Condition Monitoring of Bearing using Acoustic Emission Technique: Review

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Abstract : Bearings are perhaps the most omnipresent machine elements and therefore it is critical to get success over it. Consequently, there is a great need for a timely knowledge of the health status of bearings. Generally, condition monitoring is the way of determining the component's life or condition depend on signal detection, processing and classification in order to identify the causes of the problem. Acceleration and acoustic emission signals are considered as multisensory system. Because of high reliability and various speed ranges, monitoring will be successfully done. When more than one sensor is used, if one fails to work properly the other is still able to provide adequate monitoring. Vibration techniques are suitable for higher rotating speeds whilst acoustic emission techniques for low rotating speeds. This review paper gives a review on condition monitoring of bearing system using acceleration and acoustic emission (AE) technique. The initial stages are experimentally obtaining subsurface cracks, the type of cause in a service failure of a ball bearing, within a ball and to closely inspect the characteristics of this AE from crack emergence to the formation of a ball on the ball surface. It is closely studied that the frequency content of the AE changes during this experimental period, although this has yet to be considered consistent or even completely explained.

Keywords — Acoustic Emission, Bearing defect diagnosis, Condition monitoring, Fault detection, Rolling element bearing,

I. INTRODUCTION

Rotating machinery is mostly used and is very important equipment in the fields of Mechanical industrial. Most of the industries and Research communities refers condition monitoring and fault diagnosis of these equipment. Low prices and high reliability gives rise to use a most commonly elements like rolling contact bearing[1]. Many advanced methods are depend on vibration signals and more effective when problem became more critical. But the resultant signals are always disturbed and fluctuated by other faults and mechanical noise. Hence, acoustic emission technique is preferred rather than vibration technique.

Acoustic emissions (AE) are defined as transient elastic waves generated from a rapid release of strain energy caused by a deformation or damage within or on the surface

of a material. Particularly AE is transient elastic waves generated when there is an interaction between two surfaces. These are responsible for producing seeded defect on the outer and inner races will result in the generation of Acoustic Emission. Acoustic emission (AE) was first developed for non-destructive testing however, recently its applications are used for monitoring of rotating elements and bearings. It is advantageous as compared to other techniques because of their quick responses[5]. This technique can identify the starting phase of component deformation.[4] Rolling element bearing having faults operates, the surface faults, cracking, etc. may create strain on the surface of the roller and the race of the bearing[1]. Then Acoustic Emission signal is determined by standard parameters of the signals. This proves that the method is very effective to extract the actual characteristic frequency of the bearing by AE signal. In addition AE parameters gives sensitive response to various conditions of bearing under different loading parameters, running and defective condition.

There are two different kinds of condition monitoring methods, direct and indirect. In the context of bearing monitoring, a direct method typically involves some visual inspection for signs of wear on the surfaces of various elements of a given bearing. As can be readily understood, this approach is very time-consuming and impractical in a manufacturing plant because bearings tend to be rather inaccessible in machines. Even if such an approach is possible, it may not be desirable because the mere act of dismantling and re-assembling a bearing often induces a problem that requires future maintenance effort. An indirect method relies on the use of signals arising from a bearing while in operation. Sensors are used to produce signals containing information on a bearing's condition and the status of the signals is represented in terms of the signal-to-noise ratio. A high signal-to-noise ratio is desired, which is often achieved by placing a sensor as close to the given bearing as possible. Successful condition monitoring

suggests that there must be changes in the signals being monitored for signals that are static bear no information.

There are undoubtedly many advantages of proper condition monitoring. Chief amongst them are:

I. Preventing unexpected breakdown often with serious operational, health and safety and environmental consequences.

II. Reducing unnecessary maintenance work, often the source of maintenance induced faults, and hence lowering the cost of maintenance.

III. Minimizing spares holding by being able to predict their requirements in good time.

IV. Maximizing productivity by increasing equipment availability because incipient failure can be detected so that there is better work control matching resources (men, spares, equipment) to maintenance work load, both predictive and corrective.

II. Literature Review

1. Yongyong He, Xinming Zhang, & Michael I. Friswell demonstrated that experimental study to identify the

Acoustic emission of bearing defect evaluate the comparision between various AE parameters and the performance condition of rolling element bearings. The Acoustic emission signal is then verified using Acoustic signals to identify the source characteristics and sensitivity of rolling element bearing faults.

2. Mohd Helmi Bin Rasid introduced that experimental test-rig was designed to allow seeded defects on the inner race, corrode and contaminated defect. It is found that instead of the rotational speed and high levels of background noise, simple acoustic emission parameters such as amplitude and acoustic emission counts provided an indications of bearing faults. In addition to identify already established acoustic emission techniques, this research focuses on identifying an correct threshold level for acoustic emission counts.

3. A W Lees & Z Quiney demonstrated that experimental steps are presented, one of which loads a single ball held statically in a test rig to induce subsurface cracks, which are in sequence detected ,a pair of broadband AE sensors and recorded with the help of Lab view based software system. This method not only consider overall analysis of the AE waveforms but also approximate AE source location from the time difference between two sensors. The second experimental step details an formation of a four-ball lubricant tester in an attempt to produce naturally occurring subsurface cracks from rolling contact whilst minimizing the AE arising from surface wear. 3D modeling of rotating machinery coincides with this experiment.

4. Faisal AlShammari, Abdulmajid Addali demonstrated that in order to increase the stability of work, usually condition monitoring is used. Vibrational analysis and acoustic emission techniques are mainly used for this purpose. It has capability to find the primary phase of component deformation.

5. Mr. Avinash V. Patil 1, Dr. Bimlesh Kumar demonstrated that the fault location and integration of structural faults can be found of using this technique. As it is very noisy hence a new machine produce to restrict the allowable noise levels.

6. Pratesh Jayaswal, A. K.Wadhwani and K. B.Mulchandani were presented the further development in field of condition monitoring of machine by signature analysis. This research focused on the development of vibrational analysis. Different types of fault and running condition of machine were monitored by vibrational analysis. For e.g., Gear fault, health of rolling contact bearing, journal bearing fault, flexible coupling fault as well as health diagnosis of condition monitoring of electrical machine.

7] G. Venkata Kishore Rakshit Raju, M. Sree Veena and M.C.S. Reddy were stated in this paper that condition monitoring getting more importance and being the centre of attraction as it gives more advantages than the conventional method of maintenance. It is getting more feasible solution in continuous processing in industries today. By implementing vibrational analysis, it's becoming more feasible to determine the different kind of characteristics and number of defects as well as to find out the details of defect.

8] S. V. Shelke , A. G. Thakur , Y. S. Pathare were stated that the rotary component of machine were linked together in industries to perform manufacturing. Failure of any rotary component may caused loss of rupees per down time hours. As condition monitoring gives pre-information about abnormalities in machining component. So condition monitoring preferred for maintenance of machines.s

III. PROPOSED METHODOLOGY

1. Problem Statements:

We know that the rotating elements are mostly used and useful equipment in most of the industries. Usually Rolling element bearings are mainly used components because of their less cost and high functonalibility. Any damage in the bearings such as (fatigue cracks, pitting,etc.,) must be investigated quickly, otherwise they may cause malfunctions or any damage.

2. 3D MODEL

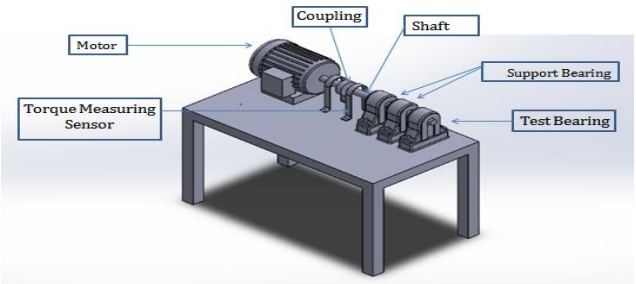

Fig. Proposed experimental setup

3. Dimensions And Descriptions :

- Motor Specifications: Speed Range:- 1. 10rpm to 4000rpm
- Bearing Specification: SKF6002 Rolling Element Bearings:-

  1. Effective Diameter:-D=141mm
  2. Roller Diameter:-d=22.8mm
  3. No. Of Rollers Z=11
- Shaft Specification: Diameter Of Shaft= 140mm, Shaft Length= 150cm
- Coupling Specification: Rubber Coupling
- AE System Specification: 1. Piezo-electric Type AE Transducer, Amplifiers.

4. PROPOSED WORK

Acoustic Emission is used to investigate experimentally characteristic of bearing defects To investigate experimentally.

i. Identification of Bearing Defects:

A rolling element bearing cannot operate forever. It has a definite life, which is determined by the number of rolling contact cycles, and the load applied on the raceways by the rolling elements. Bearing failure may occur from a variety of causes.

ii. Acoustic emission signal processing:

There is a need to interpret the AE signals so that it can be related to the actual condition of machine components. Having gathered a large amount of AE data from previous rolling contact tests with the four ball machine it was possible to compare the frequency content of the detected AE against the natural frequencies obtained through computational analysis.

iii. Expected Outcomes:

The experiment will be held to perform following task:

a) To investigate experimentally Acoustic Emission (AE) characteristics of bearing defects.

b) To validate analytically the difference between many parameters and recent conditions of bearing elements such as size of defect , radial load etc,.

c) AE parameters, such as energy, amplitude range, counting range, kurtosis will useful to investigate signals from bearings.

d) Running condition of bearing are also monitored by identify sensitiveness of these AE parameters

IV. CONCLUSION

Based on past review a systems approach has been adopted in the development of a condition monitoring system for rotating machines. For various operating conditions like changing loads and speed balanced rotating shaft, unbalanced rotating shaft, misalignment of bearing supports; behavior of system will check and estimates the results.

This project work will be helpful in proving capability of Acoustic Emission Analysis to replace the Vibrational Analysis for similar application and working condition.

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