JOURNAL OF MULTIDISCIPLINARY SCIENCES AND INNOVATIONS
GERMAN INTERNATIONAL JOURNALS COMPANY
ISSN: 2751-4390
IMPACT FACTOR (RESEARCH BIB) : 9,08. Academic research index

BASICS OF PREVENTIVE MAINTENANCE OF ELECTRIC MACHINES BY VIBRATION

Mirzaev Kahramon Sultonovich
Senior Lecturer, Department of Automotive Engineering and Transport
E-mail: k.s.mirzayev@gmail.com
Andijan State Technical Institute

Abstract: This article analyzes the basics of preventive maintenance of electrical machines for vibration in the automotive industry. In particular, it examines the sources and causes of vibration, types of vibration, vibration activity and noise, and the causes of their occurrence. It analyzes and proposes methods for solving problems of ensuring noiseless and reliable operation of electrical machines depending on their type, which directly affects the resource of electrical machines, production profitability, downtime of production machines, and equipment performance.

Key words : noise, vibration, plain bearings, rolling bearings, rotor

Introduction. The basis of modern production is electric machines and the issues of ensuring their reliable operation are significant for any enterprise. This applies to the automotive industry to a particular extent, since a stop of even less than one minute for a modern car plant with a production capacity of 200-250 thousand cars per year entails losses of at least 25 thousand US dollars. Therefore, the issues of technical maintenance of electric machines with an estimated determination of their performance are very relevant, and the study of the factors determining the choice of methods and parameters of measured quantities is also of great scientific and practical interest.

The main measurable parameters for preventive maintenance of electrical machines can be:

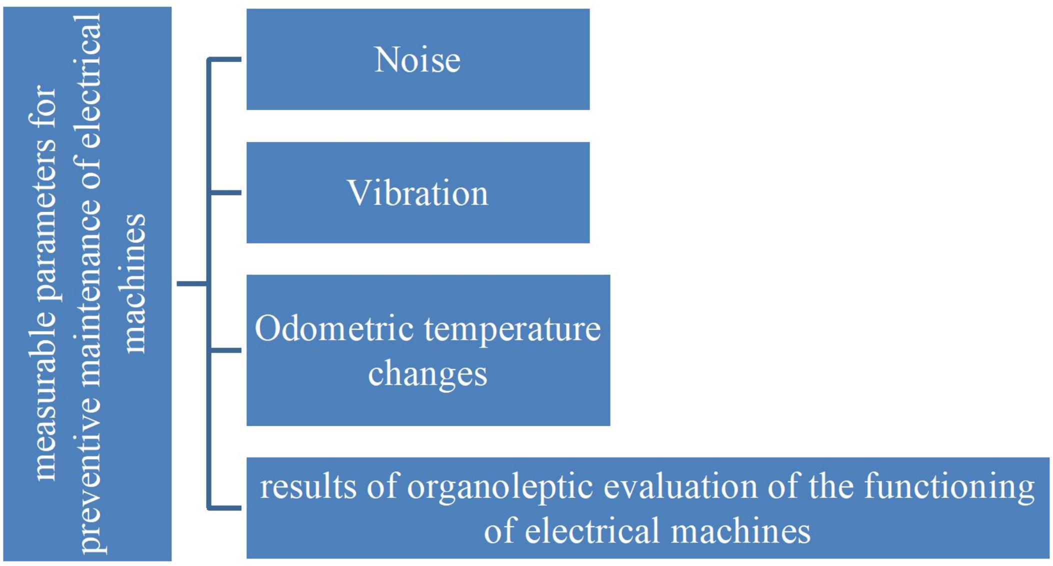
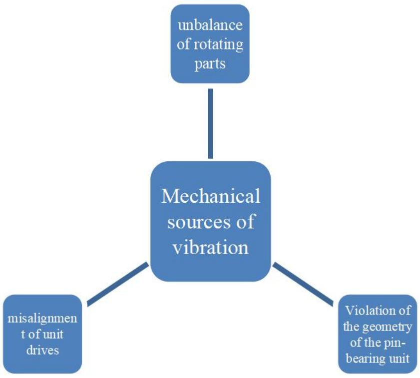


Fig 1. measurable parameters for preventive maintenance of electrical machines

The most common and easy to implement are measurements of noise and vibration indicators. The correct choice of measurement methods and tools depends on the nature of the occurrence of noise and vibration and therefore it is necessary to conduct a study of the causes of their occurrence and manifestation in the operation of an electric machine. An electric machine is a complex combination of interconnected oscillatory systems with several sources of disturbing forces [1].

The sources of disturbances inherent in electrical machines can be divided into three types: mechanical, magnetic, and aerodynamic. Mechanical sources of vibrations are caused by the design and technological features of the production of certain types of machines.



Rotor imbalance occurs due to the discrepancy between its main central axis of inertia and the axis of rotation. When an unbalanced rotor rotates, its supports are subject to dynamic forces, the components of which, lying in any plane passing through the axis of rotation, change with the angular velocity of the rotor. The reasons for the appearance of rotor imbalance can be very different [3].

Reducing the level of disturbances can be achieved by reducing the residual imbalance. However, it is impossible to completely balance the rotor. Moreover, for some types of machines, uncontrolled imbalance may occur. In this case, special design measures are used. The most well-known of them are the following:

1. elastic supports with linear and nonlinear characteristics;
2. elastic-damping and damping supports;
3. antivibrators [4].

Elastic elements, built in between the rotor and the machine body, allow to tune the rotor-body system from resonance modes and thus reduce the transfer of disturbing forces to the body and ultimately to the foundation. The design of elastic supports is diverse. Rings, plates, tapes, springs, etc. are used as an elastic element.

It should be noted that the use of elastic supports with a linear characteristic allows shifting the critical rotor speeds from the operating speed range without structural modification of the rotor itself, without changing its mass and the mass of the entire machine.

However, in this case, the range of operating speeds free from critical numbers is limited by the minimum permissible value of support rigidity. This circumstance turns out to be decisive for multi-mode machines, which have a large range of change in speed numbers. Unlike linear supports, nonlinear supports generally allow the elimination of critical modes [4].

The use of elastic-damping and damper supports allows for tuning out critical modes and at the same time significantly limiting the level of rotor oscillation amplitudes when passing through the critical speed. A common disadvantage of elastic-damping and damper supports of liquid friction is the strong dependence of their properties on the viscosity of the damping liquid, which, in turn, is determined by the thermal conditions of the support. If the same liquid is used for damping and lubrication, which significantly simplifies the design, then it is necessary to thermostatically control the liquid supplied to the damper.

The peculiarity of using dry friction dampers is that depending on the magnitude of the disturbing force and the angular velocity, the dry friction support is absolutely rigid (the damper is “closed”) or damping (the damper is “open”). This can be used to eliminate critical modes.

The dry friction damper can be installed in an intermediate or supporting support. The cross-section of the rotors of two-pole turbogenerators has different values of the main moments of inertia. This leads to vibrations of double rotation frequency. To eliminate this drawback, a number of slots or grooves are made in the large teeth of the rotor barrel. In addition, elastic damper supports are used [5].

Rolling bearings can be sources of vibrations in a wide frequency range. The level of disturbances generated by rolling bearings depends on: size, precision class, rotor speed, load. When choosing a bearing type, it is necessary to take into account that the vibration level of roller bearings is higher than that of ball bearings by 5 or more dB , and the vibration activity of heavy series bearings is higher than that of medium series bearings. Significant factors affecting the vibration activity of rolling bearings are their fit in the seat and on the shaft. The degree of accuracy of the seat machining must correspond to the quality of the bearing rings. An effective means of reducing the vibration activity of rolling bearings is the use of special vibration-insulating liners. The nature of vibration in rolling bearings is very complex. Therefore, the vibration spectrum is wide. It consists of both discrete components, multiples of the rotor speed, and continuous spectrum zones. The presence of such zones is caused by: movement of rolling elements within the gaps; movement of separators; collision of bearing parts; geometric errors of rolling elements, inner and outer rings.

An important parameter that determines the vibration activity of rolling bearings is the radial clearance, depending on the value of which various modes can arise.

In the first mode, the dynamic load on the bearing from unbalanced centrifugal inertial forces is less than the static load. In this case, the center of the journal will perform rocking movements.

In the second mode, the specified forces are equal to each other. In this case, the amplitude of the trunnion oscillations can increase and the onset of this stage depends not only on the ratio of the specified forces, but also on the size of the gap.

The second stage causes increased vibration activity and premature wear of bearings. When the dynamic load exceeds the static load, the journal rolls in, and the third mode of bearing operation occurs.

To reduce the vibration activity of the bearing unit, it is advisable to use plain bearings instead of rolling bearings. In high-speed bearings, the oil film of the plain bearing has a significant effect on the dynamics of the machine. Due to the influence of the oil film, the actual critical speed of the rotor may be 30-50% less than the calculated one on rigid supports [6].

The presence of non-conservative forces predetermines the possibility of loss of rotor stability. The most serious and frequent cause of loss of stability and occurrence of self-excitation is the action of the lubricating layer in plain bearings. The danger is explained by the fact that the intensity of oscillations in this case is high, since the amplitudes often exceed the amplitudes of resonant oscillations, and cyclic stresses arise in the rotor. In addition, during self-excitation, the amplitude of the spike oscillations can reach values commensurate with the values of the gaps in the bearings, which can lead to damage to the liners or seizure in the bearing.

List of references:

1. L. B. Alekseeva, A. N. Romanov. Sources of vibrations and noise of electrical machines. In the collection "Engineering sciences: modern problems and development prospects" Collection of materials of the international scientific and practical conference, Yoshkar-Ola, 2013.
2. Branovsky M.A. Research and elimination of vibrations of turbogenerators / M.A. Branovsky , I.S. Lisitsin, A.P. Sivkov. M.: Energy, 1989. 22 p.
3. Vibrations in engineering: Handbook in 6 volumes. Moscow: Mechanical Engineering, 1982.
4. Vibrations of power machines: Reference manual / Edited by N.V. Grigoriev, 1974. 464 p.
5. Isakovich M.M. Elimination of vibrations of electrical machines/M.M. Isakovich, L.I. Kleiman, B.H. Perganok . L.: Energy, 1989. 215 p.
6. Tondl A. Dynamics of turbogenerator rotors. L.: Energy , 1971. 387 p.