Second Life EV Batteries State of Heath (SoH)

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INTRODUCTION

- When EV batteries degrade to 80-70% of their initial capacity, the EV owners should replace these batteries.
- Residual capacity becomes insufficient for automotive use and to address vehicle safety, efficiency and performance concerns.
- These batteries will be discarded from EVs. Therefore, these battery could be repurposed in other applications for instance charging stations, renewable energy integration
- SoH reflects the general condition of a battery and its ability to deliver the specified performance compared with an unused or fresh battery.
- To estimate SoH, the capacity fade needs to be estimated.

CHALLENGE

- Accuracy in estimating the SoH.
- Battery is nonlinear system, so there is a difficulty to accurately predict the remaining useful life.
- Many factors affect the lifetime of batteries.

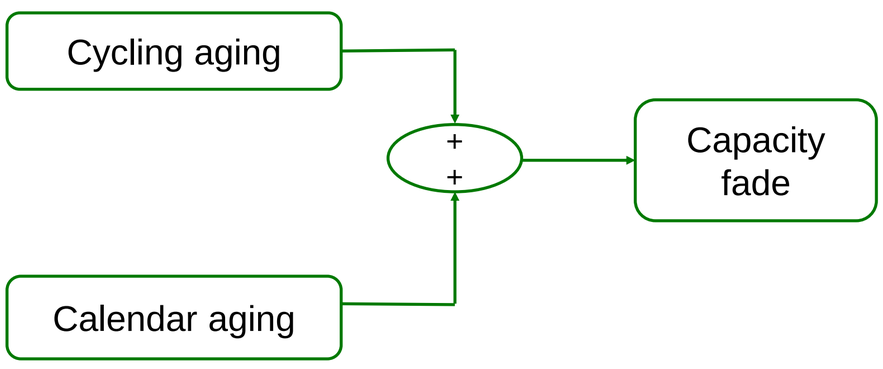

Fig. 1. Accelerated life test method.

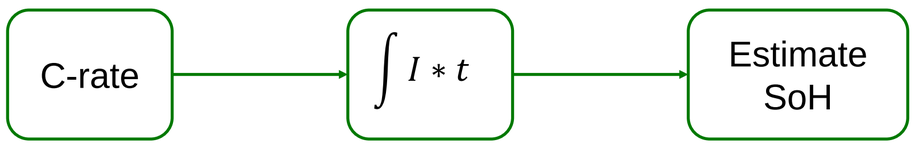

Fig. 2. Basic concept of Coulomb counting method.

OBJECTIVES

- To estimate the state of health of batteries.
- To predict the lifetime of batteries.
- To know expected performance.
- To increase the lifespan.

SIMULATION RESULTS

- Increased temperature during battery operation can improve battery performance (improve electrochemical reaction). However, high temperature shortens battery life
- Extremely low temperatures increase the battery internal resistance and decrease significant amount of discharge capacity
- Optimal cycle and storage temperature are 25 ℃ and 5-20℃ respectively
- The higher C-rate, the higher the capacity loss (should be less than 0.8C)
- NMC battery was used to predict its lifetime with one cycle per day assumption

	Temperature	SOC	C-rate	Voltage	DOD
In storage	5-25℃	Around 50%			
Cycling	20-25 ℃	25%-85%	<= 0.8	High: 3.92V Low:3V	Around 50%

Table 1. Optimal cycle or storage environments for maximum Li-ion battery longevity.

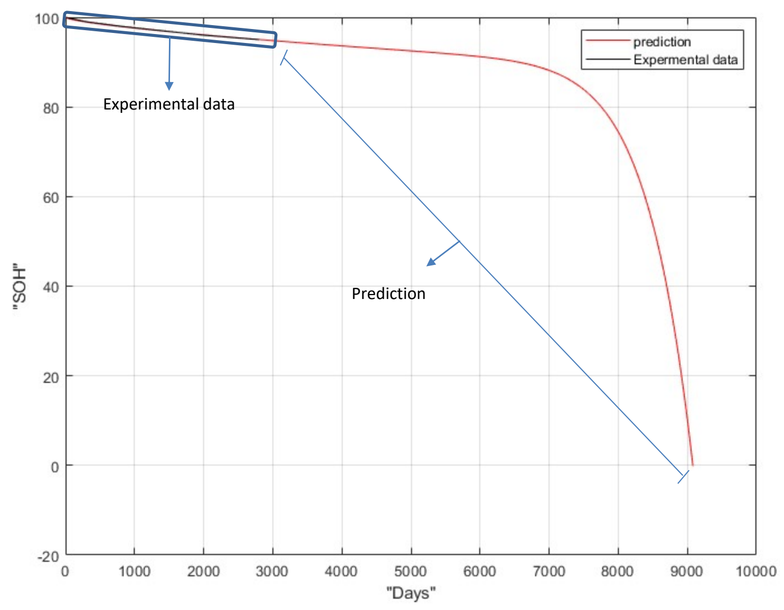

Fig. 3. Expected lifetime of the battery using accelerated life test method.

Cycle and Calendar conditions		
Cycle	$I_{ch} = 0.5C$ $I_{disch} = 1C$ DoD=87%	20℃
Calendar	50 SOC	25℃

Table 2. Operation condition of the battery.

	Lifetime
Expected lifetime (100%-0%)	24 years and 8 months
Second life (80%-40%)	2 years and 6 months

Table 3. Expected lifetime of the battery.

CONCLUSION

- Coulomb Counting method has been implemented in MATLAB to estimate SoH.
- Accelerated life test method has been implemented and this method allows one to approximately predict the lifetime of batteries and know the safety operation.

FUTURE WORK

- Validate and improve the accelerated life test method to predict the SoH under different operation conditions.

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