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# Vibration Analysis Techniques for Rotating Machinery and its effect on Bearing Faults

Khadersab A[a], Dr.Shivakumar S[b]

[a]*Research scholar, Dept. of Mechanical Engineering, Gogte Institute of Technology, Belagavi 590008 India*
[b] *Professor and Head, Dept. of I &PE, Gogte Institute of Technology, Belagavi 590008 India*

**Abstract**

Area of application of rotating machinery in day to day life, and for industrial use in manufacturing and processes, nuclear power station, automobile, oil & gas refinery etc has increase tremendously with industries revolution. And for all these rotating machinery the faults induced, due to bearing faults play a major role in failure of machine subjected to fatigue and catastrophic failure is a big problem to solve. Under the various maintenance techniques, the condition monitoring vibration technique is widely used to accurate assessment of the health condition of the rotating machinery extensively. Vibration spectrum analysis for all these faults and particular to different vibration analysis technique can be studied. In this paper the bearing faults induced in rotating machinery is investigated experimentally using various vibration analysis techniques that are time, frequency and time-frequency domains. The input signal obtained from the rotating machinery with rolling element bearings that is ball bearing with inner and outer race defects in comparison with health bearings are analysed with respect to Fast Fourier FFT and Inverse fast Fourier transformation IFFT,and future the spectrogram are obtained. And this experimental investigation will lead to the accurate assessment of the failure of rotating machinery, with respect to bearing faults.


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*Keywords:* FFT, IFFT, Rotating Machinery, Spectrogram, Bearing faults

## 1. Introduction

In rotating machine, the rolling element bearings are very common to subject to unbalance force generated in machine. This leads to different types of faults in the rolling element bearings and simultaneously led to failure of the rotating machinery. And the bearing faults cause different level of problems leading to improper functioning of the rotating machinery, as used from small to large industrial application.

Corresponding Author: Khadersab A Email:abdulkhader851@gmail.com

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All these faults in the rotating machinery can be monitored and presented in the form of the simple harmonic motion that is in terms of variation in the amplitude of the vibration signal [1-5]. Maintenance of this rotating machinery requires the overall monitoring of these machines over time period. In all of the maintenance technique, vibration condition technique play prominent role for monitoring the rotating machinery and increase the life span of the rotating machinery. These faults in the rotating machinery are induced due to the various parameters involved that may be related to cyclic loading of the machine, undeniable tolerance limits provide while fitting the rolling bearing elements in the rotating machinery between the shafts that is the error induced by maintenance workers in the industry. And inadequate lubrication is provided to the machine over the time period, or not according to the standardization of lubrications. The other one, most important parameters which leads to the failure of the rotating machinery, the improper manufacturing of the component of the rolling element bearing with respect to the size of material, manufacturing method process etc. All these mentioned parameters lead to the failure of rolling element bearing. Based on the various factors leads to defect in bearing, can be group into two categories. Those are distributed and localized defects. All these defects are categorized by the frequency characteristics in terms of vibration spectrum. And the spectrum obtained has variation in the amplitude with respect to the energy levels. And these frequencies characteristics of the bearing faults that is inner race, outer race can be analyzed with respect to different methods like analytical, numerical simulations and experimental method [6-12]. In analytical method of calculating the frequency characteristics, it depend on the various parameters of the rolling element bearings are considered like pitch and ball diameter, the angle of contact, speed of the rotating machinery and last number of balls in the rolling elements bearings[13-16]. The frequency characteristics obtained by the analytical method represent the fundamental frequencies for the different stages that is for inner and outer race called as inner race and outer race frequencies. All these frequencies represent also the various harmonics range of the frequencies at different speed and also for the different conditions. But the comparison is done with other vibration analysis technique which analysis the vibration signals with respect to time, frequency and also time-frequency domains [18-21]. The variations of the frequencies and harmonics values considerable depending on the faults in the rotating machinery. In this work the various vibration analysis techniques that is time, frequency and time-frequency domains the signals are analyzes for the rolling elements ball bearings faults. The healthy, inner and outer race defects vibration spectrum are taken are subjected to fast fourier transformation and inverse fast fourier transformation and also the spectrogram for the time domain signals.

## 2. Experimental test rig

The USB piezoelectric accelerometer sensitivity of 330 mV/g, is used to take the vibration parameters is the data of time and frequency spectrum along the direction of x and y-axis respectively. The accelerometer and DAQ is connected with usb port, in turn interface with a powerful FFT algorithms that is EI-Calc. The real time vibration signal obtained that is FFT using the usb accelerometer, this software has a range of one million range of point in FFT spectral calculation. These wide ranges of point's spectrum enable to ascertain the FFT spectral calculation for the various ranges of the data form to the minimum to maximum frequency ranges. These large frequency ranges set the sampling rates up to 44100 Hz, these software algorithms perform an independent calculation for each process with incremental time length over the cycle, accelerometer placed on the bearing housing top, and the rotating shaft speed is measured using the tachometer. The rolling element bearings used in the rotating machinery in experiment test is shown in figure 1.The length and diameter of the shaft present in the test rig is 400mm and 19mm.The coupling between the motor that is electric motor (220V DC 50HZ/0.1KW) .The motor shaft and the rotating shaft are connected with flexible coupling, to decrease the cause of the high amplitude vibration generated by the motor. The speed range of the motor is 0-3000 rpm, by using the dc power supply varying the voltage the speed of the motor is varied up to 900 rpm.