

Summary of Ph.D thesis

of MSc. Wojciech Kurpiel

on "The impact of the balancing system on the durability and safety of lithium cell batteries on selected power supply systems of mining machines"

The doctoral dissertation is devoted to the important and current issues of reliable and safe operation of mining equipment when powered by lithium-iron-phosphate batteries. Analyzes and assesses the level of threats using selected lithium-iron-phosphate (LiFePO_4) cells in the coal industry. Presents a critical analysis of the literature on lithium cell balancing systems (BMS) commonly used in the world. To assess the usefulness of selected lithium-iron-phosphate cells, the criteria for their energy efficiency and operational reliability without and with the use of as passive and selected active balancing systems have been formulated. The newly developed two models of active balancing systems are presented together with the analysis of the results of the comparative studies. To confirm the obtained laboratory results, respective tests were carried out under real mine conditions for batteries consisting of lithium-iron-phosphate cells with an active balancing system of the "cell battery" type powering the selected mining suspended vehicle type PCA-1. The usefulness of the developed active BMS structure was compared both with an active BMS system using the "battery cell" method and with a passive BMS solution. The tests were carried out under variable ambient temperature from + 5 °C to + 60 °C, simulating the conditions of mismatching a different number of cells in the battery. Particular attention was paid to the balancing efficiency of the BMS during the simulated uneven discharge of a randomly selected number of cells (from 12.5% to about 37.5% of the total number of cells in the battery). Based on the results of comprehensive laboratory and bench tests as well as in real operating conditions, appropriate conclusions and practical recommendations were formulated regarding the possibility of ensuring effective and safe operation of lithium batteries in the power supply systems of selected mining machines.

Wojciech Kurpiel