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High Precision Estimation of Internal Resistance of Battery

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Abstract

In the article we propose the new method of increasing the accuracy of the estimation of internal resistance and estimation of the residual capacitance of battery, taking into account the duality of the regime of battery. The estimation of the internal resistance of battery is widespread, but without research of the influence of the regime of battery. The duality of battery assumes a change in the activity of electrochemical active masses, which is examined in this work. In the article examined method of evaluating of residual capacitance of battery according to the value of internal resistance realized without presence of known model of battery. The method of determining of residual capacitance and internal resistance into one express test for the unknown battery without the extraction of the system is considered. Analysis of dependence, obtained in a research, leads the estimation of the internal resistance of battery to the point of testing. This makes it possible to reveal the connection of the point of testing with the residual capacitance.

Keywords: Railway safety; Battery control; Automatic control; Reliability

1. Introduction

Studying of question about condition estimation has revealed that the manufacturer of batteries and measuring devices manufacturer use to various standards for realisation of an estimation of internal resistance $(R_{int})^2$. So manufacturers of batteries estimate condition of the battery, following standard IEC896. Users use an estimation of R_{int} of the battery, as equivalent serial resistance to alternating current ESR. The manufacturers of the devices realise given technology, follow standard IEC512. Possibility not to change a battery operating mode at carrying out of

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testing[4] is advantage of the devices made according to standard IEC512. That is the user gets advantage of operative testing. Thus, at operative testing the condition of maintenance conditional for the given type of the battery of a point of the test cannot be determined. It demands research of influence of a mode the battery on an estimation of R_{int} or ESR. The received analytical expression, allow to correct estimations ESR. The given correction allows performance of estimation of ESR with the raised accuracy.

2. ESR hypothetical dependence from mode

Let's distinguish the battery in modes of loading and a source, expression (1) and (2) accordingly. The energy, stored in batteries in a load mode:

$$E_{\text{charge}} = E_{\text{initial}} + \int_0^T U_{\text{battery}}^{\text{charge}}(t) \cdot I_{\text{charge}}(t) \cdot dt, \tag{1}$$

where:

$E_{initial}$ – initial energy of battery,

I_{charge} – current of charge in time *t*,

$U_{battery}^{charge}$ - voltage of charge in time *t*,

T – charge cycle.

The energy, provided from battery in a source mode:

$$E_{discharge} = \int_{\tau 1}^{\tau 2} U_{battery}(t) \cdot (I_{discharge}^{load}(t) + I_{discharge}^{self}(t,T)) \cdot dt, \tag{2}$$

where:

$I_{discharge}^{load}(t)$ – current of discharge in time *t*,

$I_{discharge}^{self}(t)$ - self-discharge current of battery in time *t* according influence of charge cycle *T*,

$U_{battery}(t)$ - voltage on battery in time *t*,

$(\tau 2 - \tau 1)$ - time interval of discharge.

The battery mode defines processes in electrochemical mass of the battery, hence, is hypothetically prospective for a condition $I_{discharge}^{load}(t) >> I_{discharge}^{load}(t)$, and

$$\Delta R_{int}^{discharge} / \Delta I_{discharge} > \Delta R_{int}^{charge} / \Delta I_{discharge}. \tag{3}$$

The hypothetical dependence of R_{int} explaining expression (3) is shown in Fig. 1.