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Main Ways To Increase Efficiency Operations Of Asynchronous Electric Drives

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Abstract — *Energy saving in asynchronous electric drives is the main task today. This article provides information on energy saving ways in asynchronous motor electric drives.*

Keywords —asynchronous motor, semiconductor frequency converter - asynchronous motor, rheostatic control device, losses in the electric drive, direct torque control.

Introduction

Currently, the main type of controlled electric drive is a frequency-controlled asynchronous electric drive - the system "semiconductor frequency converter - asynchronous motor" (SFC - AM). However, along with this electric drive, in some cases, the system "thyristor voltage converter - asynchronous motor" (TVC - AM) is used to solve individual production problems and energy saving, which provides regulation of the voltage of the first harmonic of the voltage supplied to the stator.

Also in operation are electric drives based on asynchronous motors with a phase rotor, controlled by changing the additional resistances in the rotor circuits, the so-called rheostat control systems - "rheostatic control device - asynchronous motor with a phase rotor" (RCD - AMPR). Especially many of these electric drives are part of lifting and transport mechanisms.

Taking into account the above methods and systems for controlling asynchronous electric drives, it is possible to outline the following directions for reducing the energy consumption of AM.

Materials and methods

The first direction is associated with a decrease in losses in the electric drive when it performs specified technological operations according to specified tachograms and with a certain loading mode. These are electric drives operating in starting and braking modes (cranes, elevators, main drives of slabbings and blooming mills, auxiliary positioning mechanisms of rolling mills, etc.) or continuous modes with slowly changing load (pumps, fans, compressors, conveyors, etc.) ... In such electric drives, by reducing the losses of the electric drive in steady-state and transient modes, significant energy savings are possible. In kinematically connected electric drives (roller tables, multi-motor bogie drives, etc.), the uniform division of loads between the motors also allows minimizing losses in them.

The second direction is associated with a change in the technological process based on the transition to more advanced methods of regulating the electric drive and the parameters of this technological process. At the same time, the energy consumption of the electric drive decreases. As an example, we can cite electric drives of turbine mechanisms (pumps, fans, turbochargers), piston pumps and compressors, conveyors, systems for regulating the fuel-air ratio, etc. In this case, as a rule, the effect is not limited to energy savings in an electric drive, in many cases savings are possible resources (water, solid and liquid fuels, etc.).

For both of these directions, it is characteristic that they reduce the energy consumption in the electric drive: in the first case, due to the reduction of energy losses, in the second, due to the use of less energy-consuming control of the technological process from the electric drive.

There is also a third area that provides for the implementation of energy-saving technologies. It is known that there are a number of technological processes where an electric drive of relatively low power controls the flow of energy, the power of which is tens and hundreds of times higher than the power of the electric drive. Such objects include DC and AC steel-melting arc furnaces, vacuum arc furnaces, ore-reduction furnaces, induction heating installations, etc. On them, electric drives with a capacity of several kilowatts can control a process that consumes tens or even hundreds of megawatts. It is obvious that the efficient use of such significant amounts of energy largely depends on the perfection of the electric drive, its speed and accuracy, and the degree of process automation. This direction is not associated with a decrease in the energy flow through the electric drive, more often the energy consumption of the electric drive even increases. Nevertheless, since this direction is associated with significant energy savings, we will consider it using the example of an arc steel-making furnace.

Discussion

Let us formulate the ways of energy saving in an asynchronous electric drive.

Within the framework of the first direction, the following ways can be used to reduce energy losses in an asynchronous electric drive.

1. Reasonable choice of the installed engine power, corresponding to the real needs of the controlled mechanism. This task is due to the fact that the load factor of many motors is 50% or less, which indicates either the low qualifications of the developers,

or the imperfection of the used method for calculating the power of the electric drive. It is obvious that an engine with low power quickly breaks down due to overheating, and an engine with a large power reserve converts energy inefficiently, i.e. with high specific losses in the motor itself due to low efficiency and in the supply network due to low power factor. Therefore, the first way is to improve the methods for selecting the engine power and checking it for heating, as well as in improving the skills of developers, designers and maintenance personnel. In practice, there are cases when a failed engine is replaced with a suitable shaft height or diameter, and not power. The existing methods for selecting the engine power and checking it for heating can be considered only as a first approximation. It is necessary to develop more advanced methods based on accurate accounting of the operating modes of the electric drive, changes in its energy indicators, thermal processes in the engine, the state of insulation, etc. Of course, this presupposes the widespread use of computers and special software.

2. Transition to more economical engines, in which, due to an increase in the mass of active materials (iron and copper), the use of more advanced materials and technologies, the nominal values of efficiency and power factor are increased. This way, despite the high cost of such engines, becomes obvious if we take into account that, according to Western European experts, the cost of electricity consumed annually by an average engine is 5 times higher than its cost. During the service life of the engine, which is tens of years, the energy savings will significantly exceed the capital costs of such a modernization. As noted earlier, this path has not yet received due recognition in domestic practice.

3. Transition to a more energy-efficient electric drive system. Energy losses in transient modes change noticeably when using rheostat regulation, TVC - AM and SFC - AM systems with minimal losses when using variable frequency drives. Therefore, within the framework of each of the listed systems, there are more or less successful options in terms of energy and technology. The task of the designer is to make a competent and well-grounded choice of a specific technical solution.

4. The use of special technical means to minimize energy losses in the electric drive. Since a significant part of asynchronous electric drives operate under conditions of slowly changing load (electric drives of turbine mechanisms, conveyors, etc.), the deviation of the electric drive load from the nominal one degrades the energy performance of the electric drive. Currently, such means include devices for regulating the voltage on the motor in accordance with the level of its load. As a rule, these are either special voltage regulators based on TVC, connected between the mains and the stator of the motor, or frequency converters in which the so-called energy saving mode is provided.In the first case, the TVC performs, in addition to the energy saving function, no less important functions of controlling the start and braking modes. sometimes it adjusts the speed or torque, provides protection, diagnostics, that is, increases the technical level of the drive as a whole. In the second case, the energy saving mode is considered as an additional option of the frequency converter and is available only in some manufactured types of converters. Given the multifunctionality of their application, such devices turn out to be economically feasible for drives with varying load, even at their relatively high cost.

5. Improvement of control algorithms for an electric drive in the systems of TVC - AM and SFC - AM on the basis of energy criteria for assessing its quality, i.e. improvement of known solutions, development of effective technical means for their implementation and the search for new solutions that are optimal in the energy sense.

Conclusion

Within the framework of the second direction of reducing energy consumption, the transition from an unregulated electric drive to a controlled one and an increase in the level of automation due to the inclusion of a number of technological parameters (pressure, flow rate, temperature, etc.) in the control loop is of decisive importance.

The third direction of reducing energy consumption is characterized by the improvement of the electric drive system in combination with the automation of the technological process and the correct choice of the appropriate quality control of the electric drive from the existing ones or the development of new, higher quality systems.

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