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Bearings Degradation Prediction by Vibration Analysis

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Abstract: This research relates to the major problem of the excessive consumption of the bearings. In fact, we are obliged as long as maintenicians to seek the cause and to find the solution to decrease these failures. Knowing that approximately 66% of the problems which can bring back a bearing to a state of incapacity to achieve its mission, such as the bad assembly, bad lubrication as well as pollution, are carried even to the not qualified agents of maintenance. Thus this study presents a study on the monitoring of the bearings by vibration analysis. The vibration is physical phenomena used to highlight degradation or malfunctions of a revolving machine and give a better measurement of its state. The early detection of a bearing is highlighted by the use of an indicator of statistical defect frequencies which is the spectrum and also the curve of tendency. This approach makes it possible to develop a new form of conditional maintenance.

Key words: Bearing, vibrations, degradation, spectrum, curve tendency

INTRODUCTION

The industrial production evolves in an increasingly severe context with regard to quality, safety and the harmful effects. Consequently, the production equipment must be the subject of an effective maintenance. Unexpected catastrophic failures involve at the same time a loss of production and invoices of very high repairs (Georjon and Deborde, 1994).

If the bearings were correctly installed and are correctly used, they are likely to cease functioning correctly at a certain time, in consequence of a noise and vibration increase, operation precision loss, grease deterioration, or a surfaces of bearing chipping or tiredness.

In addition to the damages resulting from a natural deterioration, a bearing can cease functioning correctly under the effect of a seizing per heating, or the damage of a ring, such as a fissure, a rupture, or a deep scratch, or in consequence of a damage of its system of sealing.

The conditions of this kind are not regarded as component of the damages specific to the bearing itself, because they are often the result of an error made in the choice of the bearing, design or realization of the adjacent parts to the bearing, assembly or maintenance fault of (Boulenger and Pachaud, 1998).

Among the techniques allowing the monitoring of a machine, the vibratory analysis is the most used in conditional maintenance. It requires to analyze and follow the evolution of spectrum measured (curve of tendency) in one or more points of the machine, in order to determine the appearance of possible lines defects characteristic. If, in many cases, the ideal points of measurements are located at the more meadows of the parts to supervise, the size of certain machines or the accessibility of certain places makes difficult even impossible the captures of measurement to the more meadows of the parts to be supervised. All the recent data-processing techniques, although increasingly powerful, are dependent on the quality of the analyzed signal and thus the transmitter position.

Following these repeated requests, the bearings remain one of the weak points of the machine. The main purpose of this research is an early bearings deterioration detection, using the vibratory signal.

POTENTIAL CAUSE OF DEGRADATION

All these defects have the fact in common that they result early or late in a loss of metal fragments, that one calls chipping Fig. 1.

When there are chipping or indentation on one these elements of the bearing, these shocks cause a vibration of the impulse type which is propagated on the ring, then on the external cage of the bearing impulsion (Monchy, 2000). These impulses become the source of amplitude modulation of the random signal of vibrations. They are characterized by a very stiff climb and by one very short time and consequently there will be an increase in the effective value of the vibratory signal and his peak factor. By highlighting the repetition of this impulse, one thus defines the bearing defects frequencies.

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Fig. 1: Chipping on the interior ring of a ball-bearing deeps-groove

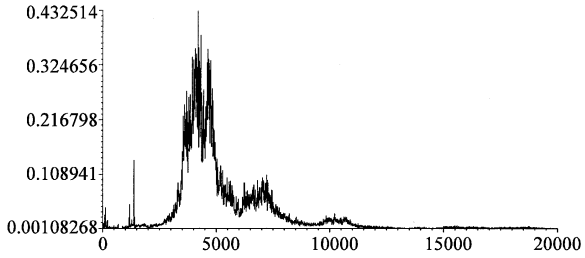

Fig. 2: Spectrum of a defect on external ring

VIBRATION ANALYSIS

To determine the fault origin, the nature reconnaissance of the vibrations is an invaluable element which cannot be given by the values of the studied physical sizes it is thus interesting to seek new physical sizes or indicators adapted to this reconnaissance, in particular to know if they are or not vibrations of the periodic type and if these last present or not a character of gravity.

The vibrations of the periodic type are generally generated by shocks which induce vibrations or "shock waves" of very short duration of amplitude significant peak and generally appearing until in high frequency (Boulenger and Pachaud, 1995). All the machines vibrate and with the fur as the state of the machine worsens (unbalance, wear of bearings, defect of greasing, fissures), the vibratory signature changes. In this study, we will highlight the detection of the early deterioration of a bearing, using one of the various indicators of the frequencies methods.

SPECTRUM

The observation of the frequency spectrum raised on the defective stage offers another possibility of analysis. It will be necessary in this case to seek the frequencies characteristic of the defects. The sum frequencies are in the vicinity of rotational frequencies and are thus overloaded parasitic vibrations.

The spectrum comprises peaks at the frequencies of the defects until a few kilocycles. Figure 2 presents a spectrum having a high resolution in the beach of a few kilocycles.

This type of defect resulting on a ventilator coupled with an engine from drive, the rotational speed of this machine is 1500 tr min^{-1} and its nominal output is 500 Kw. Data-gathering necessary to the measurement and analysis, summer carried out using a sensor (Fig. 3). Being given that the vibratory signal of a shock covers a broad frequency band, only the part high frequency will be used to evaluate the state of the bearing (Fertial, 2006).

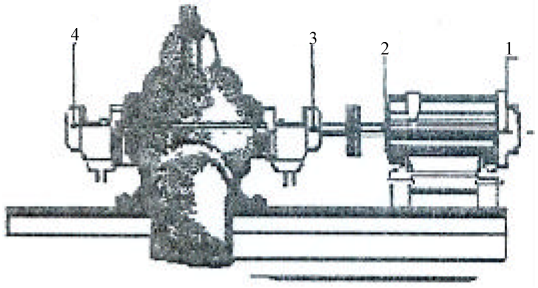

Fig. 3: Diagram of installation with the measuring points

MEASUREMENT TOTAL

One displays in this report of the measurements the values of the amplitude according to choice's of the sizes of measurements (Fertial, 2006).

Detection : Effective speed.
Unit : mm s^{-1}.
Alarms : inf = 1.8 mm s^{-1}
Sup = 11.2 mm s^{-1}.

After raised of the measurements for the installation of the ventilator as in point 3 whose position is radial horizontal. These measurements show that it there with a going beyond of threshold on the level of the item 3 of which the preceding position. According to these measurements one represents the vibration according to time, this analysis of tendencies makes it possible to check if the significant vibration on the measured machine is stable or unstable (Fig. 4).

According to this diagram one notes that the vibration on the machine is varied and exceeds higher alarm, therefore, the machine is unstable and its "inadmissible" state and that it require a diagnosis. According to the diagnosis one uses the spectrum. One presented the spectrum zoom at item 3 (Fig. 5).

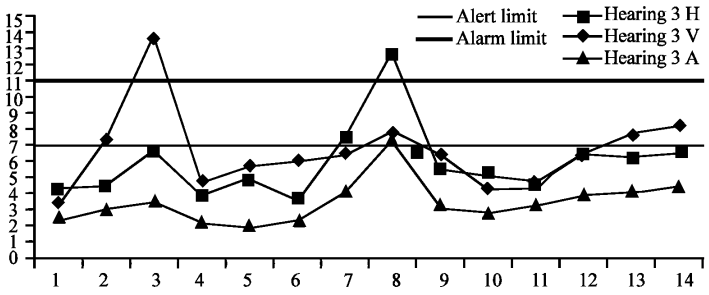

Fig. 4 : Amptitude Veff curve tendancy of bearing 1-4 in mm s^{-1} time range 15 days

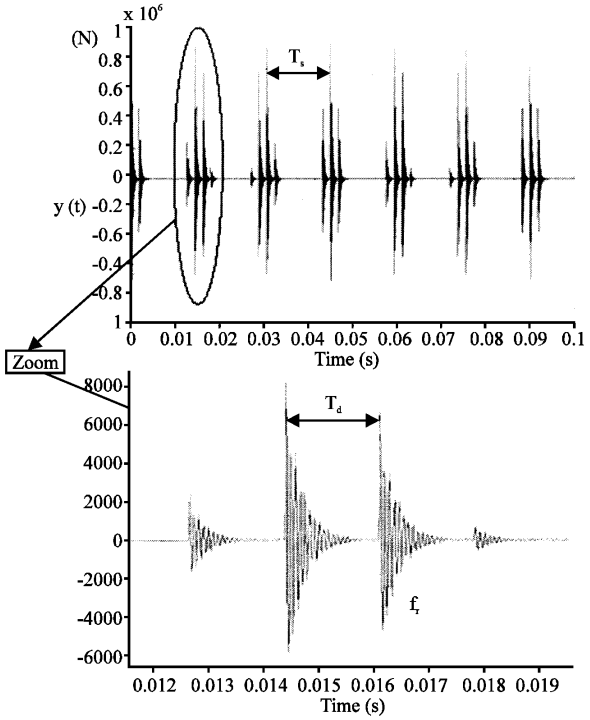

Fig. 5: Zoom Spectre: Items 3 in horizontal radial position

RESULTS AND DISCUSSION

The manifestation of the harmonic lines at the high frequency states to us directly that it there with a defect of bearing because according to the table of reconnaissance of the defects only the phenomena of bearing which appear at the high frequency.

This result of measurement directly show the systematic change of the bearing when the alarm threshold for that it exceeds is necessary to distinguish on the one hand the methods of evolution for that our objective is to guarantee a long lifespan of the bearings, for that it is necessary to determine the state of these parts in particular and the machines in general during their operations. Knowing that a good preventive maintenance will reduce the costs of maintenance.

Conditional maintenance not only makes it possible to establish the diagnosis on the state of a machine at a given moment, but more especially, it gives the elements necessary to envisage the evolution of it.

CONCLUSION

The bearing is a very significant element in the construction of the machines and more particularly in the revolving machines. Its fast wear is very expensive with our companies. The theoretical study on the bearings shows the various faults and the determination of the lifespan of the bearings. The vibratory diagnosis of the machines, based on the vibratory knowledge of the images where appears the defects in order to gather and determine the thresholds of judgements.

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