IMPROVING THE ENERGY EFFICIENCY OF THE ELECTRIC DRIVE OF THE PUMPING UNIT X-500 OF THE NAVOI MINING AND METALLURGICAL COMBINATE

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Annotation

The article presents the results of the development of a technology that provides energy efficiency improvements for asynchronous electric drives of pumping equipment with high energy performance based on modern semiconductor technology, taking into account the production characteristics of the Navoi Mining and Metallurgical Combine (NMMC).

Keywords: asynchronous electric drive, frequency converter, dynamic mode, electromechanical system, electric drive control system.

In the conditions of an ever-increasing energy crisis, the rational use of energy resources and electrical energy is an urgent problem, therefore, the development, research and widespread introduction of energy-saving technologies and devices is an urgent task for today and the entire subsequent period [1].

In the world, by improving the dynamic operating modes of technological machines and mechanisms, elements of the electromechanical system with modern regulating devices, improving the elements of the electromechanical system, using control methods, energy-efficient technologies are being created in the mining and metallurgical industry. At the same time, by increasing the energy efficiency of industrial installations, improving the control systems of electric drives, work is being carried out to reduce the consumption of electric energy and, in turn, special attention is paid to the development of this industry. As is known, the main part of industrial, agricultural and household facilities are driven by unregulated electric drives of mass use, consuming from 60 to 70% of all electrical energy consumed by electrical installations. Of the total number of electric drives of industrial mechanisms, only a small part of the objects has a complex and finely controlled technological process, for which an adjustable electric drive is used [2].

The vast majority of these mechanisms are unmanaged and non-automated, the installed power of the actuators, due to the provision of starting modes, is on average 1.5 - 3 times more than the actual required power. This paper provides recommendations for improving the energy efficiency of the electric drive of the pumping unit X-500 with an electric motor of type 5AIM315MA, switching circuit Δ, power 132 kW NMMC. To ensure the improvement of energy performance, it is most advisable to equip the electric drive with a frequency converter. As a converter, it is proposed to choose a modern frequency converter with pulse width modulation (PWM). Since this type of frequency converters is the most promising due to its more stable energy performance and high power factor. Modern frequency converters with PWM have an efficiency and a power factor of at least 0.97. In addition, frequency converters with PWM are also available without a matching transformer, which significantly improves its energy, operational and weight-dimensional indicators. For the electric drive of electrical equipment, the most suitable from our point of view is a Toshiba converter, the scheme of which is shown in Fig.1.

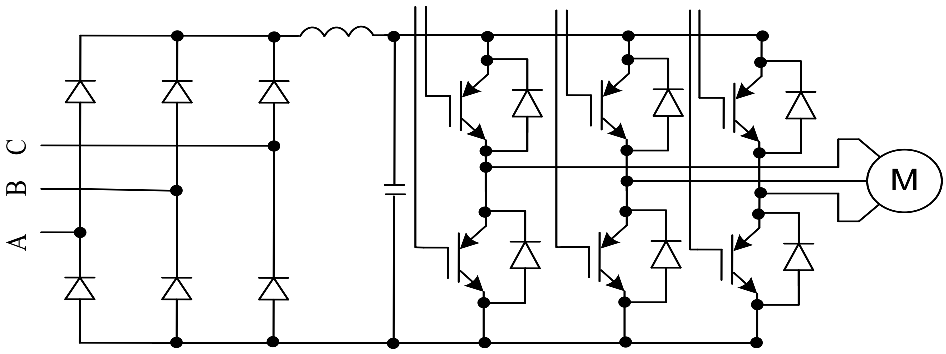

Fig.1 - Diagram of the AC frequency converter.

According to the method of controlling the electric motor, frequency converters (PE) can be divided into two groups: with vector and scalar control, and each method has its advantages and disadvantages [3].Scalar control type. With scalar (frequency) control, harmonic currents of the motor phases are formed, which means that the control is most often maintained constant by the ratio of the maximum torque of the motor to the moment of resistance on the shaft. That is, when the frequency changes, the voltage amplitude changes in such a way that the ratio of the maximum motor torque to the current load torque remains unchanged. This ratio is called the overload capacity of the engine. With constant overload capacity, the nominal power factor and efficiency the engine speed control practically does not change over the entire range

An important advantage of the scalar method is the possibility of simultaneous control of a group of electric motors.
The scalar control method allows for easy adjustment, even when using the factory settings.Vector type of control. Vector control is a method of controlling synchronous and asynchronous motors, which not only generates harmonic currents (voltages) of phases, but also provides control of the magnetic flux of the rotor (torque on the motor shaft).
Vector control is used when the load can change at the same frequency during operation, i.e. there is no clear relationship between the load moment and the rotation speed, as well as in cases where it is necessary to obtain an extended frequency control range at nominal torques, for example, 0...50 Hz for 100% torque or even for a short time 150-200% of the Mnom, this allows you to significantly increase the control range, control accuracy, and increase the speed of the electric drive. This method provides direct control of the engine torque. The torque is determined by the stator current, which creates an exciting magnetic field.

With direct control of the torque, it is necessary to change, in addition to the amplitude, the phase of the stator current, that is, the current vector. This is the reason for the term "vector control". The vector method of controlling the frequency converter allows for much better control of the electric motor than the scalar one. But setting up such a converter requires deep knowledge in the field of electric drive devices and electric machines.
Vector control method with speed feedback – used for precision control (it is necessary to use an incremental encoder) speeds when the load can change at the same frequency during operation, i.e. there is no clear relationship between the load moment and the rotation speed, as well as in cases where the maximum frequency control range is required at moments close to the nominal.
The vector method works fine if the engine's passport values are entered correctly and its autotesting has successfully passed. The vector method is implemented by complex real-time calculations performed by the converter processor based on information about the output current, frequency and voltage.
The processor also uses information about the passport characteristics of the engine that the user enters. The response time of the converter to a change in the output current (load moment) is 50 ... 200 msec. The vector method allows minimizing the reactive current of the motor while reducing the load by adequately reducing the voltage on the motor. If the load on the motor shaft increases, then the converter adequately increases the voltage on the motor. In

addition, for direct torque control at low, close to zero rotational speeds, the operation of a frequency-controlled electric drive without speed feedback is impossible. Vector control with a speed feedback sensor provides a control range up to 1:1000 and higher, the accuracy of speed control is hundredths of a percent, the accuracy of the moment is units of percent.

In this case, it is advisable to use vector control for the drive. The inclusion of the electric drive into the network "in a straight line" leads to the fact that 6 – 10x starting currents flow through the windings, which lead to large electrodynamic and mechanical forces, as a result of which the motor windings are subjected to increased wear, the service life of the mechanical and electrical parts of the electric drive and mechanism is significantly reduced. After reaching the steady speed of rotation, the electric drive operates in underload mode, as a result of which there is an unjustified overspending of the total power consumed, as a result, the technical and economic, energy and operational indicators of the installation as a whole decrease. At the same time, the specific consumption of electricity per unit of production increases. In order to reduce the starting currents of asynchronous motors and increase the energy efficiency of the automated electric drive in steady-state operation modes with a relatively low degree of load on the mechanisms, it is necessary to optimize the energy parameters according to various optimality criteria (minimum stator current, maximum efficiency and power factor).

The mechanical and electromechanical characteristics of the engine are calculated and constructed using the Mathcad 2000 program. As a result of modeling, we obtain the following characteristics of the IF-AD system (Fig. 2).

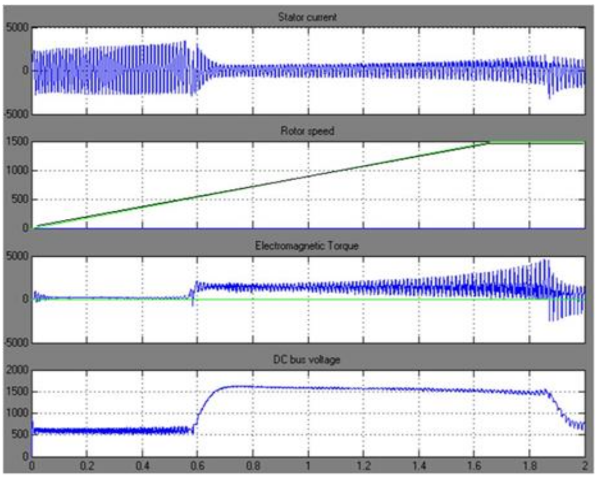

Fig. 2. Calculated oscillograms of the IF-AD system.

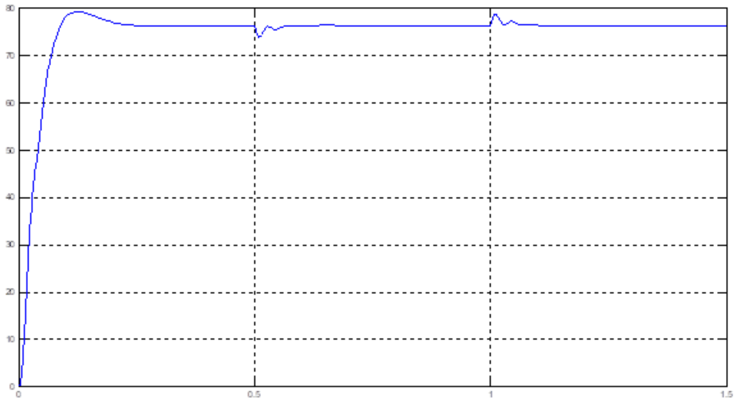

Fig. 3. Diagram of the motor speed transition process

Optimization of energy parameters for asynchronous electric drives can be implemented using the "Thyristor voltage regulator-asynchronous motor" system with microprocessor control.

The use of a thyristor voltage regulator in the implementation of an automated electric drive also allows you to increase the functionality of the system, both in static and dynamic operating modes. The use of a microprocessor control system ensures, while maintaining the constancy of the structure of the automated electric drive, to implement the selected criterion of optimality of the energy parameters of the system, to ensure smooth start-up and effective protection against emergency modes of operation.

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