

TROUBLE SHOOTING OF ROTARY EQUIPMENTS USING VIBRATION ANALYSIS

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Abstract- The success of a company mainly depends on the continued and smooth operation of rotating machinery. When a machine fails or breaks down, the consequences can range from financial problems, personal injury and possible loss of life. With the help of vibration analysis the failure of machines can be predicted much earlier before they fails. Nowadays by vibration analysis we can not only detect when a machine is developing a problem, but also to identify the specific nature of the problem for scheduled correction. Today vibration analysis gets much advantage in factories as a predictive maintenance technique. Predictive maintenance is the method of forecasting the errors in the rotating machinery by inspecting the condition of the machine. Vibration analysis technique is the most important technique applied in real life.

1. INTRODUCTION

In early days maintenance was done when a machine fails or stops working. But today it has been proved from experience that proper and timely maintenance work helps to avoid failure of machines, reduce risk and gives better profit to the company. To know the running condition of a machine condition monitoring activities are to be done, condition monitoring helps to predict the problems in machines before they cause severe damages in it.

Vibration monitoring and analysis is one such tool that can be used for determining the condition of a rotating machine and its analysis gives a clear picture of the any fault that there may be. Machine problems are the main sources of high maintenance cost and unwanted downtime in the industries. The main aim of maintenance department is to keep machinery and plant equipments in good operating condition which helps to prevents failure and production losses in the industries. The condition-based maintenance technique is being employed for continued production process in industries. Condition-based maintenance (CBM) consists of continuously monitoring the condition of the machines and find the faults in machines before they stop functioning or breakdown occurs. There are different condition monitoring and diagnostics methods used to identify the machine faults to take corrective steps. Machine fault identification can be done with different methods as vibration signature analysis, lubricant signature analysis, noise signature analysis, and temperature monitoring, with the use of appropriate sensors, different signal conditioning, and analyzing instruments. Vibration signature analysis

techniques is the most widely and most popular among these.

2. VIBRATION

Any motion that repeat itself after a constant time interval is said as a vibration or oscillation. Vibration is the mechanical oscillations about an equilibrium position. The oscillations may be periodic such as the motion of a pendulum or random Vibration occurs when a system is displaced from a position of stable equilibrium. The system tends to return to this equilibrium position under the action of restoring forces. The system keeps moving back and forth across its position of equilibrium. Vibration can be defined as simply the cyclic or oscillating motion of a machine or machine component from its position of rest. It is generated in the driveline and can be experienced, sensed and seen by any person. The source of vibration can be any part or assembly of the machine.

2.1 CAUSES OF VIBRATION IN ROTATING MACHINE ELEMENT

1. Unbalance
2. Bent shaft
3. Misalignment
4. Looseness
5. Eccentricity problems
6. Resonance
7. Sleeve or plain bearing problems
8. Defective rolling element bearings
9. Aerodynamics/Hydraulic problems
10. Electric (induction) motor problem
11. Gear problem
12. Belt drive problem
13. Oil whirl

2.2 THE EFFECTS OF VIBRATION

- 1 Unwanted noise,
2. Early failure due to cyclical stress (fatigue failure)
3. Deviation from the tolerances in machined components and poor surface finish.
4. Increased wear leading to Poor quality product .
5. Increase in rejection rate leading to additional costs.
6. Increase in field complaints leading to customer dissatisfaction.

3. VIBRATION ANALYSIS

Vibration analysis mainly consist of:

- Detection
- Analysis
- Correction

3.1 Characteristics of Vibration

The condition of machine and its problems are determined by measuring its vibration characteristics.

The more important of these characteristics are:

- Frequency
- Displacement
- Velocity
- Acceleration
- Phase
- Spike energy

3.2 Vibration Monitoring Program

There are several steps to achieve a successful vibration monitoring program. The following are the general steps:

Collect Useful Information: Look, listen and feel the machinery to check for resonance, identify what measurements are needed.

Analyse Spectrum Data: Evaluate the overall values and specific frequencies corresponds to machinery. Compare overall values in different directions and correct horizontal data.

Multi-Parameter Monitoring: Use additional technique to conclude the fault type.

Perform Root Cause Analysis: in order to identify the real causes of the problem and to prevent it from occurring again

Reporting and Planning actions: Use a Computer Maintenance Management System (CMMS) to rectify problems.

4. INSTRUMENT USED FOR VIBRATION ANALYSIS AND DETECTION

FFT:-

The term “FFT” stands for “Fast Fourier Transform” Fourier established that any periodic function (which include machinery vibration signals) can be represented mathematically as series of sine’s and cosines. In other words, it is possible to take a vibration time waveform, along with their amplitudes ,the process is called “Fourier Transform”. Although a Fourier transform can be done

manually, the process is extremely time consuming, however, with the introduction of digital technology, the process can be carried out very fast. Hence the term : Fast Fourier Transform or FFT. Digital vibration analyzers and data collectors actually include a computer chip programmed to perform the FFT function.



Fig -1: Analyzer

4.1 Vibration Measurement

Vibration is measured in three directions:

- **Horizontal** shows most vibration, as the machine more flexible in the horizontal plane.(imbalance-Radial vibration)
- **Vertical** shows low vibration when compared to the horizontal directly as the stiffness is caused mounting and gravity
- **Axial** Under ideal conditions there should be very little vibration as most forces are generated perpendicular to the shaft.

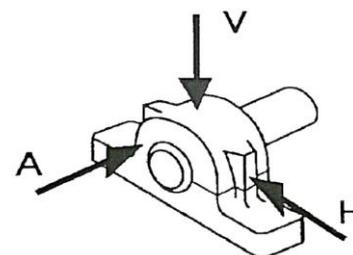


Fig -2: directions of taking the vibration reading

RANGE OF VIBRATION SEVERITY RMS VELOCITY (MM/SEC)	VELOCITY RANGE LIMITS AND MACHINERY CLASSES (AFTER ISO STANDARD 2372)		
	CLASS 1 UP TO 15KW	CLASS 2 15 TO 75KW	CLASS 3 >75KW
.28	A	A	A
.45			
.71			
1.12	B	B	B
1.8			
2.8	C	C	B
4.5			
7.1			
11.2	D	D	C
18			
28			
45			
71			

Fig -3: Definition of Machine Classes

Table -1: Relationship between fault and vibration signature

Cause	Amplitude	Frequency
1.Unbalance	Proportional to unbalance largest in radial direction	1 xRPM
2. Misalignment Couplings or Bearings & bent shaft	Large in axial direction, 50% more of radial direction	1 Xrpm Usual 2&3 xRPM sometimes
3.Bad bearings	Unsteady use Velocity Acceleration & Spike energy measurement	Very high, several times RPM
4.Eccentric Journals	Usually not large	1 xRPM
5.Bad gears or Gear noise	Low-use velocity, Acceleration & Spike energy measurements	Very high gear teeth times RPM
6. Mechanical Looseness	Sometimes erratic	2 xRPM
7.Bad drive belt	Erratic or pulsing	1,2,3 & 4 x RPM of belts

6.APPLICATIONS

- Predictive maintenance
- Acceptance testing
- Quality control
- Noise control
- Leak detection

7. CONCLUSIONS

Vibration signals are the most important parameters in machine condition monitoring techniques. Periodic and continuous vibration monitoring helps to know whether troubles are present or not. Vibration signature analysis give information about which part of the machine is defective

and why. Although a number of vibration analysis techniques have been developed for this purpose, still a lot of scope is there to reach a stage of expertise.

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