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Effects of rest time on discharge response and equivalent circuit model for batteries

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This work carries out a detailed investigation on the effects of rest time on the behavior of battery and the parameters of the Thevenin's equivalent circuit model for batteries. In traditional methods for battery modeling, the discharge responses were obtained after a sufficiently long rest time so that 0 initial conditions can be assumed for the capacitor voltages. This requirement for sufficiently long rest time prevents us to see how the duration of rest time affects the subsequent discharge behavior of the battery and its circuit model. In a recent work, we developed an algebraic method for parameter identification of circuit models for batteries under non-zero initial conditions. This makes it possible to reduce the rest time to almost 0 and drastically accelerate the modeling process. Furthermore, the new method opens a door to the understanding of the effects of rest time on battery behavior, which can be used for better simulation, analysis and design of battery powered systems, as well as for designing discharge profiles for improved battery efficiency and state of health. As we used the new method to extract circuit parameters and initial conditions after different rest time, we observed some unexpected results on the relationship between the rest time and initial conditions. The initial voltage on the dominant capacitor is negative and becomes more negative as the rest time is increased. This may indicate that energy is stored in the dominant capacitor during rest period and this energy is passed to the load during subsequent discharge. We also observed that the dominant time constant increases with rest time. Relationship between rest time and other parameters are also reported in this paper.

Keywords: Rest time, discharge response, circuit model, circuit parameters, time constants