SUMMARY OF Ph.D THESIS

of Bartosz Polnik

on "Analysis and investigations of the supply-and-control system for mine battery locomotive"

The doctoral dissertation is devoted in general to problems of efficiency and safety of operation of mine battery locomotives used under mine underground conditions. Due to serious problems with roadways effective ventilation, there is an increasing tendency to replace diesel motors by electric drives. To-day battery locomotives indicate a similar mobility as diesel locomotives, but they are much more effective and neither produce harmful gasses and nor emit higher amount of heat. Thus, to increase efficiency of operation of the electric locomotive first of all the increase in electric drives efficiency is required. To achieve this goal the author has recommended the increase of the efficiency of a supply-and-control system by application of the brushless permanent magnet synchronous motors of much high efficiency, supplied by a 4-quadrant energy transducer with simultaneous recovery of electric energy during braking.

The doctoral thesis focuses on analyses and testing of operational efficiency of supply-and-control system used in battery mine locomotives with a special attention paid to emission of hydrogen during the energy recuperation process. The efficiency of the selected battery locomotives operating in mines was first determined and a possibility of recovery of energy during braking was tested specifying the time of motor operation for each real cycle mode (motor- generator) as well as with measurement of hydrogen concentration inside batteries enclosures. On the basis of the results, the concept of a new supply-and-control system dedicated for mine battery locomotive with brushless synchronous motors with permanent magnets has been developed. A physical model of the new supply-and-control system was assembled and tested under laboratory conditions . The test results have proved a significant increase in the motor effectiveness however, unfortunately it is associated with emission of hydrogen of dangerous concentration during braking with recuperation of energy. Due to this risk the simulation analyses and testing were carried out to determine concentration of hydrogen and its distribution inside the battery enclosure. Basing on the test results it was possible to determine the places of the hydrogen accumulation therefore, the

places of installation of electrolytic gases sensors. Tests for the selected batteries were performed both under the laboratory as well as the real conditions determining also the impact of recharging current value and its waveform on hydrogen emission process . It was found that recharging current waveform does not impact significantly the hydrogen concentration. It first of all , depends on battery charging level and recharging current value. As a result the new system controlling the parameters(to secure the safe operation of acid-lead batteries) was developed and was tested in the laboratory (under conditions recreating the real operation). Reliable operation of the developed system, which was adapted for integration both with the new and the currently used supply-and-control systems of the mine battery locomotives, was confirmed . Finally,, the conclusions on practical use of the developed supply-and-control system with recuperation of energy during braking to secure effective and safe operation of mine locomotive have been formulated..