ON THE NECESSITY OF DEVELOPING AND IMPLEMENTING A CONTROLLABLE ELECTRIC DRIVE FOR MINE CHAIN CONVEYORS IN UNDERGROUND COAL MINES

Evtim Kartselin

Romeo Alexandrov

Kiril Negrevski

University of Mining and Geology "St. Ivan Rilski" Sofia, 1700 Bulgaria University of Mining and Geology "St. Ivan Rilski" Sofia, 1700 Bulgaria Ministry of Power Industry and Resources Sofia, Bulgaria

ABSTRACT

Because of some advantages of mine chain conveyors in comparison with other transportation equipment they imposed themselves as ones of the basic mine machines taking part in the technological sequence of underground coal mining. Besides those advantages which ensure a wide range of applications for the chain conveyors, they are also characterized by a number of essential drawbacks requiring new, up-to-date solutions.

An analysis of problems accompanying the utilization of chain conveyors is carried out in the present report, and the main trends and possible technical solutions for their modernization are discussed.

A special place is dedicated to the considerable impact exerted by the driving system on the qualities of chain conveyors.

The report conclusions generalize the importance of the task of developing and implementing a controllable electric drive of mine chain conveyors in underground coal mines.

Key words: mine chain conveyors, controllable electric drive, reliability, safety.

The mine chain conveyors (MCC) are used for coal transportation from mining faces in flat or steep seams and nowadays they are ones of the most widely applied machines in underground coal mining. The advantages of mine chain conveyors are connected with the high mechanical strength of their traction member (steel chain) and sections, small size, relatively simple and easy assembling and disassembling, possibility of applying them in other operations (as a carrier of a cutter plough, as a track for relocating a coal getter, etc.), operational reliability at various slopes, possibility of mechanized movement. All these advantages determine the wide range of applications and future perspectives for MCC in coal transportation as well as in underground mine construction.

The basic driving mechanism of all types of modern MCC designs is the electric drive consisting of the following main components: an electric motor; a reducer; a hydraulic turbo-coupler connecting the electric motor to the reducer, and a switching device for which mine magnetic starters are mostly used.

Squirrel-cage induction motors are most frequently used in the electric driving of MCC. The induction motor features a number of advantages in comparison to the d.c. electric motors. These advantages are mainly expressed by the lack of a brush assembly, relatively simple design, higher reliability, lower-value (for the same power) size and weight data, etc.

The insufficient controllability of squirrel-cage induction motors is the main reason not only for quickly exhausting the

performance resource of the MCC drive itself, but also for the low efficiency of its automation scheme.

Improving the driving system will not be possible without thorough and all-embracing studies of the performance regimes of MCC. These studies are oriented towards two principal directions: investigating the transient (starting, hard braking) and steady-state operating modes.

Controlling the travelling speed of traction member at a high rate of conveyor productivity (up to 1000 t/hour) allows to attain a considerable increase in its performance resource.

The operational processes of mine chain conveyors are accompanied by the occurrence of extreme mechanical loads causing failures of individual assemblies and components in the transmission and traction member. In this connection developing efficient technical means and methods for MCC protection against overloading will result in a large-scale economical and social effect. The main reason for the occurrence of dynamic overloadings is related to the abrupt increase in resisting forces acting upon the conveyor's traction member, which leads to its instantaneous shut-down.

It should be also taken into account that dynamic overloadings are directly proportional to the braking interval and the value of the system's inertia moment.

It is well known that the electric braking of squirrel-cage induction motor leads to transferring energy into the armature, and the value of that energy is equal to the kinetic energy stored at the initial instant of braking. This fact permits to make the conclusion that using electric braking in the driving system of a chain conveyor in the case of blocking up of its traction member will allow a considerable reduction of the quantity of kinetic energy consumed in the deformation of design components, and in such a way the dynamic forces emerging in the transmission and traction member will be reduced as well.

That is why, in developing a controllable system for MCC's electric drive, it should be required that the system shall ensure a possibility of constraining the dynamic forces by using an electric braking process. Such a solution will considerably simplify the mechanical part of the electric drive (there will be no need of including a protective coupler any more) by introducing a slightly more complex electric circuit at the expense of using thyristor switching devices for the control of squirrel-cage induction motors.

CONCLUSIONS

1. Developing and implementing a controllable electric drive to improve the technical and operational parameters of mine chain conveyors is an important task of considerable economical and social effect.

2. According to the initial estimations, developing a controllable system for the electric drive of squirrel-cage induction motor using thyristor switching devices is the most optimal solution that requires additional investigation and advantage evidences in comparison with other possible solutions.

3. The system of controllable electric drive for MCC should meet the requirement for realizing a regime of electric braking for the driving squirrel-cage induction motor.

Recommended for publication by Department of Mine Electrification, Faculty of Mining Electromechanics