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In-service State of Health Estimator for On-Board Battery Storage Systems (Part 2)

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Monitoring SoH (State of Health) of batteries and deterioration of batteries mounted on electric vehicles (EVs) is important to prevent accidents. To realize this function, the SoH estimating method that uses only operation data such as voltage, current and temperature is required. As such a method, we proposed delta voltage method. This method aimed for applications that use batteries as power sources, such as EVs, utilizing the concept of voltage deviation method which aimed for applications that use batteries as power regulator, such as BESS (Battery Energy Storage System) .

Delta voltage method uses difference between voltage average during charge and voltage average during operation (V_Δ) as a feature value of deterioration (FV). This method utilizes the characteristic that the voltage distribution of a deteriorated battery spreads. This characteristic is shown by Fig1. This figure shows QVplot of charge / discharge data simulating power regulator use. QVplot is a scatter diagram of SoC (State of Charge) and voltage. FV varies not only with deterioration but also with temperature (T) and power (P). Therefore, the estimation of SoH is performed by the following equations that adds temperature (T) and power (P) as explanatory variables. SoH is an objective variable. In this paper SoH is calculated by dividing 1C discharge capacity at 28℃ by rated capacity and multiplying by 100.

$$a(i) = b(i,1) * P + b(i,2) * T + b(i,3) \quad (i = 1,2)$$
$$SoH = a(1) * FV + a(2)$$

To show the robustness of delta voltage method, we applied it for another EV bus B different from EV bus A in previous paper. Data of EV bus B was obtained immediately after the start of operation. EV bus A and B have different configuration of batteries, and their conditions such as power and SoC range are also different especially in temperature (Fig 2). In order to reduce the effect of temperature difference, we used train data according to the temperature of the EV buses. Specifically, the model applied to EV bus A was constructed by train data under temperature of 36, 44, 52°C, and the model applied to EV bus B was constructed by train data under temperature of 20, 28, 36°C. Table 1 showed the results of evaluation. We confirmed estimated SoH was over 100% and SoH standard deviation was under 1% and showed that proposed method could also estimate proper SoH with small variation even for systems with different conditions.

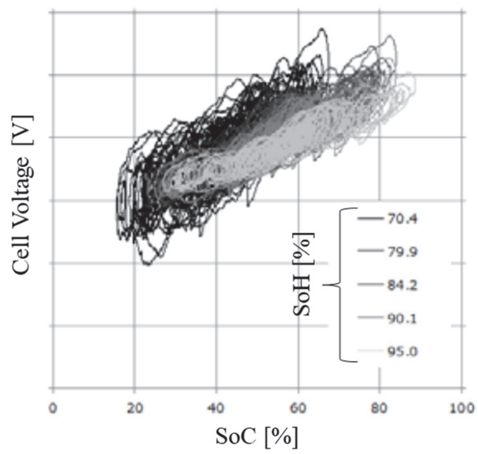

Fig1. QVplot of data of simulating power regulator

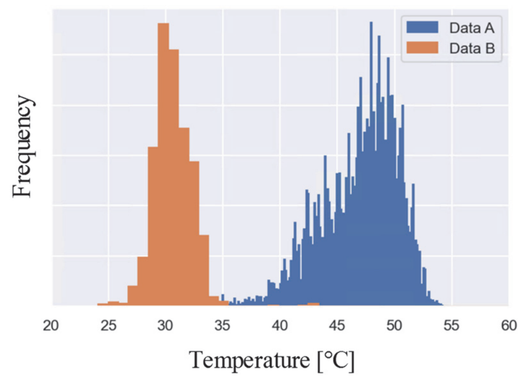

Fig2. Histograms of cell temperature

Table1 Evaluation Result

Result	Data A		Data B
	First week	Last week	
SoH mean [%]	104.16	102.85	102.36
SoH standard deviation [%]	0.94	0.97	0.54