Characterization and the state variable estimation of a carbon foam lead acid rechargeable battery

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1. Introduction

The composite plate material of the carbon foam electrode battery is lighter, longer living, and has higher active material utilization than current lead acid systems. It is also one of the few lead-acid batteries that can operate for extended time in partial-states-of-charge. The battery includes carbon-foam electrodes for the negative plates, which gives it a performance that is comparable to NiMH but at lower manufacturing costs. In the work, a carbon foam electrode battery is characterized. With an equivalent, a linear system can be used to estimate the state variables in the model.

2. Experimental setup

Programmable DC Load
TekPower 3711A
(0-500Ω)

Programmable DC Power Source
BK Precision 1788
(0-32V, 0-6A)

LCZ meter
HP 4276A

LabVIEW software

3. Results and discussion

Figure 2 The voltage profile in the battery discharging

Fig.2 shows the cyclic discharging, 30 mins on and 15 mins off, of the battery and the testing stops at 10.6V, The capacity is 85Ah at 10A and 80Ah at 15A.

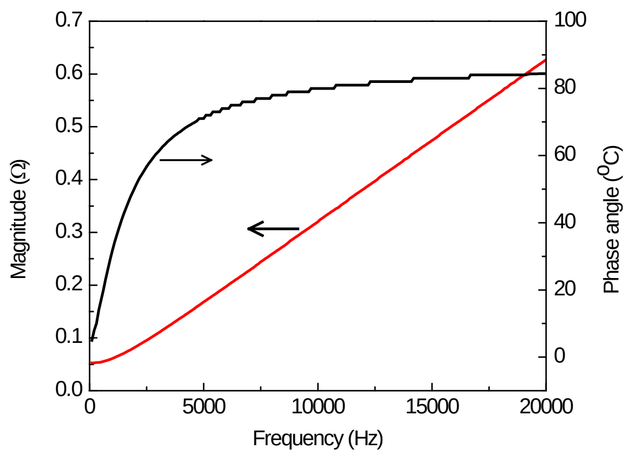


Figure 3 The impedance spectrum of the fully charged battery

The magnitude linearly increases with the frequency and the phase angle approaches to 83° at high frequency.

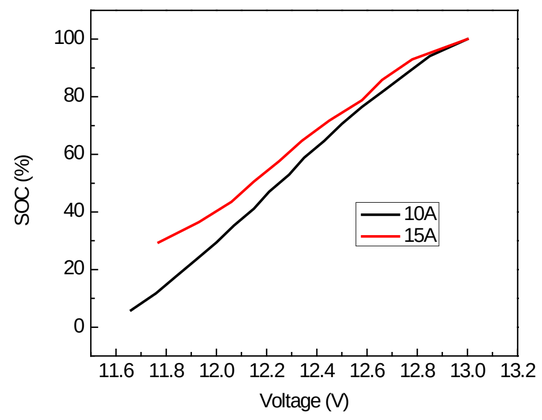


Figure 4 The relationship between the steady-state open circuit voltage

In Fig. 4, there are two curves, one for the discharging current as 10A and the other one for 20A. There is difference between them. If the discharging current is higher, the voltage drops faster.

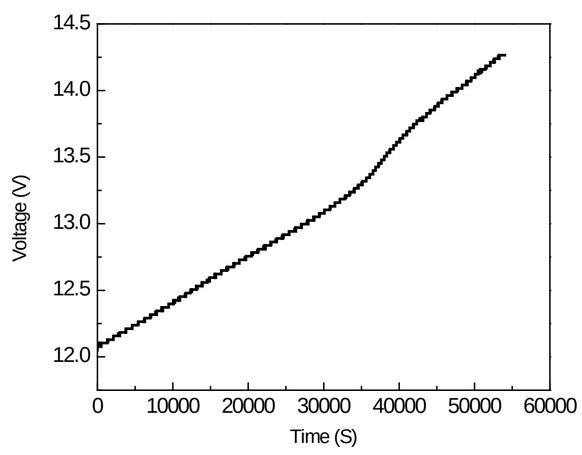
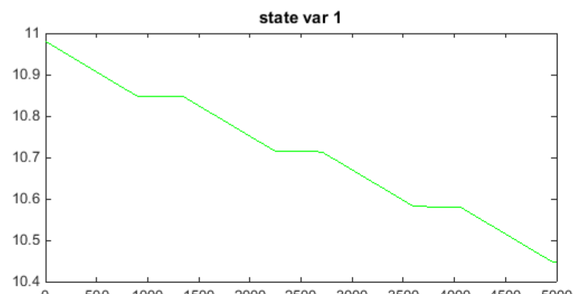
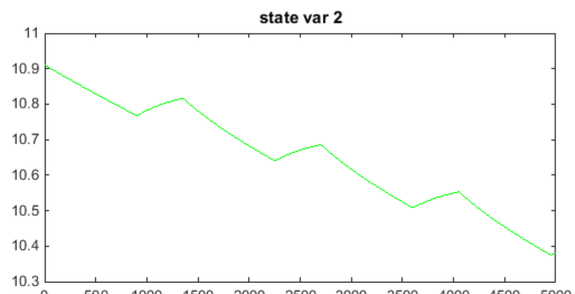
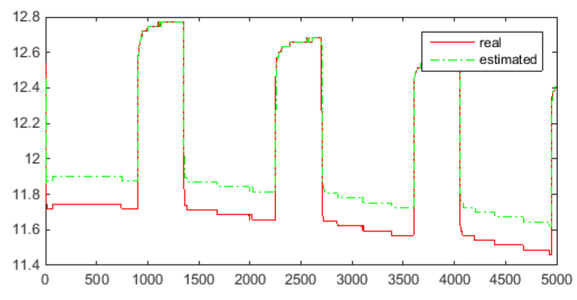


Figure 5 The voltage profile in the battery charging







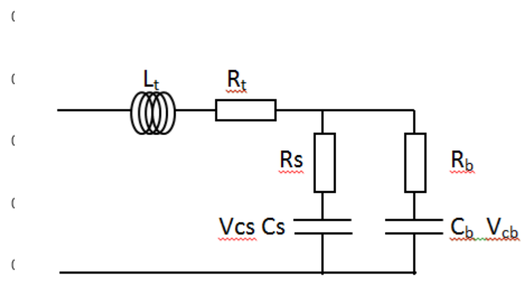


Figure 6 The profiles of the state variables and the voltage in the battery discharging

With an equivalent circuit, the state variables and the voltage can be calculated in Fig. 6

4. Conclusion

The capacity of the battery is 85Ah and the state variables in the equivalent are estimated.