) is provided. Especially, the characteristics of single and parallel battery is analyzed.

Further, in order to get the relationship between derivation curve and capacity of LiFePO4 battery over the lifecycle, the peak intensity, peak voltage,peak number and peak shift is analyzed. The characteristics of these peaks comply with the LiFePO4 battery intercalation and de-intercalation. According to the cycle data of single and parallel battery, the different capacity-fadingis shown, meanwhile, the current between the parallel batteries is tested in different battery SOC and charge rate.Under a certain interval of battery voltage V per unit time with a specific current, the area of derivation curve peak can be calculated, then the capacity of LiFePO4 battery over the lifecycle can be get.

Finally, by utilizing the actual cycle data, experiments andnumerical analysis were conducted, showing that this capacity estimation algorithm based on derivation curve has better robust performance of the practical application of LiFePO4 battery.