both velocity of ions formation and velocity of convection removal of space charge.

Key words: EHD flow, ion-molecular structures, high voltage, liquid dielectrics

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DEVELOPMENT OF AUTOMATIC SPEED CONTROL SYSTEM FOR SYNCHRONOUS DRIVE OF HIGH-POWER TUMBLING MILLS

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Purpose. Study the possibilities to increase the efficiency and decrease energy consumption of powerful tumbling mills.

Methodology. The studies were carried out through the justification of operating modes of tumbling mills and determination the methods of reaching their maximum efficiency by adjusting the operating mode.

Findings. One of the ways of efficiency increasing of powerful tumbling mills is to improve the technology of grinding, as well as the use of more modern systems of electric drive.

The grinding technology involves the following methods of minerals destruction [1]: by friction, impact, and in a combined way. The implementation of these methods in tumbling mills is created by operating modes: cascade, cataract or combined.

The cascade mode of operation has the highest power consumption, followed by a combined, and the last in this list is a cataract operating mode. To increase the efficiency of the mill means to create conditions that allow achieving the maximum productivity with minimal energy consumption of the mill. It is clear that for

different types of input grinding material it is necessary to adjust the operating modes of the mill, which depend on the speed of rotation of the drum.

The second way to improve the efficiency of grinding machines is to use a class of drive with better energy performance in the mechanism. Such type of drive is synchronous one. Its advantages, such as increased efficiency, the ability to compensate reactive power, a significant air gap, which reduces the requirements for the accuracy of the manufacturing and low speed of the shaft, thus no gearbox is needed.

Traditionally, the synchronous drive of tumbling mills is set up at a rational speed for grinding minerals of a concrete deposit. As a consequence, there is no speed adjusting throughout the entire duration of the work, regardless of the changes in the properties of the input product that occur in different areas of extraction.

Taking into account the current economic challenges and requirements for increasing mills' efficiency, the relevance of creating automatic speed control systems for synchronous drive of tumbling mills cannot be called into question.

Thus, the required range of velocity control does not exceed 50 % of its the maximum value, so for such a case the frequency control fully meets the requirements of the technological process. In addition, the use of a modern frequency converter's control strategy can allow energy savings together with other methods that are mentioned above.

According to the last conclusion and using the original model of the synchronous drive [2, 3], the preliminary structural scheme of the mill drive model is shown, where the parameters of the quadrature and direct armature current and speed regulators are calculated according to the classical methods of the theory of automatic control.

According to the results of the research, the following conclusions should be done:

- Today's economic challenges make industry to improve the efficiency of grinding equipment;
- Offered techniques for increasing the productivity of the equipment: improvement of the grinding technology by continuous adjusting of the drum operating mode depending on the hardness of the input grinding material and the attraction of more energy-saving type of drive based on the synchronous motor;
- Another way to save electrical power in the proposed electric drive system can be achieved through an energy-saving control strategy that involves selecting the desired voltage value, depending on the engine load.

Keywords: grinding, tumbling mills, operating modes, synchronous drive

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CHOICE OF CONTROLLED VARIABLES FOR ENERGY MANAGEMENT SYSTEM OF PISTON COMPRESSOR UNITS

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Introduction. Nowadays on-off control system is common for piston compressors delivery. The control system is applied in case there is no technological need in maintaining the stable pressure level in pneumatic system and there are no dramatic changes of compressed air consumption. Its advantages are described in terms of simplicity of implementation and reliability. The principle of on-off control system operation is based on setting of predetermined pressure limits. Reaching the upper level of pressure the compressor is switched off and it is switched in reaching the lower level. This occurs under the condition of single variable change control (intake pressure) in the system by means of sensor, which is installed. The regular operation of compressed air consumers is provided by means of pneumatic system pressure maintaining in the predetermined range.

Purpose statement. The main disadvantage of the system is its negligibility as for the factors influencing the general energy efficiency of «grid – compressor – pneumatic circuit» complex. It does not consider such substantial parameters as losses in power for grid, compressor, and pneumatic circuit. Hence, there is a need in describing the parameters to be changed by control system for losses determining and thus working in the proper regime of their minimizing for maintaining the regular operation of compressed air consumers.

Problem solution. To answer the question it is required that we consider the losses in power for various components of the system. The active power losses in electric grid. The losses in asynchronous drive and compressor unit. The losses in the compressed air pipelines.

Considering the abovementioned issues, to enable the control system being sensitive to losses in all units of «grid – compressor – pneumatic circuit» system it is need to install:ammeter, A, flow rate meter for compressed air, m^3/sec, pressure sensor in the receiver.