Vibration Analysis of Air Slider Fan bearing system–Condition Monitoring Technique

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Abstract— *The failures of rotating machineries can be very critical because these lead to machinery damage, production losses and personnel injury. So, a very important duty of the maintenance department is to prevent these failures when they are in its initial stage. The predictive maintenance by vibration analysis is the best tool for this purpose. The vibration analysis is a technique, which is being used to track machine operating conditions and trend deteriorations in order to reduce maintenance costs and downtime simultaneously. In this paper a vibration analysis is done in regard to a test rig representing as prototype model of an air slider fan system. For this system the critical component that is the roller bearing, the inner and outer race defect are considered for the vibration spectral analysis using industrial vibration measuring instruments.*

Keywords— Vibration spectral analysis, Inner and outer race defect, Condition monitoring

I. INTRODUCTION

Maintenance is one of the major factors that contribute in the cost and time to produce the product, while it does not contribute to improve the quality of the product. Every design engineer aims to reduce maintenance. Here in this paper we are focusing on condition monitoring maintenance which plays a vital role in present days. The defective roller bearings are major cause of failure of rotating machinery [1]. It is very important to predict the defects in the roller bearing so as to take appropriate maintenance action and repair them before they cause serious damages to the system [2]. There are several methods of condition monitoring those are vibration monitoring, shock pulse monitoring, visual monitoring.\In these methods vibration monitoring is most suitable to monitor condition of roller bearing.

II. VIBRATION CONDITION MONITORING

Vibration monitoring is a well-established method for determining the physical Movements of the machine or structure due to imbalance mounting an alignment this method can be obtained as simple. Easy to use and understand or sophisticated real time analysis.

Vibration monitoring measures the frequency and amplitude of vibrations. It is Known that readings will change as machinery wear sets in. such readings can be interpreted as indicators of the equipment's condition and timely maintenance actions can be scheduled accordingly. Electrical machines and mechanical reciprocating or rotating machines generate their own vibration signatures (patterns) during operation. However such raw signals contain a lot of background noise, which makes it difficult or even impossible to extract useful, precise information by simply measuring the overall signal. It is thus necessary to develop an appropriate filter to remove the operationally and environmentally contaminated components of signals (the background noise) so as to reveal the clear signals generated by the events under study. To capture useful condition monitoring data, vibration should be measured at carefully chosen points and directions.

Vibration monitoring usually involves the attachment of a transducer to a machine to record its vibration level special equipment is also available for using the output from sensor to indicate nature vibration problem and even its precise cause. Transducers for the measurement of vibrations employ electromagnetic electrodynamics, capacitive, piezoelectric, or strain gauge principles out of these piezoelectric accelerometers is most widely used since the recent past, Among the monitoring techniques vibration monitoring as gained considerable importance because of following fundamental factors All rotation and reciprocating machines vibrate either to a smaller or greater extent machines vibrate because of defects or incurrence in system. When inaccuracies are more it results in increased vibration each kind of defect provides a vibration characterized in the unique way. Therefore vibration characteristics reveal the health condition of machine.

III. POWER SPECTRAL DENSITY

Vibration is the mechanical oscillations of an object about an equilibrium point. Normally the terms used to describe vibration are amplitude and frequency. Power spectral density (PSD) refers to the amount of power per unit (density) of frequency (spectral) as a function of the frequency. The power spectral density, PSD, describes how the power (or variance) of a time series is distributed with frequency. By knowing the power spectral density and system bandwidth, the total power can be calculated.

The bearing frequency can be calculated from the bearing geometry using following formulae.

For Outer Race Defect

$$f = {}^{N}/_{2}\ f_r\left(1 - {}^{db}/_{dm}\cos\alpha\right)^2$$

For Inner Race Defect

$$f = {}^{N}/_{2}\ f_r\left(1 + {}^{db}/_{dm}\cos\alpha\right)^2$$

In above formulae

N = No. Of Rollers,

f_r = Relative revolution between inner and outer race.

d_b = diameter of rollers,

PSD can also be found by experimentally using modern vibration measurement devices, like X-vibrometer. This instrument can measure three dimensional vibrations

IV. MATERIALS AND METHODS

The experimental test rig consists of an electro-motor. The shaft of electric motor is extended using a coupling and extended shaft is supported with a roller bearing which is

mounted in a bearing pillow, at the end of extended shaft a 6 blade fan is attached.

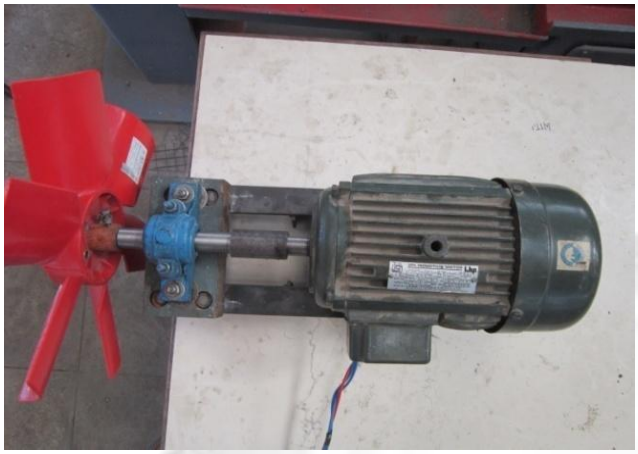

Fig. 1: Experiment setup with 6 blade fan.

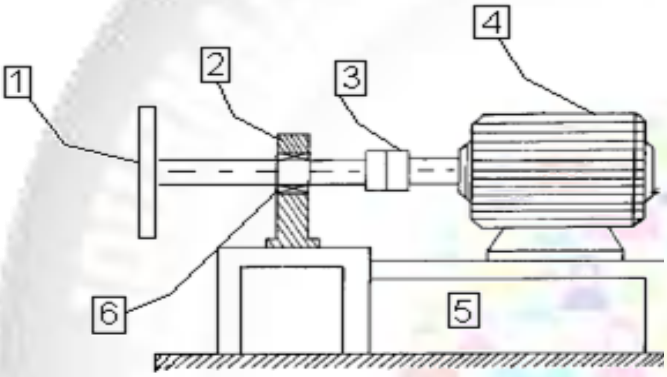

Fig. 2: six blade air slider fan system

(1) Fan
(2) Bearing Pillow
(3) Shaft Coupling
(4) Electro-motor
(5) Steel frame Bed
(6) Roller Bearing

The portable condition monitoring signal 25nalyser is used to collect dataset of the experimental setup. The bed is designed to install fan, bearing housing (pillow) and motor. All vibration signals were collected from the experimental testing of electromotor using the portable accelerometer which was mounted on the outer surface of the bearing case of input shaft of the electromotor. For each configuration different fault conditions were tested that were inner race and outer race damage of bearing as shown in fig. the signals from the accelerometer were recorded in a portable condition monitoring signal 25nalyser.

Fig. 3: outer race defect

Fig. 4: inner race defects

V. Result And Discussion

The results indicate that, bad bearing has a strong effect on the vibration spectra. Vibration spectrum analysis has been employed to identify different defects in bearings. The results have demonstrated that the technique is useful to detect problems in roller bearings. The vibration signals of good bearing and defective bearing is shown in Fig. 1, 2 and 3, respectively. The largest average value is accrued in outer race defect bearing and minimum average acceleration value accrued in the good bearing. Its value is 1.5mm/s (RMS).

The maximum and minimum value of velocity in healthy bearing, inner race defective bearing and outer race defective bearing is 2mm/s (RMS) and 1.5mm/s (RMS),3.5mm/s(RMS) and 2.5mm/s(RMS), 9.75mm/s(RMS) and 6mm/s(RMS) respectively

The result shows that area under the curve indicates the problem [3, 4]. The more area under the curve showed the deeper fault. The result shows that the different fault situation gives different curve and this could be used to find the fault in the bearing.

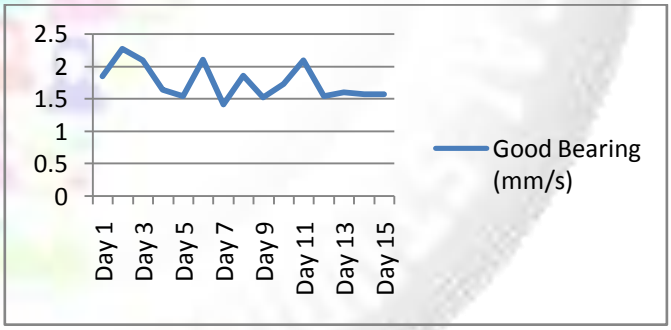

Fig. 5: Overall vibrations of driven end (DE) of electromotor in good bearing position

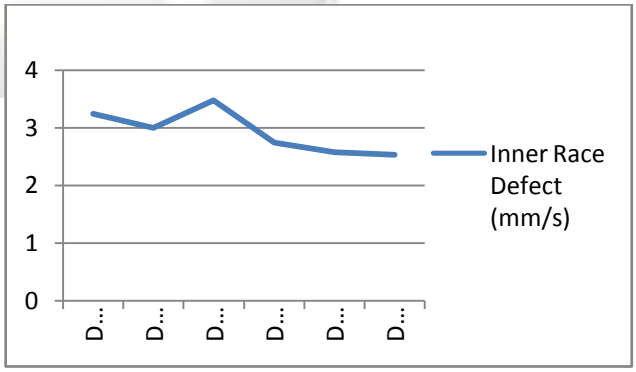

Fig. 6: Bearing Condition of driven end of electromotor in inner race bad bearing position

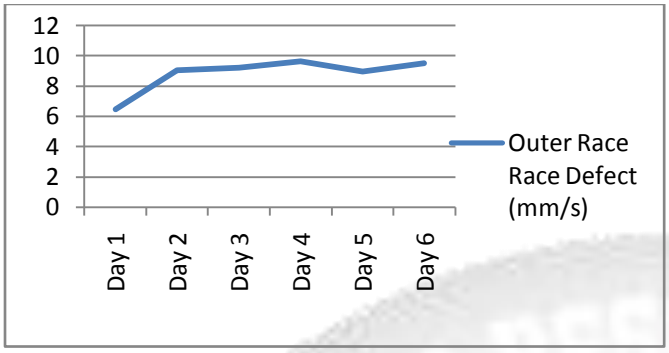

Fig. 7: Bearing Condition of driven end of electromotor in outer race bad bearing position

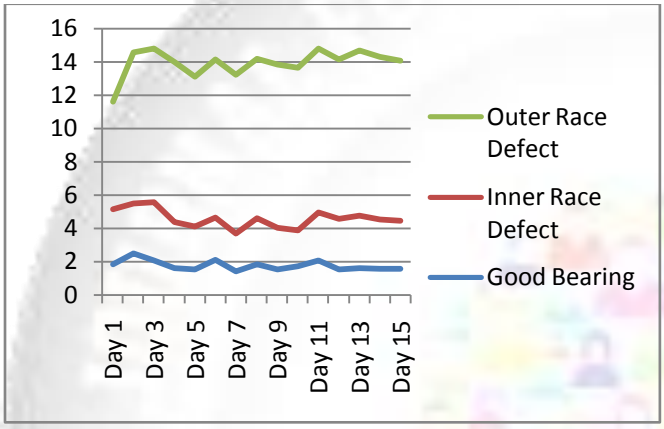

Fig. 8: Comparison between Defective bearing and good bearing.

VI. Conclusion

In this study, diagnosing techniques of the cylindrical roller element bearing defects were investigated by vibration monitoring and spectral analysis as a predictive maintenance tool. The result shows that vibration Power Spectral Density technique could fault diagnosis of roller bearing. The Power spectral Density technique provides fast and reliable information about faults in the bearing. This vibration data would be taken as a foundation material for the development of a framework for condition monitoring technique.

Acknowledgments

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