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INCREASING THE ECONOMIC EFFICIENCY OF ELECTROMECHANICAL EQUIPMENT THROUGH DIAGNOSTICS OF ITS TECHNICAL CONDITION.

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Abstract: Today, improving the methods of diagnosing the technical condition of electric motors is an urgent task for the development of a system for their development prospects, as well as for solving problems that occur during the operation of high-power motors that drive the working mechanisms of electrical technological devices in industrial and mining enterprises of our Republic. Also, the methods of diagnosing electric motors based on their transient processes and related to their mechanical parts during their operating cycle were analyzed, and several proposals were made to develop existing methods. As a result, it was substantiated that it is necessary to regularly monitor the working processes of electric motors and diagnose their technical condition using new modern devices in a wide range. Because during the operation of electric motors, parts wear out over time due to the negative effects of operating time and the environment, and their parameters change due to natural wear of electric motor parts, which is why a number of malfunctions related to their electrical and mechanical indicators arise in the working processes of electric motors.

Keywords: Vibration, electric motor, range, sensor, diagnostics, frequency, system, mechanism, complex, converter, values of lower and upper reliability limits, probability of failure, electric current.

INTRODUCTION

Failure of electric motors leads to disruption of technological processes, reduction of product production times, increase in costs associated with unscheduled repairs and technological problems [2]. In addition, re-repair of electric motors requires a lot of time and money. Therefore, it is advisable to regularly diagnose the technical condition of electric motors when finding solutions to problems associated with their electrical, mechanical and thermal parameters. The purpose of diagnostic analysis and control of the technical condition of electric motors is to detect defects that arise during the operation of

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electric motors early, prevent their unscheduled repair, prevent disruption of technological processes, and predict the state in order to maintain electrical, mechanical and thermal indicators within the specified limits during their operation, save resources and make full use of them [3].

LITERATURE REVIEW AND METHODOLOGY

Today, the development of various methods for diagnosing the technical condition of electric motors and their implementation in practice is actively underway. Systems and methods for diagnosing electric motors can be divided into two main groups. The first group includes diagnostic methods that require the formation of artificial disturbances affecting the object under study: measuring resistance, the value of the consumed current, the internal resistance of the windings of the windings, the loss of the dielectric properties of the windings, etc. [4]. The second group includes operational diagnostic methods used for electrical equipment, which are a source of natural disturbances during operation [5]. Each group, in turn, is divided into two other groups - these are methods that allow you to detect malfunctions of electrical equipment and methods that identify a specific malfunction or defect [5]. The results of research conducted by scientists show that the introduction of diagnostic tools is one of the most important factors in increasing the economic efficiency of equipment use in industry [2]. Currently, there are the following methods for diagnosing the technical condition of electric motors: Diagnostics based on the analysis of rotor vibrations of an electric motor (vibrodiagnostics). Vibrodiagnostics methods are the most common in the diagnostic analysis of the technical condition of electric motors [6]. The essence of vibrodiagnostics methods is to analyze the vibration parameters of various points of electric motors [6]. Vibration diagnostics is the most common method of diagnosing the technical condition of electric motors, which is based on monitoring and analyzing the movement of vibration parameters and is generally carried out according to a non-destructive method of monitoring the technical condition of the motor or acoustic signals that appear during the operation of the device [7].

RESULTS

Vibration diagnostics allows you to study the vibration signal of the rotor of an electric motor in the time (oscillogram) and frequency (spectrum) domain. The most commonly used vibration sensors are piezoaccelerometers (vibration transducers).

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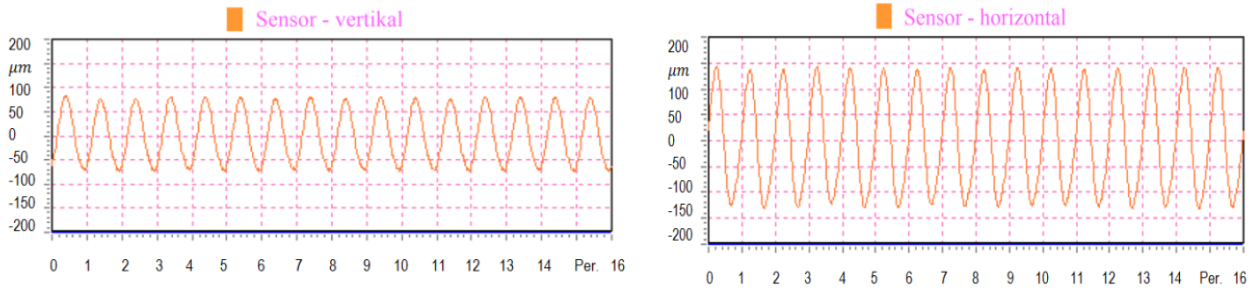

Figure 1 Vibration sensor

Figure 1 shows a typical structure of a stationary monitoring and diagnostic system that continuously monitors the operating modes of electric motors, which allows calculating the optimal and determining the timing of subsequent diagnostic checks of electric motors, depending on the type and timing of maintenance and repair. Stationary monitoring and diagnostic systems are most effective for electric drives of the same type with constant load and rotation speed - fans, compressors, and especially pumping stations. The essence of the method is based on the location of an electromagnetic sensor near the motor, which allows it to correct the external magnetic field generated around the motor, which during its operation and represents the echo of the multiplicative field in the magnetic cavity of the asynchronous motor [2]. The signal received from the sensor is digitized and transmitted to a personal computer and displayed in graphical form on the main computer screen (Figure 2). In addition, a spectral analysis of the received signal is performed and, based on certain features of the received image, the malfunction is identified [5]. However, the main disadvantages of vibrodiagnostics are: the need to use special vibroacoustic sensors, the complexity of their installation and the complexity of interpreting the results. Based on measuring and analyzing the temperature of individual elements of the machine. There are two methods for diagnosing the technical condition of electric motors based on temperature: temperature control of individual engine components and thermal imaging control[8]. Thermal imaging control of electric machines is based on the use of thermal imaging to detect defects in electrical equipment. Currently, temperature measuring devices, such as thermal imagers, infrared cameras, pyrometers, etc., are often used to control the technical condition of industrial equipment. In many cases, such devices allow monitoring all the necessary nodes[10]. Pyrometers determine the temperature at specific points of the object, while thermal imagers and infrared cameras provide a complete picture of the temperature distribution of the object. Temperature measurement for thermography

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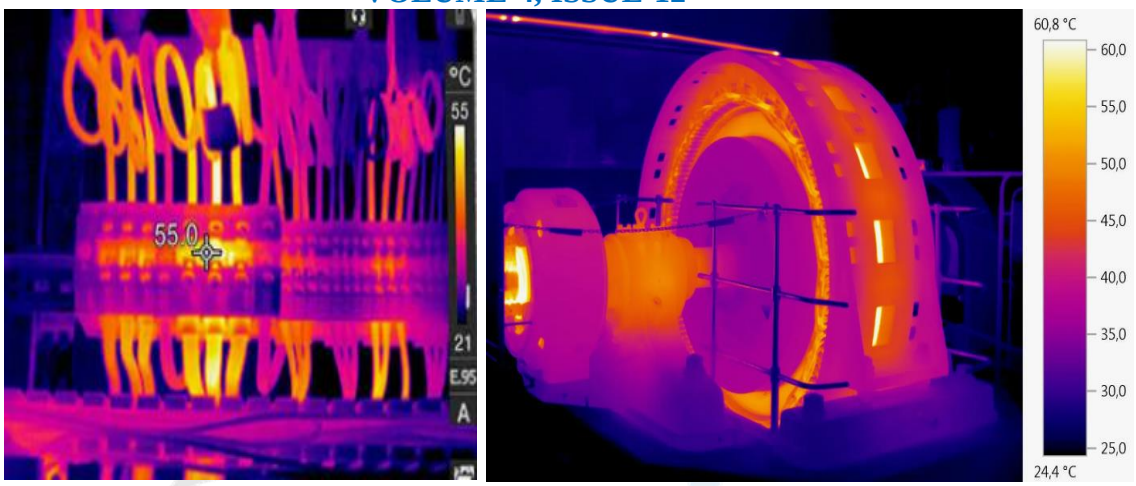

Figure 2: Temperature measuring device.

It consists of a central diagnostic station with a range from -50ºC to over 2000ºC. It consists of a computer with built-in boards for converting the signal into digital form and software packages for control, signal analysis, monitoring and diagnostics, displaying the state of the equipment, as well as external amplification and switching units, vibration and rotor speed sensors [7]. In strong electromagnetic fields, the operator must place the receiver at a convenient distance from the electric motor to obtain thermograms with a detailed image of the thermal field in the stator hole or on the surface of the frontal parts. Thermography of the electric motor is presented. The advantage of thermal imaging survey using a thermal imaging device is that the shooting is carried out remotely, in its operating conditions, under working loads.

Figure 3. Image of the obtained parameters on a computer monitor

Ua 241,6 В	Ub 237 В	Uc 244,5 В	Uab 414,4 В	Ubc 417 В	Uca 420,9 В	Ia 0,02 А
Ib 0,03 А	Ic 0,03 А	In 0,02 А	Pa 0 кВт	Pb 0,01 кВт	Pc 0,01 кВт	P 0,01 кВт
Qa 0 кВАр	Qb 0 кВАр	Qc 0 кВАр	Q 0,01 кВАр	Sa 0,01 кВА	Sb 0,01 кВА	Sc 0,01 кВА
S 0,02 кВА	PFa -0,84	PFb 0,84	PFc 0,83	PF 0,41	F 50,01 Гц	EP+ 0,07 кВт*ч
EP- 0 кВт*ч	EQ+ 0,07 кВАр*ч	EQ- 0,01 кВАр*ч	THDu A 4,57 %	THDu B 4,6 %	THDu C 5,52 %	THDi A 0 %
THDi B 0 %	THDi C 0 %	THDu A 3я 3,99 %	THDu B 3я 3,94 %	THDu C 3я 4,64 %	THDi A 3я 0 %	THDi B 3я 0 %

Table of obtained parameters

1	Ua	Phase A voltage

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2	Ub	Phase B voltage
3	Uc	Phase C voltage
4	Uab	C phase voltage AB line voltage
5	Ubc	BC line voltage
6	Uca	CA line voltage
7	Ia	Phase A current
8	Ib	Phase B current
9	Ic	Phase C current
10	In	Neutral current
11	Pa	Active power phase A
12	Pb	Active power phase B
13	Pc	Active power phase C
14	P	Total active power
15	Qa	Reactive power phase A
16	Qb	Reactive power phase B
17	Qc	Reactive power phase C
18	Q	Total reactive power
19	Sa	Full power of phase A
20	Sb	Full power of phase B
21	Sc	C phase full power
22	S	Total full power
23	PFa	Power factor of phase A
24	PFb	Power factor of phase B
25	PFc	Power factor of phase C
26	PF	Overall power factor
27	F	Network frequency
28	EP+	Active energy intake
29	EP-	Active energy return
30	EQ+	Reactive energy consumption
31	EQ-	Reactive energy return
32	THDu A	Total harmonics of the phase voltage
33	THDu B	Total harmonics of the phase voltage
34	THDu C	Total harmonics of the phase voltage

DISCUSSION

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Diagnostics of electric motor current consumption based on spectral analysis. Recently, methods for diagnosing the condition of electric motors based on monitoring the current consumption have become widespread, and special spectral analysis of the resulting signal continues to be carried out [6]. This allows you to determine the condition of various electric motor elements with a high degree of reliability. The presence of characteristic frequencies of a certain value in the current spectrum of the electric motor indicates damage to the electrical and mechanical parts of the electric motor. In addition, information about breakage of the windings, incorrect distribution of the current consumption in the stator, static or dynamic, short circuit of the stator windings, mechanical damage to the bearings can be determined using the current spectrum. However, the disadvantage of spectral analysis of the electric motor current is the complexity of evaluating the results obtained. In conclusion, it can be said that according to the analytical results of the above methods for diagnosing the technical condition of electric motors, each existing method has its own shortcomings, and in addition, based on these methods, it makes little contribution to the development of the technical condition of electric motors, and a separate device is required to apply each method in production practice, therefore, it is advisable to develop new modern methods and devices for comprehensive diagnostics of the technical condition of electric motors in a wide range, based on constant monitoring of the operating modes of electric motors and taking into account their energy and mechanical indicators [9].

CONCLUSION

In conclusion, it can be said that by introducing modern technologies into production processes, we can achieve not only greater efficiency and energy saving, but also full automation of the production process. The portable diagnostic equipment we offer allows you to perform a full and comprehensive diagnosis of electromechanical devices in a wide range, prevent the causes of breakdowns, test and achieve economic efficiency, while at the same time creating the opportunity to check and adjust the accuracy of electrical protection devices. Therefore, it is advisable to regularly diagnose the technical condition of electric motors when finding solutions to problems associated with their electrical, mechanical and thermal parameters. The purpose of diagnostic analysis and control of the technical condition of electric motors is to detect defects in the early stages of their operation, prevent their unplanned repair, prevent disruption of technological processes and predict the state in order to maintain electrical, mechanical and thermal indicators within the specified limits during their operation, save resources and make full use of them.

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