Study on LOC FOR LiFePO4 batteries

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Abstract. The concept of dead zone SOC is proposed. Under the DZSOC threshold fusing mechanism, it can effectively protect the use of batteries, avoid deep discharge, and extend battery life. Analyze the DZSOC algorithm for LiFePO4 batteries and propose a load based DZSOC solution.

Keywords: DZSOC, LiFePO4 batteries, deep discharge.

1. Introduciton

Scholars and scientists at home and abroad have focused their research on the following key directions: battery modeling, calculation of state of charge parameters, equilibrium control, and design of energy management strategies. General battery management systems mainly have the following functions: parameter detection, charging control, capacity prediction, data management, communication display, and so on. The research on new energy is relatively early abroad, so the research on battery management is also relatively in-depth. Many management systems have relatively excellent characteristics, such as dynamic overcharge protection, intelligent charging, temperature compensation, and so on. China started relatively late and invested little in the early stage, but in recent years, it has developed rapidly and started to propose some technical requirements for battery energy management systems, such as state of charge indication[1-10], charge and discharge control, temperature compensation, circuit protection, etc.

2. Battery modeling methods.

Scholars have proposed many modeling methods , such as circuit equivalence, physicochemical reactions, experimental simulation, etc. They have also established many battery models, such as elementary battery models, improved models based on elementary models, Thevenin battery models, fourth order dynamics models, fuzzy control models, artificial neural network models, etc. However, the working process of a battery is very complex, and its performance is closely related to factors such as the characteristics of the electrolyte, the amount of active substances, the conditions of physical and chemical reactions, the rate of charge and discharge, temperature, state of charge, internal resistance, etc., and has a strong nonlinearity.

3. Calculation of State of Charge (SOC) parameters

South Korea is a research achievement from Ajou University and the Advanced Engineering Research Institute. In estimating the SOC of NiMH batteries, researchers proposed the SOC calculation formula 6, taking into account the actual available capacity, self-discharge rate, and the impact of battery aging on the capacity. Document 1 proposes the current integration method; Open circuit voltage method is proposed in document 2; Kalman filter proposed by Kalman.It can be used for optimal estimation of SOC. The method of extended Kalman filtering is proposed in Document 3 to estimate SOC; Reference 4 proposes using neural network technology to estimate SOC; Literature 5 proposes using fuzzy control methods to identify SOC.

4. Balanced charge and discharge

The University of Toledo in the United States uses a centralized non dissipative selective equalizer in its BMs. The design idea of this scheme is to select the monomer to be equalized by controlling the switching of the relay network, and equalize the charging of the selected battery. The hardware circuit and equalizing method are relatively simple, but the efficiency is relatively low. Many universities and companies in China have conducted research on balanced charging and discharging. The main methods are:

1)Install an equalizing circuit on each single unit in the battery pack for shunt.

2)The discharge method is used for balancing, which means that each monomer is discharged to the same level before charging.

3)The individual equalization method for each monomer detects each monomer in the storage battery at a fixed time and in a specific sequence to perform equalization control.

4)Time-sharing control is adopted, and switching of switch components is used to enable the higher voltage single battery to charge the lower voltage single battery, thereby achieving the purpose of equalization.

5)The strategy of centralized control and respective management is adopted. The entire balancing system is controlled by a microcontroller (microcontroller or DSP, etc.), and each single battery has a balancing unit. Use a program to control each module and manage each monomer separately. After the charging is completed, the program controls its disconnection.

Wu Tiezhou and Chen Xueguang from Huazhong University of Science and Technology discussed several key issues in lithium battery management, such as SOC algorithm, improved equilibrium method, and energy management strategy. Li Honglin, Sun Fengchun, and others from Beijing University of Technology have conducted research on equalization charging and protection systems for lithium ion battery packs. Jiang Xinhua from the Shanghai Institute of Microsystems and Information Technology, Chinese Academy of Sciences, described the testing accuracy and hardware.

The research on battery performance in this topic is mainly carried out in the following aspects:

1). Models for LOC estimation and aging prediction. The models in this paper include an equivalent circuit model for battery SOC estimation, a battery capacity model for LOC estimation, and a battery aging model for battery aging prediction. The establishment of equivalent circuit model mainly includes the analysis of the Thevenin model, the fitting of open-circuit voltage and SOC curve, and the identification of resistance and capacitance parameters based on exponential fitting

method; The battery capacity model is obtained by analyzing the characteristics of battery capacity changes during a short period of use; The battery aging model is

obtained by fitting the battery rated capacity attenuation data obtained in the cyclic aging experiment. 2). The battery's DZSOC (Dead Zone SOC) is a direct basis for the minimum threshold for sustainable driving of electric vehicles. This project proposes a charging and discharging algorithm based on DZSOC based on load power and battery SOC characteristics.

5. Features

Aiming at the current large error in SOC residual power of electric bicycles, electric motorcycles, electric tricycles, and electric cars, this product fully relies on the experience of end customers. This product uses AI technology, making the accuracy under full working conditions within 10%, and the accuracy under 80% working conditions within 5%.

The input variables are typically terminal voltage, discharge current, discharge capacity, and temperature. Its advantage is that the input variables it requires can be measured, and its use method is easy to transplant to the research of various types of batteries.

Dual threshold LOC algorithm has learning ability, self correction ability, stable performance, and high accuracy

Core advantages of dual threshold LOC

1. Up to ≤ 9% accuracy. Advanced AI wavelet neural network technology with high accuracy

2. Ultra low power consumption. The product has low power consumption, reaching mA level during sleep, and long-term use has no impact on the battery..

3. Visual display. Display relevant information through the user interface

Existing products:

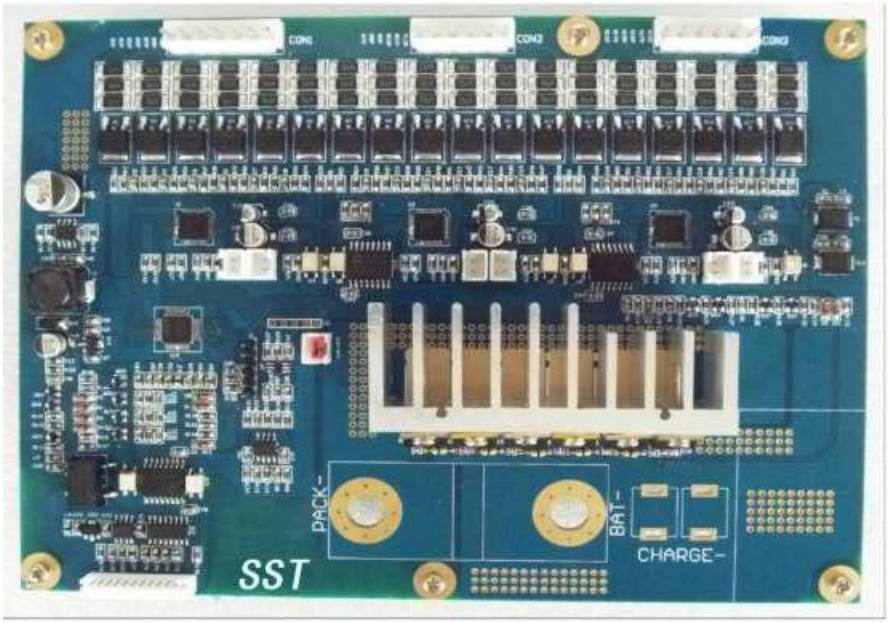

Fig.1. mainboard based on LOC algorithm

6. Conclusion

The reliability of the battery is studied from its state of charge. The relationship between the open circuit voltage and the state of charge of the battery is established using the equal charge state multi-step pulse discharge method; An improved PNGV model equivalent circuit is proposed. Using computer simulation technology, establish an estimation model for battery DZSOC and estimate the DZSOC value.

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