DEFECT ANALYSIS OF BEARING USING CONDITION MONITORING TECHNIQUE: A BRIEF REVIEW

Mr.Vivek P.Kolhe
Research Student, Department of Mechanical Engineering,
North Maharashtra University, J.T.Mahajan college of Engineering, Nhavi Marg Faizpur Maharashtra, India.425524
Email:Amechanicalengg@gmail.com

Dr. Gopal E.Chaudhari
Associate Professor, Department of Mechanical Engineering,
North Maharashtra University, J.T.Mahajan College of Engineering, Nhavi Marg Faizpur Maharashtra, India.425524
Email:gechaudhari@gmail.com

Abstract-

In today's world we tend to reduce the frequency of failure and maintenance in any business as per schedules of every machine and determined by the precise running condition of every major machinery parts utilized in industries like power plants, chemical plants, automotive industries that need precise and economical performance Bearings fail because of manufacturing error, improper assembly, loading, operation or lubrication; even if bearing is perfectly made or assembled, it will eventually fail due to fatigue of the bearing material. Condition monitoring of those machine parts like bearings, shaft and shaft mountings and installation of machine was necessary to avoid failures because in order to improve stability of work. So, condition monitoring is the process of predictive maintenance which monitors the current conditions in order to ensure safety of the machine and predicting the future condition of machines while in operation. There are many techniques of condition observance like vibration analysis, acoustic emission, oil debris observance, temperature observance. Vibration analysis is found to be the foremost wide used technique. Many techniques were obtainable and vibration observance was one among them. This paper tries the review of various sorts of bearings underneath condition monitoring techniques.

Keywords— Condition monitoring, Vibration Analysis, ANSYS

INTRODUCTION

Where there are moving elements on a machine, there are bearings. Without bearings, our industrial world would stand still in several respects. Today, bearing technology has developed to a stage wherever bearings are one in all the foremost advanced mechanical parts with relation to optimized style, prime quality materials and correct producing. Condition monitoring of antifriction bearings in rotating machinery victimization vibration analysis may be an all right established technique. It offers the benefits of reducing down time and up maintenance potency. The importance of Vibration analysis is employed to work out the operative and mechanical condition of kit. A significant advantage is that vibration analysis can establish developing problems before they become too serious and cause unexpected amount.. This could be achieved by conducting regular watching of machine vibrations either on continuous basis or at scheduled intervals. Vibration analysis may sight arrangement and imbalance before these conditions end in bearing or shaft deterioration. Trending vibration levels can establish poor maintenance practices, like improper bearing installation and replacement, inaccurate shaft alignment or general rotor leveling. All the machines whereas operative vibrate additional or less, and with most of them the vibrations are unwanted and the effort is to attenuate them. Each machine consists of rotating elements like bearings, Gears and rotating shafts etc., Failure of those elements might result in price of unplanned down time, loss of life or machinery. This could be reduced by identification of the failure before it prevalence that is termed predictive maintenance.

Condition monitoring is one in all best technique among numerous predictive maintenance techniques. Condition monitoring is that the method of unendingly observation the operating health of machinery. Condition monitoring of rotating instrumentality has been awfully vital side within the field of maintenance engineering. There are numerous kinds of condition monitoring techniques, namely: Vibration Analysis, Lubrication Oil debris Analysis, Current signature analysis, Fourier transform, Wavelet transform, Shock pulse monitoring and

Temperature analysis. Among of these techniques, vibration analyses have gained abundant importance within the field of condition observation due to its accuracy in sleuthing faults. Vibration-based condition observation (VCM) needs vibration activity on every component. Bearing pedestal employing a range of vibration transducers then signals process for all the measured vibration information to spot faults.

From on top of listed techniques of condition monitoring, current research work is specialized in vibration analysis mistreatment frequency domain analysis. There are many vibration analysis techniques accustomed analyze the vibration. The vibration analysis technique categorised the subsequent way:Frequency domain, Time domain, Time Frequency Analysis.

Frequency domain, or spectral analysis, is that the hottest technique for the diagnosing of faults of assorted rotating members. Frequency-domain techniques convert time domain vibration signals into separate frequency elements employing a quick Fourier rework (FFT). Merely declared, FFT mathematically converts time-domain vibration signals trace into a series of separate frequency elements. In a frequency spectrum plot, the coordinate X-axis is frequency and the Y-axis is that the amplitude of displacement, velocity, or acceleration the most advantage of frequency-domain analysis over time-domain analysis is that it's ability to simply observe the bound frequency elements of interest.

II. Literature Review

Bearings are one amongst the foremost necessary parts of each system. This review introduces the background of a brief work already done in the field of bearings.

Attel Manjunath, et al [2018], have investigated the vibration response of latest and defect Carbon fiber bolstered plastic (CFRPTEF) bearing is compared. The quick Fourier rework, Kurtosis and RMS square measure performed on every of the four bearings. From the vibration information, the amplitude of vibration spectrum is relatively tiny for brand spanking new bearing and ball defect bearing cases, whereas vibration spectrum is moderately larger for defects on outer race and inner race at 30N. The RMS worth reveals that because the speed will increase, the vibration response magnitude additionally redoubled.

K.Deak, J.Menyhart, et al [2018], have focused five completely different wavelets, Daubechies, Gaussian, Coiflet, Ratibida columnaris, Meyer are compared in step with the Energy to engineer Entropy magnitude relation criteria to reveal their potency for fault detection.

Rabinarayan Sethi, Subhasini Muduli [2018], have discussed the prognostic technique to forecast the bearing defect. By using vibration analysis there is a change on the mode shapes and natural frequencies of the ball bearing in the decrease of ball radius. The ball radius of a ball bearing can be evaluated by using the values of relative natural frequencies by obtained from analysis. It can be observed that several damages can be found out by using artificial intelligence technique of ANN models which are trained with only relative natural frequencies with a reasonable accuracy. It also observed that when there is a decrease in ball radius, then the relative natural frequency of vibration increases.

Arka Sen, et al, [2017], have discussed Decision Tree Method has been used for identification and to determine the location of the fault in the vibrating system. Artificial Neural Networking and Fuzzy Logic techniques were used to determine the machine health condition.

Ilhan Asilturk,Halit Aslanci,et al,[2017], have studied a number of the foremost ancient options used for machinery medicine and prognostics and conferred a number of the signal process parameters that impact their sensitivity. First the art processing strategies that are usually employed in the gear failure determination and identification space that has frequency domain, time domain, joint time-frequency analysis. UN agency administered these strategies to their applications were investigated. The results from this study have given a lot of understanding on the dependent roles of vibration analysis in predicting and designation machine faults.

Jabid Quiroga Méndez, et al [2017],have studied Experimental results showed a progressive rise in the PSD magnitude of the ultrasonic signal, in the bandwidth studied, with increasing severity level of the emulated fault.

Jing Liu, Zhifeng Shi, [2017], have investigated the extended non-Hertzian contact calculation method for calculating the contact stiffness coefficient between the logarithmic-profile roller and the defective race is more accurately than the classic Hertzian contact calculation method.

Purnima Trivedi, Dr. P K Bharti [2017] have investigated Empirical Mode Decomposition (EMD) is a self-adaptive signal processing method that can be applied to non-linear and non-stationary processes effectively. It improves traditional FFT method in applying harmonic functions to show all kinds of faulty signals into a sequence of amplitude modulation/frequency modulation.

Salim Meziani, et al [2017], have investigated the method of the analysis of variance "ANOVA" employing a comprehensive arrange of experiments incontestable the flexibility to assess the influence of things (speed, centrifugal load associated size of the defect) on the vibration behavior and acoustics bearings an early stage of degradation. The comparative study of various time descriptors, showed the effectiveness of TALAF indicator for the detection and observance of the evolution of the scale of the defects of the bearings with a contribution of ninety seven.87% and 76.35 vibrations close acoustic emission. Also, it absolutely was found that the result of the speed of rotation and also the radial load will increase with increasing the scale of the defects.

Wael Moussa, [2017], have studied a passive thermography approach has been planned for bearing condition observation. completely different bearing conditions have incontestable the potential of the planned technique within the detection of each bearing physical damages and lubrication shortage.

Žarko Mišković, [2017], have investigated the correlation between bearings vibration characteristics, their operating time and concentration level of exploitation contamination particles in their grease for specific working conditions of open pit mine conveyor idlers was bestowed. Developed mathematical model was generated by correct package for applied mathematics analysis and knowledge interpolation with rather high gained values of constant of multiple determination and adjusted coefficient of multiple determination – that confirmed the validity of developed equation.

Dipen S. Shah, V. N. Patel,[2016],have studied excitation forces caused due to bearing race defect have been simulated and the characteristic defect frequencies have been confirmed with their theoretical values.

George Georgouls and George Nikolakopoulos, [20116], have investigated a simple method for the detection and diagnosis of bearing faults, by fusing the information coming from two accelerometers.

V. M. Nistane, S. P. Harsha, [2016], have studied the quality of feature is extracted from vibrations signals for effective prognostics of bearing. These options explore info of foretelling the time of failure before it happens.

Vinayak Kulkarni, M.M.Nadakatti, et al, [2016], have investigated CM of the roller part bearing defects mistreatment vibration signature analysis information underneath numerous hundreds and speed. Also, Necessary hardware like DAQ, My RIO, Lab VIEW, and MATLAB was procured, and also the vital study was done.

Faisal Alshammari, Abdulmajid Addali, [2015], have studied that vibration analysis isn't as thriving at low move speeds (below one hundred rpm). This as a result of the energy generated inside this speed region isn't detectable victimization standard vibration.

Sham Kulkarni, S.B.Wadkar, [2015], have discussed the process of rolling of balls on the bearing races, forces between the interacting the structural components excite vibrations, that successively result in noise, wear and rolling resistance. At constant speed and constant load with totally different defect sizes on outer ring, amplitudes of vibration vary with increase within the defect size. For the outer race roughness, the spectrum had parts at outer race defect frequency and its harmonics. different orders of roughness generate sidebands at multiples of cage frequency concerning these peak. It shows that there was variation in the amplitude of vibration with respect to position of defect on outer race for the bearing.

P.Venkata Vara Prasad, V.Ranjith Kumar, [2015], have investigated vibration response of the rolling bearings to the defects on outer race, inner race and also the rolling parts is obtained and analyzed.

K.Gunasekar, et al, [2014], have investigated time wave and frequency spectrum offer helpful data to permits to predict presence of defects on inner race, outer race analyze defects in antifriction bearings.

Shinde Ashaykumar, [2014], have studied the defect frequencies are 1st computed for numerous masses steps and speeds of the shaft. The prevalence of peak amplitudes of vibration at multiples of variable compliance frequencies, are determined together with the interactive effects of assorted parameters..

Various Methods Used in Literatures for defect analysis

1. Defects analysis with optical and semi-contact method

Dents on the rollers are measured below magnifier typically 50x magnification. Size and sort of the dent is set. Cracks are analyzed each with magnifier and Eddy current testing. For deeper analysis rollers are typically any investigated. Rollers ought to be clean in unhearable tub. they're submerged into acid P3 UPON 5805 4-6% to emphasise the crack initation. 5-10 minutes are necessary to the method however longer times will cause corrosion of the 100Cr6 bearing steel. aqua fortis 1-2% was accustomed initate the finished surface of the roller. Then 6-10% natrium-carbonate was accustomed neutralize the weather. They were washed in clean water, dryed below compressed gas, finally lubricated with Castrol DW30X material. Rollers may be move see the inner cracks of the rollers. It is sometimes analyzed and measured under optical microscope.

2. Empirical Mode Decomposition (EMD)

The empirical mode decomposition is an adaptive signal decomposition method, which is able to decompose non-linear and non-stationary data into a sequence of amplitude modulation/ frequency-modulation (AM/FM) components or alike. These independent components to be obtained are called intrinsic mode functions, which must satisfy the two conditions

3. Passive Thermography Approach

Passive diagnostic procedure may be a non-contact watching approach with an excellent potential to be used for early bearing fault detection. diagnostic procedure is one among the foremost advanced ways for temperature watching. ancient systems that monitor the equilibrium temperature have found several applications together with food and drug temperature watching. However, alternative applications like high speed rotary machines would like a lot of sensitive health assessment systems which will notice faults in early stages. Therefore, rather than watching the equilibrium temperature, the temperature transient behavior for a few applications is employed for review and non-destructive testing. Passive diagnostic procedure has been wide employed in

production, prognostic maintenance, medicine, hearth forest detection, building thermal potency survey, road traffic watching, agriculture and biology, medicine, gas detection and non-destructive testing.

4. Data Acquisition System

Using DAQ System parameters and Lab VIEW, NI MyRio, USB, Ethernet, and much more. Lab VIEW provides the best answer for human action with any of these protocols. During this paper, an experimental setup is explained, and an answer is deduced where Lab VIEW and DAQ systems communicate among themselves.
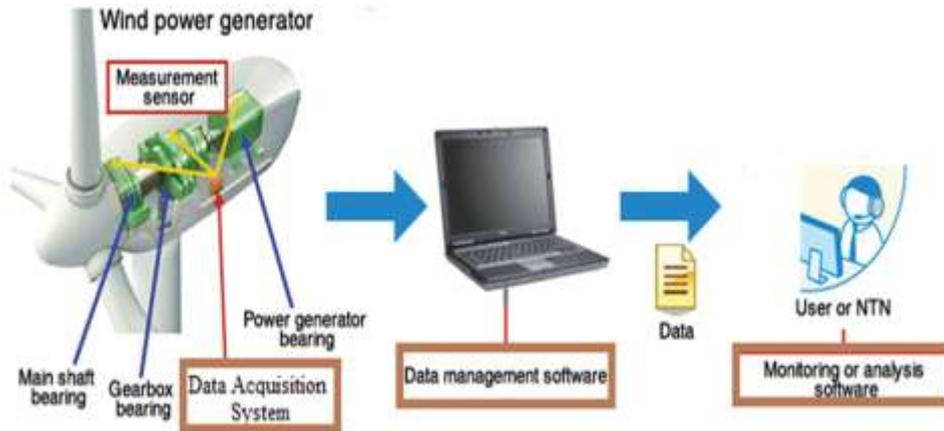

Fig1.Data Acquisition System

5. Acoustic Emission Technique

Acoustic emission has the power to observe the initial section of element degradation. Materials naturally unleash elastic potential energy once they are misshapen, that is understood as acoustic emission (AE) or stress wave emission. Throughout the past thirty years, several researchers have investigated the event of acoustic emission applications for observation the condition of bearings. one in all the earliest documents that self-addressed the employment of AE technology to spot artificially-induced defects in rolling part bearings, and is taken into account to be the primary application for observation bearing. The simulation of the defects enclosed each outer and inner defects, covering the race and ball defects, and also the lack of lubrication. The resonant and loud ranges with AE were compared, and also the blessings of the resonant vary over the loud vibration range were confirmed.

Condition watching is regular monitoring of machineries and predicting failure. The most advantages of this are Predicting failure, planned outage, Cost saving because of reduction in sharp failure and unwanted repairs. It covers the theory and application of all the progressive analysis techniques for condition monitoring by vibration analysis. This paper conjointly covers the analysis of vibration of various rotating machines. The problem of a bearing is additionally monitored and analyzed.

Recommendation

In future the analysis work can involve the theoretical and experimental approach of healthy and defective bearings victimization condition-monitoring technique for rising lifetime of bearings.In addition, also measurement of Stress developed deformations, material properties, and thickness. To get vibration characteristics of healthy and defective bearings under different speed and loads.

Conclusion

This paper associate degree analysis of the bearings utilized in the trade and various techniques used for defect analysis of bearings using vibration analysis techniques. In day nowadays life within the trade there's a use of bearings in large number of variety, due to constant use bearing get defected, therefore the defected bearings has been tested by victimization FFT analyzer. More investigations are required to verify such results and extend them to relevant industrial facilities.

This paper gives an ideas in terms of detection bearing fault that occur in any rotating machinery using various methods. Edges like detection of kind of bearing fault (whether fault on inner race, outer race, ball or combined), Severity of Bearing fault, Check for lubrication of bearing inside few seconds. We will get plan of replacement of bearing or not.

References

1. Attel Manjunath, et al, "Vibration analysis of Polytetrafluroethylene deep Groove Ball Bearing", IOP Conf.Series: Materials Science and Engineering 376(2018).

2. K.Deak, et al, "Defect analysis of bearings with vibration monitoring and optical methods", International Journal of Engineering and Management Sciences (IJEMS) Vol. 3. (2018). No.1

3. Arka Sen et al, "Condition Monitoring of Rotating Equipment Considering the Cause and Effects of Vibration: A Brief Review" International Journal of Modern Engineering Research, Volume 7, Issue 1, Jan.2017, ISSN: 2249–6645.

4. Ilhan Asilturk,et, Halit Aslanci, et al, "Machinery Monitoring Using Vibration Signal Analysis", International Journal of Mechanical and Production Engineering, Volume- 5, Issue-2, Feb.-2017, ISSN: 2320-2092. 2017.

5. Jabid Quiroga Méndez, et al, "Ultrasonic-based monitoring of tapered roller bearings infrequency and time domains" Ingeniare Revista chilena de ingenieria, volume 25, No.2, 2017 pp-235-241.

6. Jing Liu, et al, "An analytical model to predict vibrations of a cylindrical roller bearing with a localized surface defect", on linear Dyn (2017) 89:2085-2102.

7.Purnima Trivedi, Dr. P K Bharti,"Study Of Bearing Rolling Element Defect Using Empirical Mode Decomposition Technique" IJEDR 2017,Volume 5,Issue 2,ISSN:2321-9939.

8. Salim Meziani, Djamal Zarour, et al, "Experimental Study for Early Detection of Bearing Defects by Vibration and Acoustic Emission ", 1st September 2017.

9. Wael Moussa, "A passive thermography approach to bearing condition monitoring", JOJ Material Sci 1(4): JOJMS.MS.ID.555567 (2017), ISSN; 2575-856X.

10. Zarko Miskovic, et AL, "Analysis and Prediction of Vibrations of Ball Bearings Contaminated by Open Pit Coal Mine Debris Particles", Tehnicki vjesnik 24, 6(2017), ISSN: 1941-1950.

11. Dipen S. Shah, V. N. Patel, "Study on Excitation Forces Generated by Defective Races of Rolling Bearing", Science direct, Procedia Technology 23(2016) 209-216.

12. V.M.Nistane, S.P.Harsha, "Failure Evaluation of Ball Bearing for Prognostics", ICIMAE 2016, Science Direct, Procedia Technology 23 (2016).

13. Vinayak Kulkarni, et al, "Lab View based Bearing Failure Prediction Using Data Acquisition System", Indian Journal of Advances in Chemical Science S1 (2016) 142-145, 2016.

14. Faisal Alshammari, Abdulmajid Addali, "Bearing Condition Monitoring with Acoustic Emission Techniques", World Academy of Science, Engineering and Technology International Journal of Mechanical, Aerospace, Industrial, Mechatronic and Manufacturing Engineering Vol: 9, No: 12, 2015

15. Sham Kulkarni, S.B.Wadkar, "Experimental Investigation for Distributed Defects in Ball Bearing using Vibration Signature Analysis", Science Direct, ICOVP 2015, Procedia Engineering 144 (2016) 781-789.

16. P.Venkata Vara Prasad, V.Ranjith Kumar, "Detection of Bearing Fault Using Vibration Analysis and Controlling the Vibrations", International Journal of Engineering Sciences & Research Technology, Oct.2015, ISSN: 2277-9655.

17. K.Gunasekar, et al, "Experimental Investigations on Finding Ball Bearing Defects Using Signature Analysis", Asian Journal of Science and Applied Technology, Volume 3, No.2, 2014, ISSN: 2249-0698.

18.Shinde Akshaykumar,et al, "Theoretical And Experimental Studies On Vibrations Produced By Defects In Double Row Ball Bearing Using Response Surface Method", International Journal of Research in Engineering and Technology, Volume 03,issue 7,July 2014,eISSN:2319-1163.