Diagnostics of the Technical State of Bearings of Mining Machines Base Assemblies

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Abstract: The article reviews the methods of technical diagnostics of equipment used during maintenance of mining machines in accordance with their actual technical state, and considers the basics of vibration parameters measuring. The classification of existing methods for diagnosing the technical condition of rolling bearings is given. The advantages and disadvantages of these methods are considered. The main defects of rolling bearings arising during manufacturing, transportation, storage, and operation are considered.

1. INTRODUCTION

Vibration diagnostics – technical discipline that considers the theory and methods of recognition of technical state of machines and mechanisms at the source of the information contained in vibro-acoustic signal [1]. Is the primary method of functional diagnostics of mining machines and equipment. Methods of vibration diagnostics aimed at the detection and identification of malfunctions of units of mining machinery and equipment, affecting their vibration – defects of the rotors, components of the stator reference system, plain bearings and rolling bearings, toothed and belt transmissions experiencing or generating dynamic loads [1, 2].

The objectives of monitoring are:
- Warning the development of defects in the assembly and reducing the cost of its restoration
- Determining the optimal technology to restore the unit if the defect eliminates the possibility of normal operation

Carrier of information about the technical state of elements of working equipment in the vibration diagnostics is a vibro-acoustic signal – a collective term that includes information about oscillatory processes (vibration, hydro - gasdynamic, etc.) and acoustic noise mechanism [3, 4].

The peculiarity of the process of vibroacoustic signal almost instantly responds to changes in the condition of the equipment that determines the speed of diagnosis and decision making.

Vibration diagnostics solves the following practical tasks of maintenance of machinery and equipment:
- the division of the many possible technical status of the unit into two subsets: good versus bad;
- detection of a possible defect at an early stage and predict its development in time;
- the diagnosis consists in determining the nature and localization of one or group of defects corresponding to the vibrating condition of the unit;
• detection of hidden defects;
• absence, as a rule, installation and dismantling works of the equipment and reducing the time of diagnosis
• the reduction of the emergency situation when the equipment is operated;

However, vibration analysis is not without disadvantages, which include:
• special requirements to the method of mounting the vibration sensor;
• the dependence of vibration parameters from a large number of factors and the complexity of the allocation of the vibration waveform due to the presence of a fault that requires a deep application of methods of correlation and regression analysis;
• the accuracy of diagnosis in most cases depends on the number of smoothed parameters, for example, the number of estimated SPM [1].

From the point of view of creation of technical regulations vibro-acoustic diagnosis is necessary at the stage of creating the product, in the process of testing to solve a number of tasks aimed at the formation of technical features and values of the bands corresponding to the technical requirements or safe operation. For the formation of ranges of appropriateness in vibration diagnostics is one of the most important tasks is the definition of own and forced frequencies of the products [6-8].

2. FAULT DIAGNOSIS METHODS

Vibro-diagnostic approach is effective if it includes direct methods of spectral analysis, envelope and synchronous accumulation that allows you to obtain the necessary information about the state of gears, as well as to identify signs of defects and criteria of the maximum allowable technical condition [9].

One of the most common problems of vibration diagnostics is to determine the technical condition of rolling bearings installed on the shafts of the nodes of mining machinery. In many cases trouble-free operation of this equipment largely depends on the condition of rolling bearings and has an impact not only on the technological process, but also the safety of the unit, unit, area mining operations. Thus, the question of diagnosis of these nodes is a very important task [10, 11].

During the rolling of rolling elements, mechanical defects on the bearing races, as in the defects on the rolling elements in the bearing vibration processes occur. The cause of the vibration is a single pulse excitation. The duration of the excitation efforts is very small and is often of the shares or units of milliseconds. Each pulse force is from a defect occurring in the bearing elements and the elements of the mechanical design of the unit shall be considered as free fading fluctuations. Since the exciting force is of short duration, the ranges of frequencies of free oscillations occur is very wide and could occupy a frequency band from hundreds of Hertz to hundreds of kilohertz. This explains the successful application for diagnostics of rolling bearings of various diagnostic methods that analyze vibration in the audible frequencies and in the area of ultrasound and higher [12].

3. RESULTS

There are the following types of bearing damage – primary and secondary [13, 14]:

Primary injuries include:
• Wear occurs when bearing penetrate debris or insufficient lubrication. It can also be the result of vibrations of non-rotating bearing. Figure 1. Wear of a rolling bearing ;
• Dents on the raceways and rolling elements can occur in cases when the forces are transmitted to the mounting ring via the rolling elements. Equally dents occur when excessively large loads on bearings at a time when the bearings do not rotate. The cause of the dents can be penetration into the bearing of foreign particles. Figure 2. Dents on the raceways of a rolling bearing.

• Burrs occur when there is insufficient lubrication of sliding surfaces under load, when there is a transfer of metal particles from one surface to another. The surface look rough. If you encounter scuffing of the bearing material is heated to a temperature at which there is vacation. Occurs local stress concentration that resulted in the formation of cracks and cavities. Also bullies can arise when the rolling elements enter the loaded zone with great acceleration. Figure 3. Burrs on the raceways of a rolling bearing.
Surface destruction occur in case of too thin lubricating layer between the tracks and the rolling elements when the top of the roughness briefly touch each other. While on the surface minute cracks occur. In the process of surface destruction of the initially microscopically small, then increase rapidly and, in the end, prevent a smooth rotation of the bearing. Cracks of the described type can speed up the process of formation of fatigue cracks under the surface of the raceways and thereby reduce the durability of the bearing. With adequate lubrication there is no risk of destruction of the described type as long as the lubricating layer becomes too thin, either due to changes in oil viscosity due to temperature increase or excessive increase in workload.

Atmospheric corrosion occurs in the case of penetration into the bearing to atmospheric moisture or an aggressive environment in such volume, that the break (dilute) lubricating film in the contact of bodies and raceways.
The passage of electric current through the bearing from one ring through the rolling elements to another ring causing bearing damage. In places of transition process similar to electric arc welding. The bearing material may be heated to the melting temperature. In this form the coated areas of different size in which the material is annealed and hardened again, and sometimes even melted. In places where the metal has been melted, there may also be small moons.

Secondary damage can be attributed:
- Fatigue sinks – which are the result of normal fatigue damage that occurs at the end of the normal long-term operation of the bearing. This, however, is not the most frequent cause of bearing failure. In most cases, can have causes different from the process of fatigue fracture of the material. If the shell detected at an early stage, when their sizes are not too large, it often becomes possible to identify the cause of the damage, allowing to develop appropriate cautionary measures, and thereby to prevent re-injury. If the shell has reached a certain stage of development, the presence of damage to detect noise and vibrations.
Figure 7. Fatigue sinks on the raceways of a rolling bearing

- Cracks that occur in the rings due to improper Assembly or disassembly of the bearing, too tight fit of the ring on the tapered shaft neck, can also occur due to burrs. Figure 8. Cracks on the raceways of a rolling bearing;

Figure 8. Cracks on the raceways of a rolling bearing

4. CONCLUSIONS

Thus, with the help of modern software tools it is possible to conduct a spectral analysis of the signal and determination of possible damage to the bearing assemblies, and in the case of condition monitoring key nodes mining machines – prediction of residual life of bearings [12, 15].

The recording of vibrations in a digital format allows you to more accurately and without the use of special instruments to assess the level of vibration and noise, to build a spectrogram and a qualitative assessment of the reliability of the mechanism by increasing the degree of vibration and noise from the original or regulated values

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