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Battery Grading Algorithm in 2nd-Life Repurposing LI-Ion Battery System

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Abstract : This article introduces a methodology that improves reliability and cyclability of 2nd-life Li-ion battery system repurposed as an energy storage system (ESS). Most of the 2nd-life retired battery systems in the market have module/pack-level state-of-health (SOH) indicator, which is utilized for guiding appropriate depth-of-discharge (DOD) in the application of ESS. Due to the lack of cell-level SOH indication, the different degrading behaviors among various cells cannot be identified upon reaching retired status; in the end, considering end-of-life (EOL) loss and pack-level DOD, the repurposed ESS has to be oversized by > 1.5 times to complement the application requirement of reliability and cyclability. This proposed battery grading algorithm, using non-invasive methodology, is able to detect outlier cells based on historical voltage data and calculate cell-level historical maximum temperature data using semi-analytic methodology. In this way, the individual battery cell in the 2nd-life battery system can be graded in terms of SOH on basis of the historical voltage fluctuation and estimated historical maximum temperature variation. These grades will have corresponding DOD grades in the application of the repurposed ESS to enhance system reliability and cyclability. In all, this introduced battery grading algorithm is non-invasive, compatible with all kinds of retired Li-ion battery systems which lack of cell-level SOH indication, as well as potentially being embedded into battery management software for preventive maintenance and real-time cyclability optimization.

Keywords : battery grading algorithm, 2nd-life repurposing battery system, semi-analytic methodology, reliability and cyclability
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