DETECTION THE CONDITION OF A FAN TRANSMISSION IN METAL SMELTER FENI KAVADARCI USING VIBRATION SIGNATURE

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Abstract: In the process of hard working mode the transmission fan of metal smelter FENI Kavadarci appear possible failures of vital elements. Detecting the condition of periodically measuring the vibration condition allows early detection and timely intervention renounced by replacing damaged parts. From the experimental data is most problematic is observed that transmission of the fan with the engine. Specifically, the engine rolling bearings are often subjected to cancellations. The paper will show the procedure for early detection of failure the rolling bearings using vibrating signature of the measurements.

KEYWORDS: OUT OF BALANCE, VIBRATION ANALYSIS, BEARING LIFE

1. Introduction

In the process industries, vibration monitoring is now a well-accepted part of many planned-maintenance regimes and relies on the well-known characteristic vibration signatures, which rolling bearings exhibit as the rolling surfaces degrade. However, in most situations bearing vibration cannot be measured directly and so the bearing vibration signature is modified by the machine structure. This situation is further complicated by vibration from other equipment on the machine, such as electric motors, gears, belts, hydraulics, structural resonance etc. This often makes the interpretation of vibration data difficult, other than by a trained specialist, and can in some situations lead to a missed diagnosis, resulting in unnecessary machine downtime and costs.

Bearing vibration analysis can detect lubrication failures, misalignment, out of tolerance running, rubbing, improper gear teeth meshing, out of balance, bent shafts, loose components, worn parts, faulty couplings, improper operating conditions (like pump cavitations) and deflecting support structures. However to be able to analyses the presence of these type of problems requires a highly skilled person with much experience and exposure to bearing vibration signatures at various stages of failure.

Unfortunately, many bearings fail prematurely in service because of contamination, poor lubrication, temperature extremes, poor fitting, unbalance and misalignment. All these factors lead to an increase in bearing vibration and so condition monitoring has been used for many years to detect degrading bearings before they fail catastrophically, resulting in associated downtime costs and/or significant damage to other parts of the machine.

The vibration produced by a healthy, new bearing is low in level and looks like random noise.

As a fault begins to develop, the vibration produced by the bearing changes. Every time a rolling element encounters a discontinuity in its path a pulse of vibration results. The resulting pulses of vibration repeat periodically at a rate determined by the location of the discontinuity and by the bearing geometry. These repetition rates are known as the bearing frequencies, more specifically:

- Ball passing frequency of the outer race (BPFO) for a fault on the outer-race
- Ball spin frequency (BSF) for a fault on the ball itself
- The fundamental train frequency (FTF) for a fault on the cage.

The bearing frequencies can easily be calculated from the bearing geometry using the formulae given in Fig. 1.

2. FFT analysis of the motor-fan assembly

A Motor-fan assembly existing in FENI-Kavadarci Industry is used to predict a defect in rolling bearings is shown in Fig. 2. The function of the fan is to take warm air (about 300 c), which is located in first and second chamber lepol from oven and transfer into the third chamber where the heating is carried ore located the chain of lapel oven. The assembly consists of a shaft with fan at the end of it, which is supported on a bearing. The design incorporated a bearing, damage bearing at driven head of electromotor and a coupling disk system. V01.57 fan is drive by electric engine (motor) with the speed \( n = 974 \) rpm and power of 800KS (600KW)-6000V. Both bearings of the electric engine
The basic goal of this investigation is measuring the vibration of all rotating machinery in Feni Industry.

For that purpose was used VIBROTEST 60 (Bruel & Kjaer) instrument with appropriate modules.

All measurements of rotating machines via a memory card of the VIBROTEST 60 were transferred to a computer. The computer has installed XMS software where all measurements are recorded on the machine. XMS (extended monitoring software) is the professional software for optimum implementation of the concept “condition-oriented machine maintenance” and provides perfect support through an intelligent database. By measuring the route covered all machines in the factory (Fig. 4).

By measuring the vibrations in this program and register at the same time frequency analysis are too. But if there’s a problem of the machines are made more frequent measurement to monitor the amount of vibration and to determine whether resulting from lineups: Bad bearings in electric motor or the working circuit. Sometimes a problem with the clutch which can be damaged by irregular lubrication of electric motor with a working circuit, or by imbalances that may occur with consumption of the fins from the working circuit. Spending the fins can occur from hot air and dust that is in him. To determine what caused the vibration, it has been establish measurements and software through the frequency analysis of all bearings, and it is seen from the pictures (Fig. 9.). In images, if any of the peaks coincided with the red vertical lines (1-5), who read part of the slot is damaged, (read from right image)

If the vibrations are caused by damage to the bearings, then take a further reading of the frequency analysis. When you determine what caused the vibrations, we look in the documentation that the manufacturer of that machine in which boundaries are allowed to run. According to the number of revolutions we see what the allowable vibrations are.

RESULTS AND DISCUSSION

The Four Stages of Bearing Failure

A roller bearing progresses through four stages to failure. Vibration analysis permits the monitoring of the bearing’s progression through each stage and to estimate when failure will actually occur. In the case of a raceway failure these would be the four progressive stages.

1. The bearing is new and has no defects (fig. 5). This is the time to record its frequency ‘signature’ and normal operating acceleration and velocity values.

2. If examined at this stage there would be no visible defects (fig. 6). However under the surface of the raceway sub-surface defects have started. The frequency signature has changed, the overall base level noise has risen and the velocity spectrum (graph) has risen higher.
3. At this point the raceway shows visible signs of surface failure (fig.7). The extent of the failure increases and grows with more metal coming off in minute sheets (delaminating). The velocity spectrum is much higher and much more background noise has developed. Within the background noise particular frequencies start to stand out (side bands) and indicate failure is fast approaching.

4. If the bearing is still in service everyone knows it is time to change it out because they can hear it (fig. 8). More vibration frequencies appear and more velocity side bands develop. Readings start to indicate amplitude changes and the noise moves into the range of human hearing.

Permanent monitoring and measured results of the vibrations (Fig.9,10) at the characteristic points in three directions showed that the rolling bearings SKF 6228 defined with the point 1 and 2 in Fig.3 are most sensitive of the electric motor. The results of periodic measurement of these points in the 2002-2011 periods were given in Fig.9,10.

It is obvious that the rolling bearing SKF 6228 in point 2 have never undergone the critical limits of vibration in the monitored period. So, bearing in point 1 is critical, because in periods from 18/02/2010 to 11/17/2010 steadily increasing amplitude of rolling elements rotational frequency (red point 3) and amplitude of vibration of the cage (red point 5).

In further analysis is given vibration condition of the rolling bearing set on the front and the back of the electric motor and a point marked by the point 1 and point 2. Finally, recent measurements at the beginning of 2011 showed a significant increase in the amplitudes of vibration rolling elements and cage (Fig.8).

Two types of bearing defects, namely, rolling elements and cage defects were studied. Measurements were carried out on two sets of bearings. The defective bearing was replaced by good bearing (Fig.14) after predicting the failure with vibration signal analysis.

After dismantling the bearing, the photo showed the place where it caused the failure of the bearing cage (Fig.11).
Defects on the rolling elements (Fig.13) can generate a frequency at twice ball spin frequency and harmonics and the fundamental train frequency. Twice the rolling element spin frequency can be generated when the defect strikes both raceways, but sometimes the frequency may not be this high because the ball is not always in the load zone when the defect strikes and energy is lost as the signal passes through other structural interfaces as it strikes the inner raceway. Also, when a defect on a ball is orientated in the axial direction it will not always contact the inner and outer raceway and therefore may be difficult to detect.

The bearing cage tends to rotate at typically 0.4 times inner ring speed, has a low mass and therefore, unless there is a defect from the manufacturing process, is generally not visible. Unlike raceway defects, cage failures do not usually excite specific ringing frequencies and this limits the effectiveness of the envelope spectrum. In the case of cage failure, the signature is likely to have random bursts of vibration as the balls slide and the cage starts to wear or deform and a wide band of frequencies is likely to occur.

Following are some example of problem that can cause the generation of the fundamental train frequency. These are in addition to other conditions already discussed.

1. In rare cases when one or more rollers are missing from a bearing, the FTF can be generated. The problem occurs as a pulse at the FTF. The frequency spectra contain a series of harmonics of the FTF. The amplitude of the first harmonic is quite low, the second, third, and fourth harmonics are higher in amplitude as determined by the pulse.

2. Sometimes, attempts to lubricate sealed or shielded bearings can cause the seal or shield to deflect inward. If the cage touches the seal or shield, the FTF and/or two times FTF plus harmonics can be generated.

3. Excessive clearance in an antifriction bearing can cause the generation of a discrete frequency at the FTF and/or modulations of the FTF at rotating speed and harmonics.

Except for defects that occur in bearing components during manufacturing, the cage is usually the last component to fail. The typical failure sequence is as follows: defects form on the races, the balls, and then finally the cage. A severely damaged cage can cause constant frequency shifts that are observable with the use of a real-time analyzer.

When the cage is broken in enough places to allow the balls or rollers to bunch up, wide shifts in frequencies accompanied by loud noises can occur. When these signs are present, bearing seizure is imminent.
REFERENCES


