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# Electrohydraulic control systems for powered roof supports in hazardous conditions of mining tremors

*Dawid Szurgacz* *

*Katowicki Holding Węglowy SA, KWK Wujek – Ruch Śląsk Mine, Katowice, Poland*

ARTICLE INFO

*Article history:*
Received 13 September 2015
Received in revised form
2 December 2015
Accepted 7 December 2015
Available online 14 December 2015

*Keywords:*
Powered roof support
DOH-matic control system
Workplace safety

ABSTRACT

This paper presents an application of a powered roof support equipped with an electro-hydraulic control system to underground excavations with mining tremors hazard. The research included an analysis of mining and geological conditions of longwall 2, seam 506, section K in Wujek Mine, Ruch Śląsk and an assessment of a system providing protection from dynamic loads for a hydraulic leg of Glinik-12/23-POz powered roof support. The final results of the research include an optimization of a powered support's protection system designed to work in mining and geological conditions of longwall 2 located in seam 506 K. The optimization was based on tests of the hydraulic leg and the support system for hazardous conditions of mining tremors. The process included proper operation of relief valves, leg's valves (check control valve), bearing capacity of the leg and a cross-bar.



## 1. Introduction

Powered roof support is one of the basic machines of the whole longwall complex that determines the safety and efficiency level of the mining process. The roof support working in hazardous conditions of mining tremors should be adapted to absorb dynamic loads. In the next years Polish mining industry will try to design solutions that allow limiting the number of personnel responsible for the control of machinery in the longwall. Decreasing the number of failures of machinery and equipment connected to technological process of coal mining is equally important as increasing the safety level of staff during mining (Lu et al., 2011). Control system of the powered roof support takes place according to specific stages. In order to conduct its proper and safe operation the following aspects should be provided (Smużyński, 1993):

- maximum safety level of the staff,
- maximum time reduction of process individual stages by elimination of unnecessary breaks and, as a result, greater speed of sets readjustment,
- optimal adjustment of the roof support to difficult mining conditions,
- elimination of personnel errors by application of semi-automatic and automatic systems.

Basic presentation of the control system for roof supports is presented in Fig. 1.

Katowicki Holding Węglowy S.A. uses newer and more reliable machinery systems in order to increase efficiency of coal mining. The basic characteristic of coal mining is an increasing level of hazardous mining and geological conditions which are caused mainly by mining in lower levels. This

* ul. Kominka 23B/28, 44-217 Rybnik, Poland. Tel.: +48 696 775 496, +48 32 244 86 62; fax: +48 32 244 8559.
E-mail address: dawidszurgacz@vp.pl.

Peer review under responsibility of Central Mining Institute in Katowice.
http://dx.doi.org/10.1016/j.jsm.2015.12.001

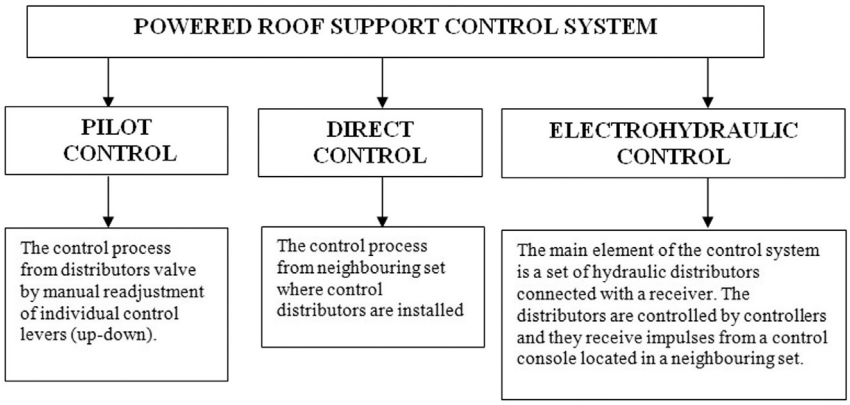


**Fig. 1 – Powered roof support control system.**

raises the level of mining tremors occurrences. Thus, the mines that are a part of KHW S.A. are trying to limit the number of necessary personnel working directly by operating machinery.

DOH-matic electrohydraulic control system for Glinik-12/23-POz powered roof support has been applied for the first time by KHW S.A. in KWK Murcki-Staszic – Boże Dary Mine. The control system was designed in cooperation with Elsta Company, Centre of Hydraulics DOH and University of Science and Technology in Krakow with executive work of Katowicki Holding Węglowy S.A.

The aim of the research project was to determine the capabilities of the longwall operation working in an automatic mode. The project involved a number of tests and research focused on data which would allow to design software for a powered roof support operation in a full automatic mode. Obtained data also proved the correctness of the method for roof support selection to work in given mining and geological conditions. Measurement data gathered in the system allow to conduct a number of analysis, such as pressure parameters monitoring in the under-piston compartments of hydraulic legs, operation of fast-release valves proving the proper selection of the roof support and hydraulic support in regard to given mining and geological conditions.

Such system allows using all functions required to control the powered roof support and enables to integrate it with other elements of the mining system. Moreover, the system includes full monitoring of the mining complex both, in underground excavations and at the dispatch office (Janik, Kuska, Świeczak, Wojtas, & Fitowski, 2011, 2012; Kasprusz, Mikuła, & Wojtas, 2013; Kozieł, Jasiulek, Stankiewicz, & Bartoszek, 2012; Krauze, 2007; Schaeffer, 2008).

The article provides possibilities of the longwall complex automation, including DOH-matic electrohydraulic control system designed to work with the powered roof support in mining and geological conditions of longwall 2, seam 506 K in KWK Wujek – Ruch Śląsk Mine.

## 2. Basic functions of the system

The electrohydraulic control system for powered roof supports has a number of advantages and positive characteristics. The research showed that the longwall equipped with the electrohydraulic control system, when its operation process is correct, has a greater level of safety than the longwall without such system. Even if the capabilities of the automation of the system are not fully used, the system is a valuable tool supporting top productive results. Such control system, however, has to be set and configured in a way allowing a steady shift from manual control to fully automatic control (Liduchowski & Wojtas, 2004; Wen & Lian, 2011).

Safety of the mining exploitation is the basic requirement that must be met by the electrohydraulic control systems. It should be done by introducing function of emergency manual control for work of a given unit directly from the electrohydraulic set. Additionally, the system should be adjusted to work in extremely difficult environment and should be protected from mechanical damage (Jaszczuk & Krodkiewski, 2001).

DOH-matic electrohydraulic control system for powered roof support units consists of a number of devices. The range of responsibility of such devices is presented in Photos 1 and 2.

These units form a unite element responsible for:

- control system of solenoid valves in the main control valve of a given unit,
- gathering of control and measurement data required to diagnose the system and data used as input data for algorithms controlling a given unit,
- user's interface for a unit's operator during manual operation, support for the unit's operator during advanced control and providing an automatic mode of control system and control of a roof support unit.

The set includes the following devices (acc. to tasks) (Janik et al., 2011, 2012; Kasprusz et. al., 2013; Kozieł et al., 2012; Krauze, 2007; Schaeffer, 2008).

- MS-01 module mounted in solenoid valve module, responsible for safety control – the unit consists, in addition to main elements, of a system responsible for feedback diagnosis as controlled by the solenoid valve,
- LR-01/*/* device used as distributor/concentrator of data from/to the set of solenoid valves. Due to module character