An Algorithm of Charge-Discharge Curve Estimation and Full Charge Capacity Correction for Lithium-ion Battery Module

Masahito Arima [a b], Lei Lin [b], Masahiro Fukui [b]
[a] *Daiwa Can Company, 5-5-1, NishiHashimoto, Sagamihara-shi, Kanagawa, Japan*
[b] *Ritsumeikan University, 1-1-1, Nojihigashi, Kusatsu-shi, Shiga, Japan*

E-mail: m-arima@mail.daiwa-can.co.jp

As measure to reduce the influence of the renewable energy penetration, virtual power plant containing lithium-ion battery is considered. For economical operation of virtual power plant, full charge capacity (FCC) and charge-discharge curves of lithium-ion battery needed to be estimated in real time, so we studied an algorithm for it.

In order to study this algorithm, 8-series lithium-ion battery module (NMC ternary compound type, 29.6V, 1.48kWh) was cycled in 1085W constant power charge-discharge and 25 centigrade atmosphere. Then module's OCV and internal impedance vs state of charge (SOC) were calculated as 12 degrees polynomials. These polynomials and FCC from initial charge-discharge data were treated as initial functions.

In the estimation of charge-discharge curves, we studied the model which corrects a polynomial of OCV vs SOC by fixed learning rate based on the actual charge-discharge measurement in every 60 seconds. In order to correct this charge-discharge curves smoothly, it carried out by adding a gauss function and fitting of a polynomial of OCV again. In the correction of FCC, two points data of voltage and SOC from charge-discharge cycles were selected from SOC range of 0.4 to 0.6 and calculated the SOC difference (ΔSOC) between two data. Initial charge-discharge cycle SOC values which correspond to these voltage values were extracted by using the initial function. Consequently, the SOC difference between these data (ΔSOC_{ini}) were calculated. FCC value was corrected by ΔSOC_{ini} /ΔSOC value and fixed learning rate.

The result of calculating 1st to 1600th (every 50 cycles) cycle is shown in fig.1. and fig.2. Thus, charge-discharge curves and FCC values were calculated with sufficient accuracy.

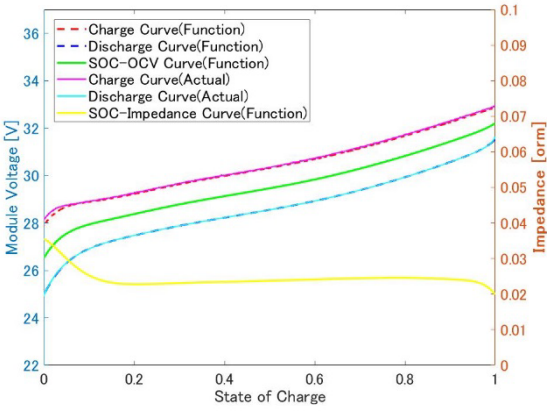

Fig.1. 1600th cycle curves estimation

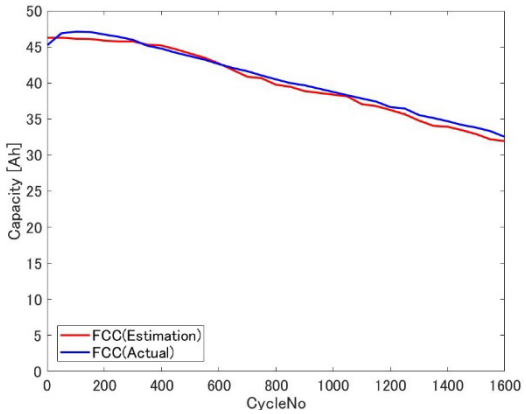

Fig.2. FCC values correction

References:
[1] L. Lin, N. Kawarabayashi, M. Fukui, S. Tsukiyama, I. Shirakawa, IEEE Vehicle Power and Propulsion Conference, (2014), 1-6.