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Study on the Charging and Discharging Characteristics of the Lithium-ion Battery Pack

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Abstract. As the charging and discharging current ratio has an important influence on the charging and discharging characteristics of the lithium-ion battery pack, the research on it can provide the basis for the calculation of SOC and the safe use of the lithium battery. In this paper, the change rule of charging and discharging voltage is studied by means of experimental study. The results showed that the higher the charging current ratio is, the more the voltage drop after the voltage reached the stable state, and the maximum decrease of 0.95V.The higher the discharging current ratio is, the greater the battery discharge to the cut-off voltage after reaching steady state voltage, highest in 1.21 V. Namely, the battery pack is stable after the open circuit voltage and closed circuit voltage difference between charging and discharging current into positive correlation.

Introduction

Aviation lithium battery pack, as the planes' auxiliary power energy, is used to check the main instruments, supply electricity for the ignition device and emergency energy supplement for a sudden accident. In practical application, it is used with groups no matter in electrical car or in aerospace. But at present, the study of lithium battery's charging and discharging electrical performance aims at researching single lithium battery cell. Thus the conclusion may ignore the inconsistencies between the group work units and a single cell, and then it will influence the status of lithium battery when estimating the group lithium battery status. And finally this process will lead to the wrong estimation of lithium battery state. So it is necessary to study the charging and discharging characteristics of aviation lithium battery in groups.

At present, some researchers have done some researches on the working characteristics of lithium batteries in groups. Mao Wenlong, Liu Jianwen et al. studied the electrical properties of a high-power lithium iron phosphate battery after full charge storage for a long time; Fu Qiang, Wei Pingfen et al. studied the key parameters of the battery pack in terms of battery pack performance evaluation methods; Rao Minmin, Wang Zuolong et al. studied the room temperature and low temperature startability, rate override performance, and low temperature discharge performance of lithium iron phosphate battery packs used in automotive start-up power supplies.

This paper mainly studies the performance changes of lithium-ion battery packs under different charging and discharging rates. The charging-discharging experiments at different magnifications are used to obtain the parameter curves that characterize their state changes, thus provide a theoretical basis for the effective and safe use of lithium battery packs.

Experimental Procedure

The capacity test of aerated lithium cobalt oxide battery used the method of full discharging. Lithium-doped lithium cobalt oxide batteries are placed in different temperature environments for discharge experiments to discuss the impact of changes in ambient temperature on the battery discharge capacity. Specific steps are as follows:

1) The charging method is: charging the battery pack at constant charge rate A, and stopping the charging until the battery pack voltage reaches 29.05V or any single battery in the battery pack is greater than 4.15V;

2) The discharging method: put the battery in the ambient temperature for one hour, and then discharge the battery pack at the discharge rate B, until the battery voltage drops to 21V or any cell voltage in the battery pack is lower than 3V. Stop discharging;

3) Change the battery charge and discharge rate, charge and discharge experiments, record the battery voltage during charge and discharge changes, the charge and discharge rate as shown in Table 2;In witch, a is the charge rate, b is the discharge rate.

4) According to the experimental data, the curves of the battery voltage under different charging and discharging rates are drawn in the course of charging and discharging.

Table 1. Basic technical parameters of 7ICP3 lithium battery.

Factor	Parameters
Rated voltage/V	3.7
Rated capacity/(A·h)	4
Discharge cut-off voltage/V	3
Charging cut-off voltage/V	4.15
Working-temperature range/℃	-15~70

Table 2. Charge and Discharge Current Magnification.

	2ed-group	3th-group	4th-group	5th-group	6th-group
a	0.2C	0.3C	0.5C	1C	1.2C
b	0.5C	0.2C	1C	1.2C	0.3C

Experimental Results and Analysis

The Charge Characteristics for Lithium-ion Battery Pack with Different Rate

Figure 1 is the change curve of the battery voltage with time in the charging process. It shows that in the lithium battery charging process, higher the current multiplying rate is, the faster the battery group can reach the set charge cut-off voltage.

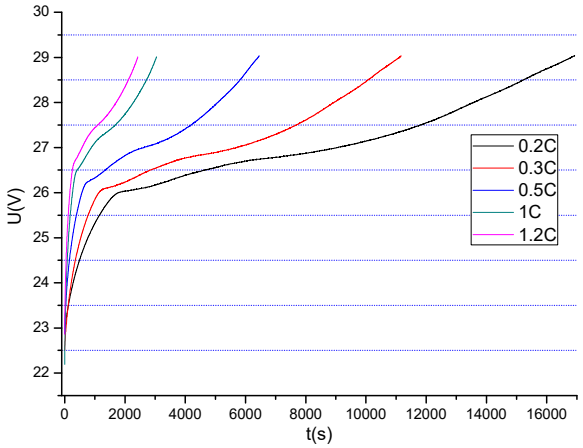

Figure 1. The change of battery voltage with charge current multiplying ratio.

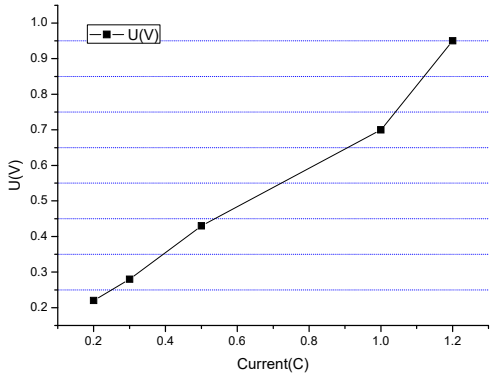

Figure 2. The voltage variation with the discharge rate of recovery.

The phenomenon of voltage drop in memory at the end of the charge is mainly caused by Ohm internal resistance and polarization internal resistance. Table 3 is the voltage parameter of the battery pack after an hour after charging.

It is shown by Figure 2 that the voltage drop caused by the ohm internal resistance and the polarization internal resistance is positively related to the charging current multiplying. The growth trend is faster and faster, that is, the charge current ratio is negatively correlated with the open circuit voltage.

The Discharging Characteristics of Different Rate

As shown in Figure 3, Aeronautical lithium battery pack are drawn through experimental data to draw the curve of battery voltage changing with time at different discharge rates in the discharge process.

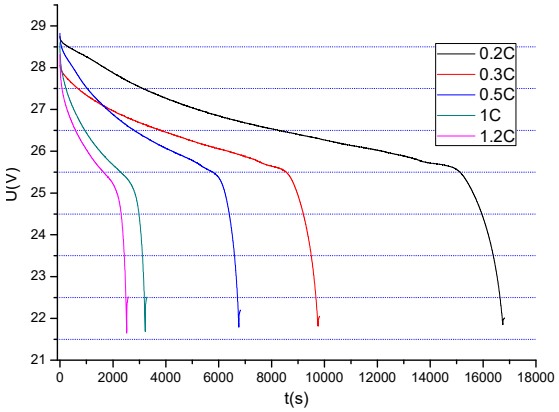

Figure 3. Change of battery voltage with discharge current multiplex.

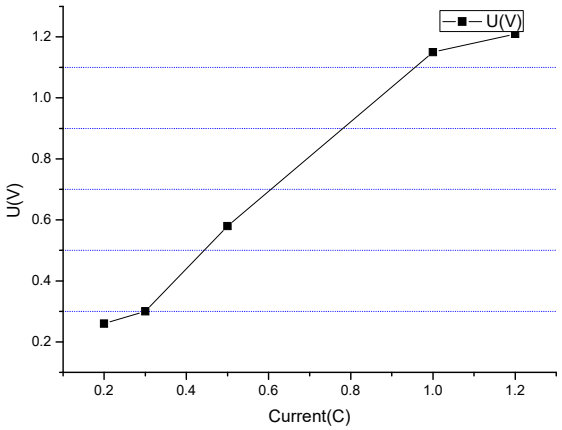

Figure 4. Variation of voltage recovery with discharge ratio.

Due to the influence of the battery pack inconsistencies, a battery monomer to cut-off voltage in advance and make the battery voltage can't down to 21 v, as shown in figure 3, the voltage is greater than 21 v voltage variation curve. Learning from the voltage change curve, the discharge inception voltage is affected by the charging ratio and differences, in the process of discharge of the lithium battery pack, the discharge current ratio, the greater the battery faster to set the default of electric discharge by the voltage, and reaches the cut-off voltage value, the smaller the discharge end because of the ohm internal resistance under different discharge rate and polarization resistance, the influence of the size of the voltage recovery also has bigger difference. Fig. 4 is the relationship between the voltage recovery of the battery pack and the discharge rate after an hour after discharge.

Figure 4 illustrates the battery discharge after the electricity, the ohmic resistance and the polarization resistance caused by voltage recovery are positively correlated with the charging current rate, the growth trend along with the increase of current ratio gradually flatten out.

Conclusions

By detecting in non-charging and discharging rate, the aeronautical cobaltic acid lithium battery charge-discharge curves of voltage and the voltage change on stand for an hour after charging and discharging, this paper analyzed the relation between the charge-discharge rate and the aeronautical cobaltic acid lithium battery properties. In the charging process, if sufficient charge is supplied to the battery, a small rate charge current is selected, in the discharge process, can use large rate discharge current that the battery could be withstood to achieve the actual power requirements.

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