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MAINTENANCE OF BEARINGS USED IN A COAL MILL

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Abstract. *This work presents a technique for bearing maintenance using monitoring by vibration analysis. The goal is to apply the method of repowering on cylindrical roller bearings and conical roller bearings used in a coal mill of a Cement industry, through dimensional analysis, predictive maintenance and inspection of the bearing. It was analyzed the process of repowering of a Conical Roller Bearing (EE 380080/380190) and one cylindrical roller bearing (A-5248-WMR6/240 ERU52). The bearings were taken from a coal mill of a cement industry. Inspection procedures were performed using vibrations analysis, to assess the bearings condition. Analyzing the results it was found effective gains in both bearings. Has been obtained a reduction in maintenance costs, and increased the availability of equipment. The present work has demonstrated the effectiveness of the repowering of bearings.*

Keywords: *Bearing, Maintenance, Vibration Analysis, Repowering.*

1. INTRODUCTION

Bearings are machine elements that reduce friction, facilitate movement between two surfaces supporting loads (axial, radial or combined). The need to reduce the maintenance costs have done companies look for methods to increase the useful life of the equipment and its components. Re-powering is a technique applied to bearings in order to reduce maintenance costs and care for the environment to prolong useful life to avoid the need for new acquisitions (Shigley, 2010; Melconian, 2007).

During maintenance and repair of machines, many bearings are removed and replaced as a precaution, although they still have working conditions by a repair. This care in disassembly often hides great potential for cost savings in maintenance. The characteristics and conditions of the bearings have a significant influence on the production process.

The Repowering is a maintenance process that seeks to increase the capacity of performance and useful life of bearings that are already in use, through the restoration of surfaces and components of rolling bearings, removing surface imperfections caused by corrosion, impregnation and oxidation of particles. In order to reduce the costs involved in this process, it is often highly recommended to apply the repowering than replacing them with new ones. (Nepomuceno, 1989).

The preventive maintenance measures based on specific conditions intended to maintain a consistent level of high availability of the bearing. In some cases, the cost of repowering is significantly lower than the cost of a new bearing an average of 15% to 75%. This procedure provides shorter delivery times and in most cases with operating characteristics very close to a new bearing (Kardec, 2009).

The repowering offers mainly reduced maintenance costs and extending the useful life of the bearing with the possibility of customization to the needs involved in the application, such as increasing and decreasing radial clearance, construction of tapered bore holes and canals to lubrication. It also allows a gain of availability of the item that will cause a reduction of new items in stock. Using the process of repowering contributes to preserving the environment, since, for the manufacture of new bearings is required the extraction and processing of iron ore for steel production. Re-powering is not recommended in the following cases: (a) bearings that suffered cracks, (b) widespread shelling, (c) overheating, (d) bearings whose tracks had extreme wear, (and) bearings subjected to high flame temperature (Mirshawka, 1991).

Vibration analysis is a technique which investigates the cause of vibrations in mechanical systems through the analysis of the displacement amplitude at a particular frequency (Den Hartog, 1956). Bearing defects at an early stage are located on the rolling elements, inner rings, outer rings and cage. These are manifested by periodic shocks with low amplitude, where the repetition frequencies depend on the geometry of the bearing. The objective of this analysis is to determine the optimal point for the withdrawal of the bearing to perform the repowering process before it submits a recoverable fault (Berry, 1991). Some distributing companies of products and services for maintenance, sell bearings,

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belts, seals, bearings, lubricants and predictive maintenance services, such as vibration analysis, laser shaft alignment and dynamic balancing.

This work presents a technique for bearing maintenance using monitoring by vibration analysis. The goal is to apply the method of repowering on cylindrical roller bearings and conical roller bearings used in a coal mill of a Cement industry, through dimensional analysis, predictive maintenance and inspection of the bearing.

2. METODOLOGY

In this work it was analyzed the process of repowering of one Conical Roller Bearing EE 380080/380190 and one cylindrical roller bearing A-5248-WMR6/240 ERU52. The bearings were taken from a coal mill of a cement industry.

Before repowering, it is necessary to perform some preparatory steps, namely: (a) monitoring of bearings through vibration analysis, where the first measurement was performed with approximately 120 days of operation after installation, (b) monitoring the disassembly of bearings and visual inspection in the field, (c) identification of possible failures that cannot be repowering.

2.1 Monitoring by Vibration Analysis

The monitoring of the bearings by vibration analysis was performed with data acquisition in the field using a data logger (01 db MVP-2C with 02 channels) and an accelerometer 01 db (ASH 201, 100mV / g 80g peak). The results were analyzed in software management predictive XPR 300 version 4.01 where it was used the techniques of speed, acceleration and envelope.

2.2 Disassembly of the bearings

Disassembly of the bearings was performed together with a team of specialized maintenance. After disassembly is performed a visual inspection to assess the physical conditions, such as cracks and / or geometric deformations and possible failures in mechanical components. At each step the photographic recordings are performed in order to obtain a history.

2.3 Repowering

After this preliminary step, if approved technically, the bearings are free to begin the process of repowering. The methodology applied in repowering is divided according to the steps.

- **Inspection and Requalification:** At this stage the bearings undergo a metrology inspection. The bearings that are in good condition and do not require the use of repowering are assembled, lubricated and returned to the customer.
- **Reform:** This step is applied to remove light scratches and corrosion. The main element in this step is the surface treatment of the rings. This method is also effective in removing discoloration, such as those resulting from lubricant additives. Mechanical processes can be applied as grinding and polishing of the tracks and rotating elements. Chemical methods can also be used for cages, particularly those of brass that undergo a change in its color depending on the lubricant used.
- **Remanufacturing:** At this stage, in addition to mechanical and chemical processes, the rolling elements are replaced. This may occur if the bearings present high levels of wear or geometry defects. This step involves not only the correction of wear, but also adjusting the axial clearance which is an important parameter for increased bearing life.

3. RESULTS AND DISCUSSIONS

The studied bearings for possible application of repowering, were monitored by vibration analysis which will determine the ideal point for dismounting before presenting irreparable flaws that that render it unfeasible to process of repowering. Table 1 shows the dimensions of the bearings used in this paper.

Table 1. Dimensions of the bearings (TIMKEN, 2008).

	Bearing EE 380080/380190	Bearing A-5248-WMR6/240 ERU52
Diameter of the outer ring	482.600 mm	440.000 mm
Diameter of the inner ring	203.200 mm	240.000 mm
Width	117.475 mm	146.050 mm

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For monitoring the vibration analysis, it was used the technique of acceleration envelope, where is obtained the values in overall levels of the gravity acceleration (g). This process consists in capturing the acceleration signals in the high frequency region (above 2 kHz) and using the method of acceleration enveloped and fast Fourier transform, the signal is modulated to low frequency area (between 0 and 500 Hz) where the amplitudes appear more clean and failures become more evident.

The range of values recommended for bearings is 0g to 4g, where values between 0g to 2g are normal levels for the operation. In the range between 2g and 3g is considered that the bearing is in alarm 1, wherein the bearing shows signs of wear, without interfering with its operation. In the range between 3g and 4g is considered that the bearing is in alarm 2, wherein the bearing presents increased wear of components, with moderate operational risk. Above 4g, the bearing wear has more advanced features, which is advised to withdraw and replace the bearing. Before repowering, three measurements were performed with a 40-day interval between each one. The first measurement was performed with approximately 120 days of operation after installation.

3.1 Conical bearing EE 380080/380190

Figure 1 shows the trend graph for the conical bearing EE 380080/380190.

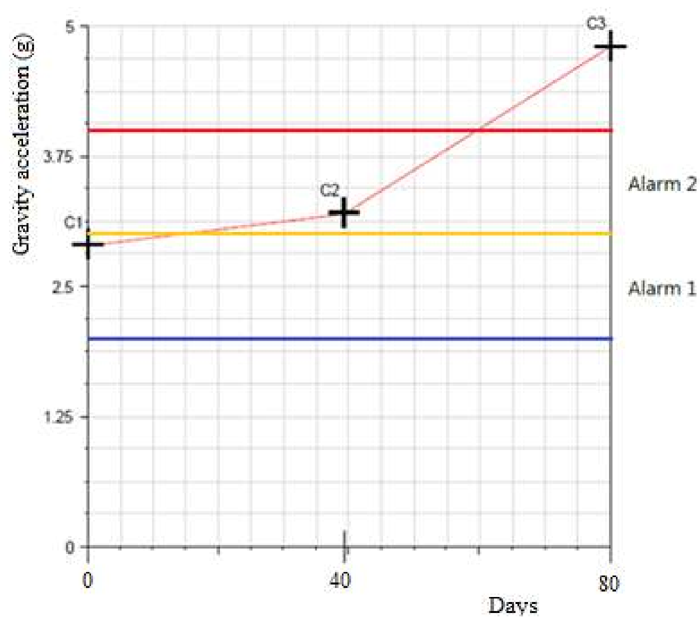

Figure 1. Spectrum of acceleration of conical bearing before repowering.

In the first measurement performed (C1) the bearing presented an acceleration of 2.9 g, being in the range of the first alarm. In the second measurement (C2) acceleration increased to 3.21 g, entering in the range of alarm 2. The third measurement (C3) showed a value of 4.8 g, exceeding the alarm 2 limit. It was recommended the removal and disassembly of the bearing for a visual inspection and a possible repowering.

After performing the visual inspection, it was not found any problem of cracks in the rings, indentations, severe peeling and rust. A metrological analysis was also performed, where was found a small ovalization, within the limits of tolerances specified by the manufacturer. After visual and dimensional inspection, the bearing is ready to be rectified. Then the bearing is polished and subjected to surface hardness testing on the track and rolling elements, being the recommended range between 58HRC to 62 HRC. The bearing races present a hardness of 60 HRC and the rolling elements present a hardness of 59 HRC. The process is completed with the bearing assembly as shown in Figure 2.

ISSN 2176-5480

Figure 2. Conical bearing after repowering.

After repowering, the bearing was placed in operation, and a fourth measurement (C4) was performed, obtaining an acceleration of 1.77 g. This value is below the alarm 1, which characterizes normal operating levels. In order to verify the efficiency of the process, a fifth measurement (C5) was performed 40 days post and the acceleration decreased to 0.45 g. This is due to the adjustment of the mechanical components. The values found show the effectiveness of repowering process and are shown in Figure 3.

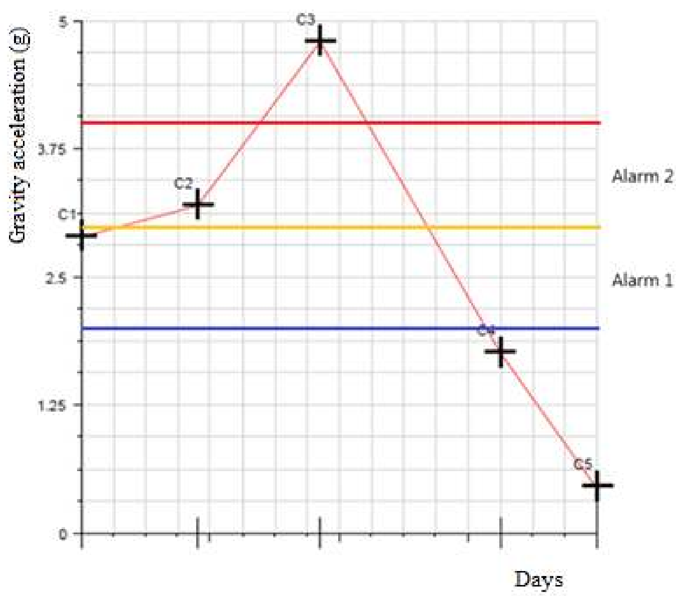

Figure 3. Spectrum of acceleration of conical roller bearing with repowering.

3.2 Cylindrical bering A-5248-WMR6/240 ERU52

Figure 4 shows the trend graph for the bearing A-5248-WMR6/240 ERU52.

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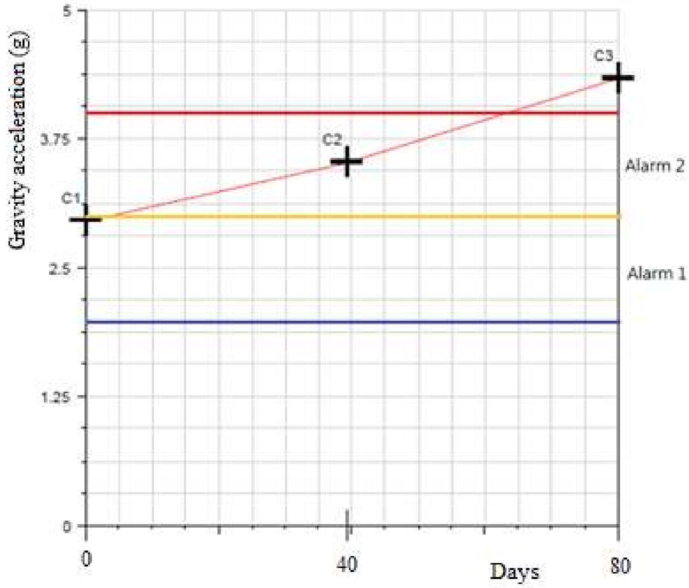

Figure 4. Spectrum of acceleration of cylindrical roller bearing before repowering.

In the first measurement performed (C1) the bearing presented an acceleration of 2.96 g, being already close to the alarm 2. In the second measurement (C2) acceleration increased to 3.51 g. The third measurement (C3) showed a value of 4.3 g, exceeding the alarm 2 limit. It was recommended the removal and disassembly of the bearing for a visual inspection and a possible repowering.

Inspection procedures were performed, finding no problems that prevented repowering. However, in this roll was checked a radial clearance of 0.94 mm, where the tolerance range allowed for the class R6 has the interval from 0.18 to 0.27 mm. Thus was performed the replacement of rolling elements.

In tests of surface hardness, the bearing races presented a hardness of 58 HRC and new rolling elements showed a hardness of 60 HRC. The process is completed with the roller assembly as shown in Figure 5.

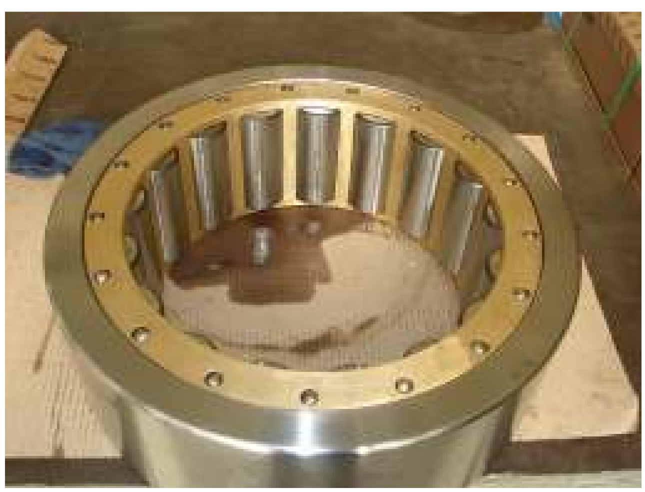

Figure 5. Cylindrical Roller Bearing after repowering.

After repowering, the bearing was placed in operation, and a fourth measurement (C4) was performed, obtaining an acceleration of 2.16 g. This value is slightly above the first alarm, but this value is expected to decrease after adjustment of mechanical components. In order to verify the efficiency of the process, a fifth measurement (C5) was performed 40 days post and the acceleration decreased to 1.32 g. The values found show the effectiveness of repowering process and are shown in Figure 3.

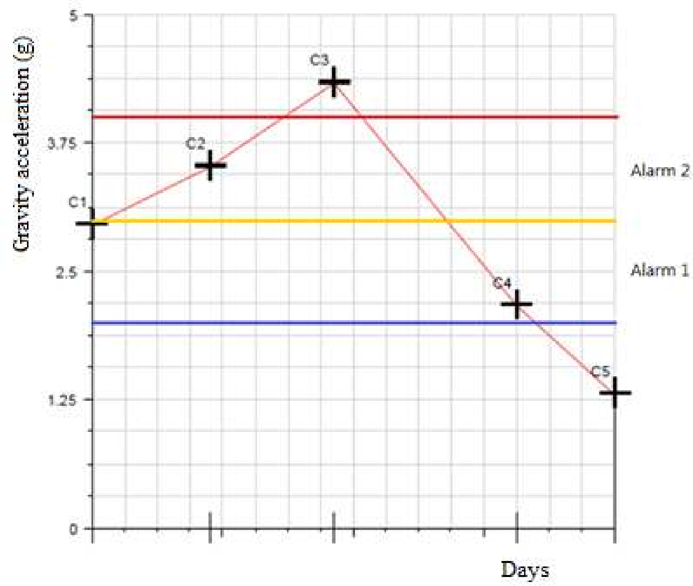

Figure 6. Spectrum of acceleration of cylindrical roller bearing with repowering.

4. CONCLUSIONS

The present work has demonstrated the effectiveness of the repowering of one cylindrical roller bearing (A-5248-WMR6/240 ERU52) and one conical bearing (EE 380080/380190). Analyzing the results it was found effective gains in both bearings. The bearing EE380080/380190 there was a reduction in the acceleration of 4.8g to 0.45g. In the bearing A-5248-WMR6/240 ERU 52 there was a reduction in the acceleration of 4.3g to 1.32g.

Cost reduction was approximately 85% due to the high cost of new bearings. Another advantage of the process of repowering is the increased availability of the bearing for the client in approximately 12 months, because it is a specific item without immediate availability of delivery for new acquisitions. The process is shown as a technically and economically viable alternative to bearing maintenance.

5. ACKNOWLEDGEMENTS

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7. RESPONSIBILITY NOTICE

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