www.ierjournal.org International Engineering Research Journal (IERJ) Special Issue 3 Page 117-120, 2016, ISSN 2395-1621

ISSN 2395-1621

Review of Condition Monitoring and fault diagnosis technologies for Bearing.

#1Ms.Shelke A. A.,#2Dr.DongreA.D., #3Prof. Galhe D.S.

#1Department of Mechanical Engineering, SCSCOE Rahurifactory 413706
#2Department of Mechanical Engineering, SCSCOE Rahuri factory 413706
#3Department of Mechanical Engineering, JCOE Kuran 410511.

ABSTRACT

In order to develop robust condition monitoring and prognosis technologies and systems for bearing, a comprehensive reviewof the state-of-art of condition monitoring and fault diagnosis techniques has been carried out. The challenges and opportunities are identifiedto guide future research in improving the life and ability of condition monitoring and prognosis systems for bearing. Thisreview also focuses on the fault diagnosis technologies and application of novel sensors in wind turbine gearbox condition monitoring.

Keywords— Condition monitoring;bering; oil analysis; signal processing; operation and maintenance

ARTICLE INFO

Article History

Received: 28th February 2016

Received in revised form :

1st March 2016

Accepted: 3rd March 2016

Published online :

5th March 2016

1.INTRODUCTION

The machine tool industry, sugar factory, petrochemical, power station aims for high precision and repeatability while it is in operation. The safety, reliability, efficiency and performance of rotating machinery are major concerns in industry. Condition monitoring in process control industry has got now a day's very big relevance. The task of condition monitoring and fault diagnosis of rotating machinery is significant but is often cumbersome and labour intensive. Diagnosing the faults before in hand can save the millions of rupees of industry and can save the time. Bearings have played a vital role in engineering.The main purpose of a bearing is to support a rotating shaft or play as intermediate between a rotating part and a stationary part. It has been found that Condition monitoring of bearings has enabled cost saving of over 50% as compared with the old traditional methods. The most common method of monitoring the condition of bearing is by using vibration signal analysis.

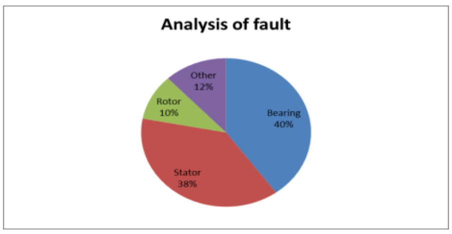

Fig 1.1 Analysis of Fault

Measure the vibrations of machine recorded by velocity sensor or Accelerometer which is mounted on the casing of the machine. The failure of bearing in the process can results in loss of rupees per down time hours. Maintenance of machine can be done either by preventive or breakdown technique. Condition based maintenance is preferred in industries now a day's .IEEE analysis reveals the analysis of fault in below pie chart (fig 1.1). In rotating machines mainly fault occurs due to bearing.Bearing life analysis is based on the initiation or first evidence of fatigue crack. The term "basic rating life," as used in bearing catalogs, usually means the fatigue life exceeded by 90 percent of the bearings or the time before which 10 percent of the bearings fail. This basic rating life is referred to as "LlO life" (sometimes called BlO life or 10-percent life). The 10-percent life is approximately one-seventh of the mean life, or MTBF (mean time between failures), for a normal life-dispersion curve.[1]In process industries i.e. the Machine Tool industry, sugar factory, petrochemical, power station aim for high precision and repeatability while it is in operation. The failure bearing in the process can results in loss of rupees per down time hours. Failure of bearing can disturb the entire process, losses in terms of production, manpower and equipment repair. Therefore maintenance of bearing is necessary. Condition based maintenance is preferred in industries now a days. After detection of bearing fault, faulty bearing is directly replaced with new bearing. It can be concluded that prediction of life of bearing using measure crack depth is not discussed.Fault is detected, diagnosed. Crack depth of bearing is measured for prediction of remaining useful life of the bearing. Once the remaining useful life of bearing is known, then decision is made about replacement, repair and maintenance. Elimination of unexpected downtime, reduction of repair cost, increased service interval and extension of bearing life, all lead to reduced product cost.[2]

II. FAILURE MODES OF BEARING

Bearings generally operate under extremely harsh environment conditions including dustiness, humidity, temperature, air pressure and unpredictable high loads. Localized fatigue damage of the bearing raceways and rolling elements will be easiest failure mode to detect because the characteristic bearing defect frequencies are well understood. Wear and geometric form errors of the raceways can also give rise to periodic vibrations. For the majority of other failure modes such as lubrication, starvation, corrosion, excessive looseness or faulty installation, definitive vibration characteristics are not well understood and the use of comprehensive trending and/or the application of advanced signal processing will be required. The Bearing faults degrade machine performance, decrease life time service and cause unexpected failure which are dangerous for safety issues. Non-intrusive measurement e.g. surface vibrations are appropriate monitoring methods for early stage journal bearing faults in low, medium and high frequency. The common faultsobserved in bearings aredamage, Broken, cage fault, race fault, leaking oil and high oil temperature, where bearing failures due to micro-pitting, scuffing andwhite structure flaking are found.A prematurely failed rear bearing cone from a mountain bicycle, caused by a combination of pitting due to wet conditions, improper lubrication, and fatigue from frequent shock loading. Rolling-element bearings often work well in non-ideal conditions, but sometimes minor problems cause bearings to fail quickly and mysteriously. For example, with a stationary (non-rotating) load, small vibrations can gradually press out the lubricant between the races and rollers or balls. Without lubricant the bearing fails, even though it is not rotating and thus is apparently not being used. For these sorts of reasons, much of bearing design is about failure analysis. Vibration based analysis can be used for fault identification of bearings.There are three usual limits to the lifetime or load capacity of a bearing: abrasion, fatigue and pressure-induced welding. Abrasion occurs when the surface is eroded by hard contaminants scraping at the bearing materials. Fatigue results when a material becomes brittle after being repeatedly loaded and released. Where the ball or roller touches the race there is always some deformation, and hence a risk of fatigue. Smaller balls or rollers deform more sharply, and so tend to fatigue faster. Pressure-induced welding can occur when two metal pieces are pressed together at very high pressure and they become one. Although balls, rollers and races may look smooth, they are microscopically rough. Thus, there are high-pressure spots which push away the bearing lubricant. Sometimes, the resulting metal-to-metal contact welds a microscopic part of the ball or roller to the race. As the bearing continues to rotate, the weld is then torn apart, but it may leave race welded to bearing or bearing welded to race. Although there are many other apparent causes of bearing failure, most can be reduced to these three. For example, a bearing which is run dry of lubricant fails not because it is "without lubricant", but because lack of lubrication leads to fatigue and welding, and the resulting wear debris can cause abrasion. Similar events occur in false brinelling damage. In high speed applications, the oil flow also reduces the bearing metal temperature by convection. The oil becomes the heat sink for the friction losses generated by the bearing.

There are several techniques that can be employed to predict the condition of bearing, these include: vibration monitoring, Current Signature Analysis, Tribology, Thermography, etc. Several studies showed that the most important technique in predictive maintenance is vibration analysis as it gives clear indications regarding the condition of the machine in question, in addition the level of vibrations and the frequency at which these vibrations occur can serve in determining the exact location of the defect and possibly severity of such defect. Following table shows the Comparison of various methods of fault detection[4].

Table2.1Comparison of Various Methods of Fault Detection

Sr. No.	Method of analysis	Temp.	Press.	Flow	Oil Analysis	Spm meter	Vibration FFT
1	Ball brg. Damage	x			x	x	x
2	Journal brg. Damage	x	x	x	x		x
3	Gear damage				x		x
4	Mechanical looseness						x
5	Mechanical rubbing					x	x
6	Noise						x
7	Cracking						x

III. RECENT METHODS OF CONDITIONMONITORING AND FAULT DIAGNOSIS OF BEARING

Condition monitoring is the process which predicts the present and future conditions of the machinery when in operation. It gathers the information about internal effects of the operating machine. Main methods of condition monitoring are

1. Vibration Analysis

Vibrations are always produced by machines even though they are in good conditions, this is due to periodic events in the machine's operation, such as rotating shafts, meshing gear teeth, rotating electric fields, bearing and so on. Condition monitoring using vibration measurement can be classified into time domain technique, frequency domain technique and time-frequency technique.

(a). Time Domain Technique

Some of the time domain techniques can be used or applied for condition monitoring, such as root mean square (RMS), mean, peak value, Mean Square, crest factor

ii. Mean:

The mean acceleration signal is the standard statistical mean value. Unlike RMS, the mean is reported only for rectified signals since for raw time signals, the mean remains close to zero. As the mean increases, the condition of the bearing appears to deteriorate

$$\text{Mean}=\frac{1}{N}\sum_{i=1}^{N} f_n$$

iii. Peak value:

Peak value is measured in the time domain or frequency domain. Peak value is the maximum acceleration in the signal amplitude.

$$P_v=\frac{1}{2}[\max(f_n)-\min(f_n)]$$

iv. Crest factor:

Crest factor is the ratio of peak acceleration over RMS. This metric detects acceleration bursts even if signal RMS has not changed.

$$\text{Crest factor}=\frac{P_v}{RMS}$$

(b). Frequency Domain Technique

The frequency domain refers to the display or analysis of the vibration data based on the frequency. The time domain vibration signal is typically processed into the frequency domain by the application of Fourier, transform, usually in the form of fast Fourier transform [FFT] algorithm. The principal advantage of the method is that the repetitive nature of the vibration signals is clearly displaced as peaks in the frequency spectrum at the frequency where the repetition takes place.

2.Oil Analysis

This can be divided in to three categories:

(a) Chip Detectors

Filters and magnetic plugs are designed to retain chips and other debris in circulating lubricant systems and these are analyzed for quantity, type, shape, size, and so on. Alternatively, suspended particles can be detected in flow past a window.

(b) Spectrographic Oil Analysis Procedures (SOAP)

In this procedure, the lubricant is sampled at regular intervals and subjected to spectrographic chemical analysis. Detection of trace elements can tell of wear of special materials such as alloying elements in special steels, white metal or bronze bearings, and so on. Another case applies to oil from engine crankcases, where the presence of water leaks can be indicated by a growth in NaCl or other chemicals coming from the cooling water.

(c) Ferrography

This represents the microscopic investigation and analysis of debris retained magnetically but which can contain non-magnetic particles caught up with the magnetic ones. Quantity, shape and size of the wear particles are all important factors in pointing to the type and location of failure. Proper use of oil analysis requires that oil sampling, changing and procedures are all well-defined and documented . It is much more difficult to apply lubricant analysis to grease lubricated machines, but grease sampling kits are now available to make the process more reliable.

3. Performance Analysis

With certain types of machines, performance analysis (e.g. stage efficiency) is an effective way of determining whether a machine is functioning correctly. One example is given by reciprocating compressors, where changes in suction pressure can point to filter blockage, valve leakage could cause reductions in volumetric efficiency, and so on.

4. Thermography

Sensitive instruments are now available for remotely measuring even small temperature changes, in particular in comparison with a standard condition. At this time, thermograph is used principally in quasi-static situations. Bearing distributed defects generate excessive heat in the rotating components. Monitoring the temperature of a bearing housing or lubricant is the simplest method for fault detection in rotary machines.[3]

IV. CONCLUSIONS

Vibration analysis is the most prevalent method for machine condition monitoring because it has a number of advantages compared with the other methods.

1.It reacts immediately to change and can therefore be used for permanent as well as intermittent monitoring. With oil analysis for example, several days often elapse between the collection of samples and their analysis, although some online systems do exist. Also in comparison with oil analysis, vibration analysis is more likely to point to the actual faulty component, as many bearings, for example, will contain metals with the same chemical composition, whereas only the faulty one will exhibit increased vibration.

2. Most importantly, many powerful signal processing techniques can be applied to vibration signals to extract even very weak fault indications from noise and other masking signals.

REFERENCES

[1]Stephan E,"Expert system development for vibration analysis in machine condition monitoring",science direct ,34(2008)291-299.

[2]Mohamed et al,"Monitoring of fatigue crack stages in a high carbon steel rotating shaft using vibration", science direct,10(2011)130-135.

[3] HARLIŞCA Ciprian, SZABÓ Loránd," Bearing Faults Condition Monitoring – A Literature Survey",Journal of computer science & control system,vol 5 no 2,oct 2012.

[4] A R Bhende, G K Awari and S P Untawale, "Assessment of Bearing Fault Detection Using Vibration Signal Analysis", VSRD-TNTJ, Vol. 2 (5), (2011), pp:249-261

[5] SudhanshuGoel,RipulGhosh, Satish Kumar, AparnaAkula,a,"A Methodical Review of Condition Monitoring TechniquesFor Electrical Equipment".

[5]Condition monitoring manual; Michael Neale, HMSO; UK.

[6]Colin Sanders.: "Vibration analysis and associated techniques in CM", CSA, 2011.

