CONSIDERATION REGARDING THE DIAGNOSIS AND REPAIR OF BEARINGS

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Abstract: This paper presents some aspects of diagnosis bearings in preventive maintenance and the importance of bearing repair as an alternative to replacing them. Bearing repair is not a new concept, nor has it changed a great deal over the years. Repairing damaged bearings is a precise science that has been fine-tuned over time through careful and gradual enhancements to provide superior results. Knowing and understanding the value of bearing repair means knowing what repair can do, when to use it, and where to get it done.

Keywords: maintenance, monitoring, diagnosis bearings, bearings repair

1. INTRODUCTION

The growing investment machine tools and production systems requires their maximum availability. The complexity of such systems, which are automated and consist of many modules which are linked and have to work together without failure, increases the risk of breakdowns.

The monitoring system has to ensure that a machine works correctly without malfunctions. The result of its operation is a corresponding message about the machine state. This test can be performed according to a plan, periodically or continuously. A diagnosis system goes further, identifying the incorrect function and the reason for this malfunction. It gives an indication of the reasons and it is initiated when an incident occurs or upon demand.

Different methods can be applied for M & D (monitoring and diagnosis) [4]:
- signal-based Monitoring & Diagnosis (heuristic);
- model-based M & D with signal prediction;
- model-based M & D on parameters;
- feature recognition or classification;
- knowledge-based M & D.

Considering the trends of manufacturing developments, the following reasons can be pointed out to explain why monitoring technology is becoming more and more important in modern manufacturing systems:

(1) Large-scale manufacturing systems should be operated with high reliability and availability because the downtime due to system failure has a significant influence on the manufacturing activity. To meet such a demand, individual unit processes should be securely operated with the aid of reliable and robust monitoring systems. Monitoring of large-scale systems is already beyond the capability of humans.

(2) Increasing labor costs and shortage of skilled operators necessitate operation of the manufacturing system with minimum human intervention, which requires the introduction of advanced monitoring systems.
Ultra-precision manufacturing can only be achieved with the aid of advanced metrology and the technology of process monitoring.

Use of sophisticated machine tools requires the integration of monitoring systems to prevent machine failure.

Heavy-duty machining with high cutting and grinding speeds should be conducted with minimum human intervention from the safety point of view.

Environmental awareness in today’s manufacturing requires the monitoring of emissions from processes.

2. DIAGNOSIS SYSTEMS AND FAILURE DETECTING

In current industrial practice there is an offer of a wide range of products, from portable measurement and control instruments, the continuous monitoring systems and complete software to centralize and evaluate the results.

Monitoring tools cover a wide range of measurements [2]:

- vibration measurements with FFT signal analysis and automatic evaluation of results;
- shock pulse measurements to determine the conditions of lubrication of bearings and early detection of wear;
- measurements of speed;
- temperature measurements;
- measurements of analog signals;
- determining the resonance frequencies of the machine;
- orbit calculation for sliding bearings.

These equipments detect operating faults since their infancy, thus offering the possibility of planning repairs or maintenance work, resulting in minimizing or eliminating downtime of the production process. A continuous monitoring system consists of sensors installed permanent camps dynamic equipment and connecting them to the monitoring unit. These sensors can be, for example: vibration transducer; shock pulse transducer; temperature sensor; speed sensor, and more ...

Measurement units of measurement signals have specific responsibilities, local assessment of the measurements and conditional triggering of certain local events (warning, open / close relay power supply, etc.). And, last but not least, the transmission results in different formats to a centralized unit (control room). Figure 1 show the path from process (and the source of the measurants) through the sensor, extraction of a control signal, and application to process control for both heuristic and quantitative methodologies [5].
3. DIAGNOSING BEARINGS

All equipment for assessing and analyzing the frequency made at this time in the world captures the vibration signal, processes and provides information on the technical state of camp, location and nature of defect. In modern industrial practice there are equipments and work procedures based on this principle. It is known that if a bearing get to vibrate, already bearing is compromised and does not provide reliability. It is shown a method of measuring and monitoring of the lubricant film thickness rolling elements and taxiways, which allow identification of the moment when, for one reason or another (as lubricant, additional tasks camps etc) film lubricant is thinning and surface roughness of the metal balls / rollers and roller paths, get in contact directly.

This method it called Shock Pulse Method (SPM). The main advantage of the shock pulse method is just finding its expertise in shock. When a ball / roller hits the defective area path produces a shock wave in a metal machine table. These shock waves are starting with a short stroke that pays off quickly. In a recording time displayed on an oscilloscope, these waves are observed superimposed on the overall machine vibration. When their frequency corresponds to the frequency of crossing objects rolling or cage, is a testament to the defect occurred in the capital. SPM transducer shock wave excites the characteristic frequency ≈ 32 kHz resonance, amplifying the signal. Circuit analysis of electrical and mechanical signal is calibrated to filter out other signals of vibration [1].

By this method it can be determined what led to this situation, necessary corrections could be made in time, thus coming back to "wellness" page. Otherwise, the elements bearing wears, wear later will lead to the appearance of vibrations. Only in the due course, equipment to measure and analyze vibrations proves their usefulness, but already too late: the bearing is compromised (fig. 2).
Due to the sensitivity shock pulse method can be measured even overall lubrication of the bearing, the parameter dBc. Filtered transducer signal reflects the variation of pressure in the contact area between rolling objects and ways of rolling bearings.

When the lubricant film is thick, the shock pulse is low, no significant peaks (green). Level increases when the lubricant film thickness decreases, but still not present significant amplitude components (yellow area). Wear causes strong pulses at irregular intervals (red zone - fig. 3). The shock pulse method can be extended by performing an FFT analysis (Fast Fourier Transformation) of the signal taken, leading to more thorough analysis possibilities [1]. By identifying each bearing their own frequent (symptoms can now be identified these common SPM spectrum, thus diagnosing component even showing wear (running path inside / outside, roller / ball, cage).
The advantages of implementing a maintenance system based on periodic measurements and analysis of shock pulse signal:
- Saving of materials and spare parts;
- Shortening the residence time in repair;
- Increasing the availability of equipment

Basically, measurements are performed on all equipment camps (fig. 4). The instrument acquires a sample shock pulse signal, it breaks down, the Fast Fourier Transformation (FFT), resulting in SPM spectrum, and where frequencies are shown in the pulse occurs predominantly from running bearing.

In terms of defects that can be detected can include:
• lubrication failure / improper camp;
• early wear on the outer raceway;
• early wear on the inner raceway;
• early wear on the roller rolling object / ball;
• wear the cage early.

Specialized software associated test equipment must contain a rich database symptoms being able to automatically diagnose the probable causes of failure of bearing. At the end of a round of measurements, it releases a report of measurements, including assessment of shock pulse signal level standards in force, diagnosing and locating possible causes of wear of the bearing and the recommendations on what action should be taken when appropriate.

4. BEARINGS REPAIR: AN ALTERNATIVE TO REPLACEMENT

Bearing repair is not a new concept, nor has it changed a great deal over the years. Repairing damaged bearings is a precise science that has been fine-tuned over time through careful and gradual enhancements to provide superior results. Just as new designs and technologies improve bearings, growing expertise and technology of bearing repair continues to increase the reliability and performance of reconditioned bearings, keeping it an economical alternative to purchasing new bearings. Knowing and understanding the value of bearing repair means knowing what repair can do, when to use it, and where to get it done [3].
When to repair?

Although it offers many benefits, reconditioning is not always the best option for a damaged bearing. The challenge of properly utilizing bearing repair services is determining if and when a bearing needs repair, and deciding which options is the best economical and long-term decision. Visual inspection serves as the first step in deciding if a bearing needs repair. Careful review of additional criteria assists in determining the need for repair, such as:

- Is the bearing nearing or has it exceeded its suggested life expectancy?
- Have operating temperatures exceeded 90 °C?
- Has the bearing been exposed to excessive vibration?
- Has the bearing been subjected to sudden changes in lubrication or temperature?

Early detection of a problem through routine checks can spare companies' unnecessary downtime and expense and help to capitalize on the capabilities and benefits of bearing repair. Regardless of the manufacturer, type of bearing, or application, proper treatment may preserve a bearing and restore it to like-new condition for continued use. Bearings with little or no damage often can be reconditioned and recycled easily and at low cost.

Remanufacturing process

Once a bearing is damaged, it should undergo a rigorous process to determine if it is a candidate for repair. Bearings to be repaired should be thoroughly cleaned. Next, and the most critical step, is a detailed inspection on 100% of the bearing. Inspection begins with a careful review for major damages such as fractures, significant spelling, and bluing due to excessive heat. Any evidence of these usually results in scrapping the bearing. If the bearing passes the first stage of inspection, it should undergo further review. This step serves to reveal a mode of damage, assessment of damage, and the scope of repair. The degree of bearing repair typically fits into three types:

- **Type I** reconditioning is used for minor trouble spots and includes polishing, resetting of internal clearances, and spot grinding of any small surface defects to prevent further damage.

- **Type II** repair is for bearings with more extensive damage. This level involves major procedures such as regrinding of races, new spacers, and polishing of the bore and cup OD. The regrinding of raceways will also necessitate the manufacture of oversize rollers to maintain bearing geometry and clearance.

- **Type III** remanufacturing takes Type II repair one step further by replacing one or more of the major components of the bearing that are not repairable. These levels of repair have traditionally been suited for bearings with a minimum bore size of 200 mm.

However, reclamation service can be done for bearings as small as 75 mm.

**Expertise in bearing repair**

Technology and material advancements contribute to an increased potential for bearing remanufacturing and reconditioning programs. However, experience in recognizing and treating various types of damage is the only way to guarantee an accurate inspection and proper repair. It is important to have any bearing repair performed by properly trained and experienced personnel, because unnecessary repairs can lead to additional damage and limited bearing life. Common reconditioning mistakes include:

- Improper roller polishing that creates flat spots
- Excessive deep spot grinding
- Mixing of preset components.

In addition to expertise, proper equipment is required not only to fix the problem, but also to ensure all damage has been reviewed and addressed. Magnifying glasses and proper lighting and measuring equipment are essential to perform thorough inspections and repairs.

5. FINAL REMARKS

Repair after damage their equipment is expensive and takes time. Repair equipment based on the number of hours of operation is expensive and it is possible to scrap parts that would have run. Simple measurement of vibration will indicate if the vibration is normal, still acceptable or unacceptable, but we will provide information on which the defect and where it is located. The problem is more complicated for complex machinery where vibration evaluating a camp, we will not know if they come from working, the clutch, the gear etc.

The advantages of implementing a maintenance system based on periodic measurements and analysis of vibration signal:
- Saving of materials and spare parts;
- Shortening the residence time in repair;
- Increasing the availability of equipment for production.

Bearing design takes into account the use and application of the bearing and establishes an appropriate prediction for service and fatigue life. No matter who the manufacturer is, bearings often deviate from these expectations due to factors such as contamination, inadequate lubrication, and misalignment. When a bearing is damaged, the entire machine of which it is a part suffers. Conventional practice suggests that a damaged bearing should be scrapped and replaced. The growing popularity of bearing repair has helped companies understand its value by providing an efficient and cost-effective way to resolve the problem.

Bearings often can be returned to original specification for less time and money than purchasing new ones. A quality repair and reconditioning program can result in significant savings compared to discarding and replacing bearings. Depending on the scope of the work, bearing repair can save as much as 50% to 90% of the cost of purchasing a new bearing. Beyond the cost, repairs often save time compared to ordering replacement bearings, reducing costly downtime. Another value-added service of bearing repair is using damage analysis as a tool to identify difficult conditions and prevent future problems.

REFERENCES: