VIBRATION ANALYSIS OF BEARINGS USING FFT ANALYZER

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ABSTRACT

Industrial vibration analysis is a measurement tool used to identify, predict, and prevent failures in rotating machinery. Implementing vibration analysis on the machines will improve the reliability of the machines and lead to better machine efficiency and reduced down time eliminating mechanical or electrical failures. Vibration analysis programs are used throughout industry worldwide to identify faults in machinery, plan machinery repairs, and keeps machinery functioning for as long as possible without failure. The measurement and analysis of vibration involves accelerometers to measure the vibration, and a data collector or dynamic signal analyzer to collect the data. The plots of amplitude vs. time, (Time Waveform) and amplitude vs. frequency (FFT) are required for the trained technician or engineer to analyze and determine the machine fault. Since each rotating element generates an identifying frequency, analyzing the frequency disturbances will identify the faulty element. Once the fault is identified, parts can be ordered and repairs can be scheduled.

Keywords - *FFT, Rotating machinery, Time Waveform*

I. INTRODUCTION

Mechanical industries have gone through the significant changes in last decade. Competition, cost, and equipment complexity have increased while budgets, operating margins, and maintenance staffs have decreased. So, maintenance department must be able to show a positive effect on the "bottom line". Customers focus on product quality, product delivery time and cost of product. Because of these, a company has to develop or introduce quality and maintenance system. For medium scale industry annual maintenance cost is 2 to 3 crore. If equipments are not maintained properly then breakdown occurs which results in different losses as production loss, loss due to accidents, parts replacement loss etc. Cost of these losses is more than 3 crore. So inline monitoring and offline tests of equipments are necessary to maintain equipment properly. A variety of technologies can and should be used as part of a comprehensive condition based maintenance programme. Since mechanical systems or machines account for the majority of plant equipment, vibration monitoring is generally the key component of most condition based maintenance programmes. Comprehensive condition based maintenance programmed must include other monitoring and diagnostic techniques. These techniques include: Vibration analysis, Corrosion analysis, Lubricant analysis, Process parameter monitoring, visual inspections.

II. PROBLEM STATEMENT

We carried out our project at Jijamata Paper Mill, Islampur MIDC. They are having the boiler capacity of 15 tons through which steam is generated which is required for different process like drying of paper which is the most important

step in the production of paper this drying is done at different stages so boiler is the heart of the paper mill. Different boiler accessories are feed water pump, ID fan etc. These accessories are having bearings as their major component. These bearings are needed to be replaced frequently. These bearing can fail due to vibration suddenly that's why there is necessity of vibration analysis so that further damage can be prevented. We did this vibration analysis using FFT analyzer because it is more accurate and fast method of vibration analysis than any other solutions available in the market. Also it gives the amplitude vs. frequency graph which we can't get from any other machine or software.

III. INTRODUCTION TO FFT ANALYZER

An FFT spectrum analyzer works in an entirely different way. The input signal is digitized at a high sampling rate, similar to a digitizing oscilloscope. Nyquist's theorem says that as long as the sampling rate is greater than twice the highest frequency component of the signal, then the sampled data will accurately represent the input signal. In the SR760, sampling occurs at 256 kHz. To make sure that Nyquist's theorem is satisfied, the input signal passes through an analog filter which attenuates all frequency components above128 kHz by 90 dB. This is the anti-aliasing filter. The resulting digital time record is then mathematically transformed into a frequency spectrum using an algorithm known as the Fast Fourier Transform or FFT. The FFT is simply a clever set of operations which implements Fourier's basic theorem. The resulting spectrum shows the frequency components of the input signal. Now here's the interesting part. The original digital time record comes from discrete samples taken at the sampling rate. The corresponding FFT yields a spectrum with discrete frequency samples. In fact, the spectrum has half as many frequency points as there are time points. (Remember Nyquist's theorem). Suppose that you take 1024 samples at 256 kHz. It takes 4 ms to take this time record.

IV. PROCEDURE FOR INDUSTRIAL VIBRATION ANALYSIS BY FFT.

- Firstly decide the areas where to take readings.
- Clean that area with the help of clean cloth.
- One end of accelerometer connects to the FFT port.
- FFT analyzer then connected to Laptop having 'RT Photon pro' software installed in it.
- After these settings, give power supply to whole system.
- Another end of accelerometer mounts on the bearing housing in radial direction.
- This set up gives the analysis in the form of time and frequency domain curves.
- Wait for 1 minute to achieve accurate graphs.
- Then do the same procedure for induced draft fan and forced draft fans.
- For the above components take two readings each in radial and axial directions.
- After achieving all readings compare these readings with ISO 10816 and also with Severity and acquisition charts.
- With the help of all standard results diagnose that what causes take place into each equipment and conclude their remedies for each equipments.

Fig. 1- FFT Analyazer.

V. Vibration causes identification.

Sr. No.	Fault	Frequency	Direction of Vibration	Remark
1	Rotating Unbalance	Same as Running Speed	Radial	Vibration amplitude is proportional to unbalance.
2	Misaligned Couplings, bearings & bent shafts	Usually same or double the running speed	Radial & Axial	Fairly large Axial Vibrations
3	Oil film whirl	Approx. Half the running speed	Radial	Occurring in high-speed turbo machines
4	Rolling bearing defect	Mostly at ball or roller speeds	Radial & Axial	-
5	Damaged or worn gears	Tooth-meshing Frequency	Radial & Axial	Side bands near tooth-meshing frequencies
6	Unbalanced reciprocating forces and couples	Usually double the running speed	Usually Radial	
7	Aerodynamic and Hydraulic forces	Flow pulsation frequency	Radial & Axial	

VI. BOILER EQUIPMENTS

I) Feed pump

A boiler feed pump ensures continuous supply of feed water to the boiler, preventing overheating and damage to the boiler. The boiler feed pump is an essential part of the boiler feed system. The article explains the construction and working of a boiler feed pump. A feed pump supplies feed water to the boiler as and when required. An essential part of the Boiler feed water system, a boiler feed pump is selected according to the quantity and the amount of pressure required by the boiler. The feed pump raises the pressure of the feed water to a level high enough for the water to enter the boiler. The type of the boiler also plays an important role in selecting a feed water pump. For example, in case of auxiliary boilers, where the amount of feed water required is less, a steam driven reciprocating positive displacement pump is generally used. It's necessary to be concerned about vibration because it has a major affect on the performance of your pump. At least six components are seriously affected by vibration: The life of the mechanical seal is directly related to shaft movement. Vibration is also a major cause of set screws becoming loose and slipping on the shaft, causing the lapped seal faces to open. Packing is sensitive to radial movement of the shaft. Excessive leakage, but excessive sleeve or shaft wears also. Additional flushing will be required to compensate for the heat that'll be generated by the high friction packing. Bearings are designed to handle both a radial and axial load. They were not designed for the vibration that can cause a brinneling (denting) of the bearing races. Critical dimensions and tolerances such as wear ring clearance and impeller setting will be affected by vibration. Bearing internal clearances are measured in tenths of thousands of an inch. (Thousands of a millimeter) Pump components can be damaged by vibration. Wear rings, bushings and impellers are three examples. Bearing seals are very sensitive to shaft radial movement. Shaft damage will increase and the seals will fail prematurely. Labyrinth seals operate with a very close tolerance. Excessive movement can damage these tolerances also. Pump and motor hold down bolts can become loose. Three basic causes of pump vibration

1. MECHANICALLY INDUCED

-bad bearing

-Bent shaft

-Unbalanced rotor

-Misalignment

-Looseness

-Maximum size impeller

2. SYSTEM INDUCED

- Partially/pluged strainer

- clogged impeller or suction line

- Installation

3. OPERATION INDUCED

- cavitation

-flow

- Speed

Fig. 2. Feed Pump

Sr. No.	Particulars	Pump
1	Make Type	CRI
2	Motor Kw/HP	3HP
3	RPM	1440

II) INDUCED DRAFT FAN (ID FAN)

Another method of producing mechanical draft is the induced draft system. This consists of a fan installed in the flue gas duct between the boiler and the stack. This fan pulls the gases through the boiler and pushes them up the stack. A pressure slightly lower than atmospheric is created in the boiler. It is important that the boiler casing and openings are sealed to prevent air leaking into the boiler, which would rapidly lower the capacity and efficiency of the fans. The boiler casings must be made strong enough to withstand the external pressure of the atmosphere.

The induced draft fan which is required to provide the same volume of air is larger than a forced draft fan, due to the following:

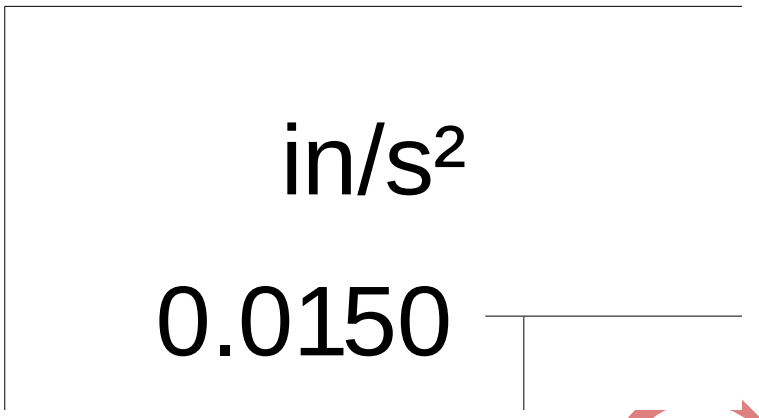
• The I.D. fan must move a larger mass because the flue gases consist of the mass of fuel as well as the mass of air (one kg of fuel that uses 15 kg of air, for complete combustion, produces 16 kg of gases)

• The I.D. fan must be able to handle any air leakage into the boiler setting

• The I.D. fan must deal with a greater volume of gases since the temperature of the flue gas is higher than the air moved by an F.D. fan.

VII. RESULTS

1. FEED PUMP AXIAL



Spectral Lines: 400 Time Capture Points: 1024 Frequency Span: 16000 Time Domain
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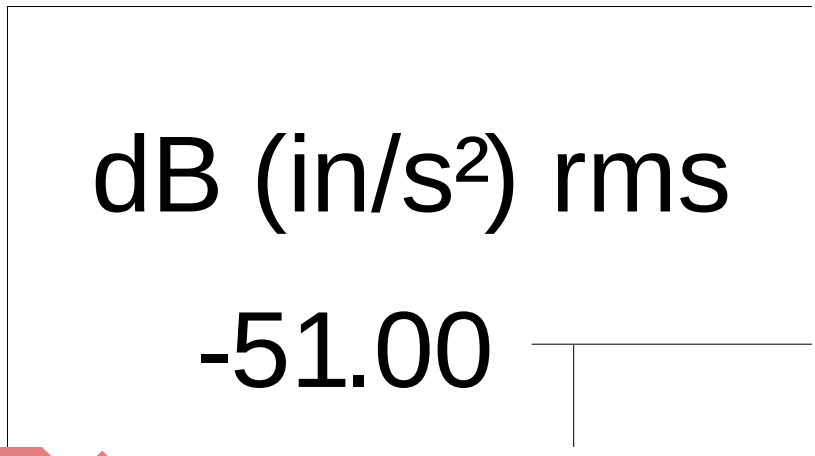
GRAPH EXPLANATION

From the above graph accelerometer fitted axially to the feed pump bearing casing there are fluctuations in the graph which occurred at regular intervals then shaft is imbalance so there is no need of replacing the bearings only there is need of repairing the shaft.



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GRAPH EXPLANATION

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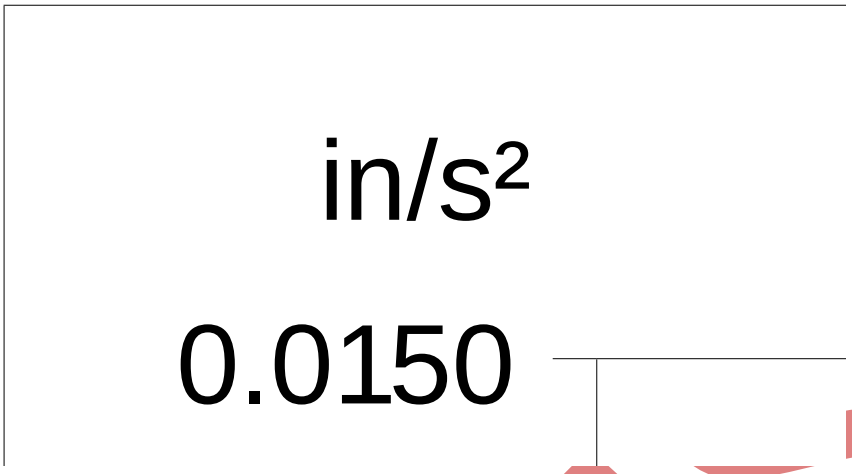
2. FEED PUMP (RADIAL)



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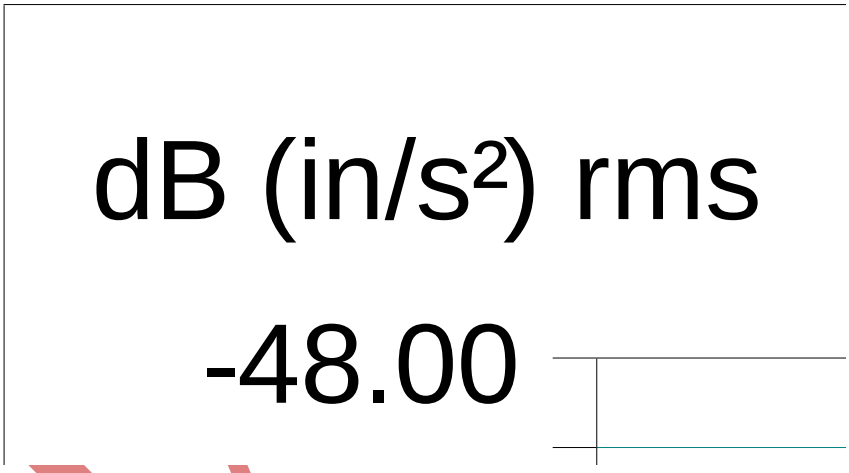

Spectral Lines: 400 Time Capture Points: 1024 Frequency Span:16000 Frequency Domain
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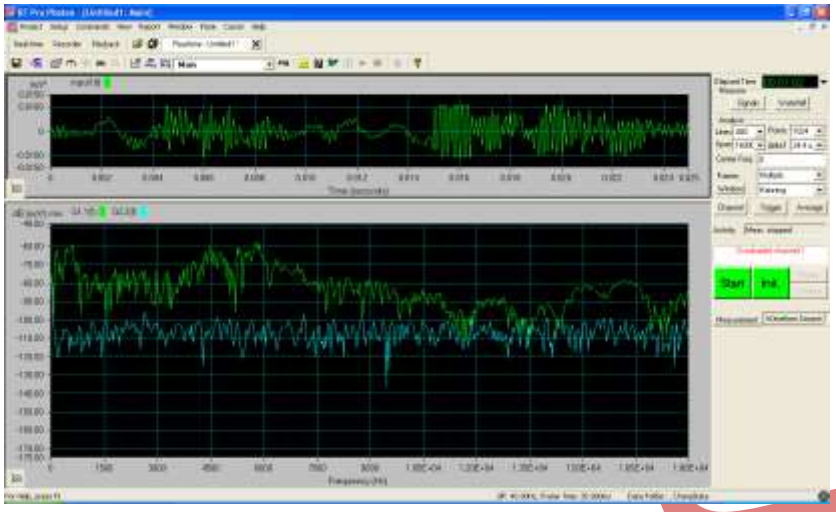
GRAPH EXPLANATION

From the above graph accelerometer fitted radial to the feed pump bearing casing there are fluctuations in the graph which occurred at regular intervals then shaft is imbalance so there is no need of replacing the bearings only there is need of repairing the shaft.



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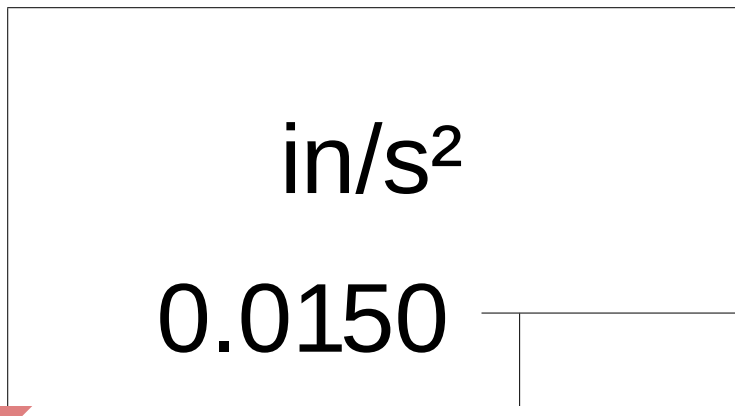
Real Time Screenshot Of FFT Analyzer (Feed Pump)

ID FAN (AXIAL)



Spectral Lines: 400 Time Capture Points: 1024 Frequency Span: 16000 Graph 8.5 Time Domain
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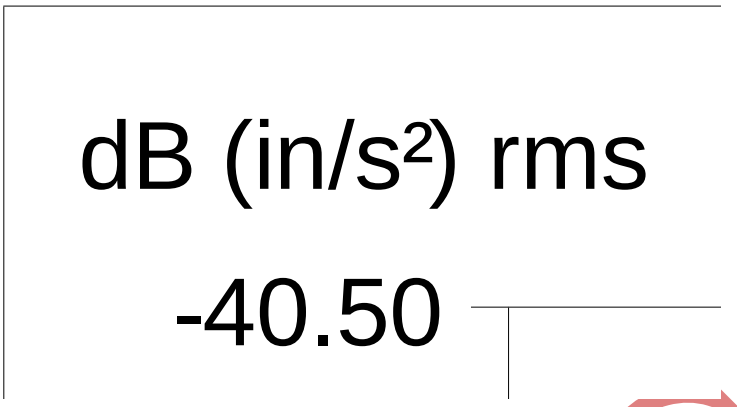
GRAPH EXPLANATION

From above graph accelerometer fitted axially ID fan bearing casing there are no fluctuations in the graph. So we come to conclusion that there are no unwanted vibrations in the ID fan bearing means bearing is in good condition.



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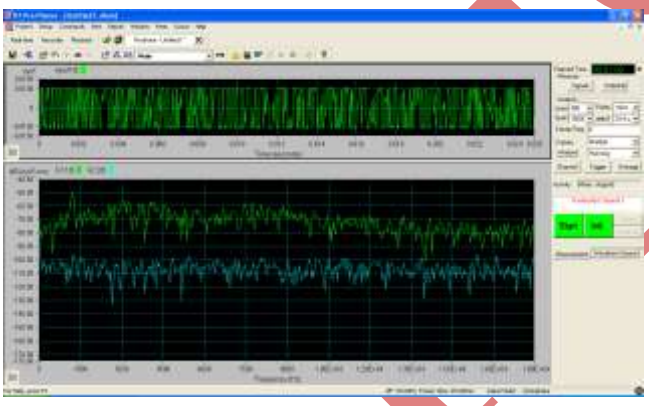

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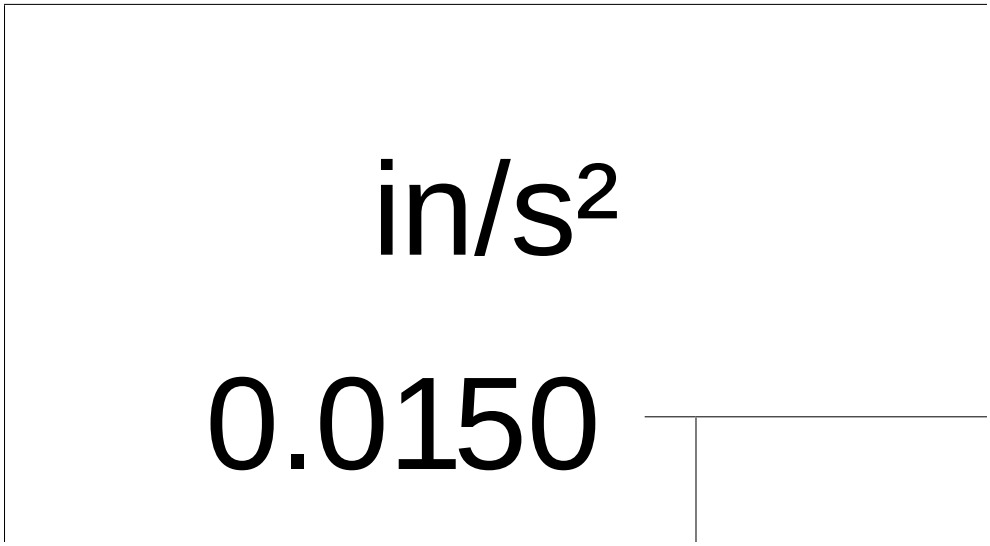
Real Time Screenshot Of FFT Analyzer (ID Fan)

ID FAN (RADIAL)



Spectral Lines:400 Time Capture Points: 1024 Frequency Span:16000 Time Domain
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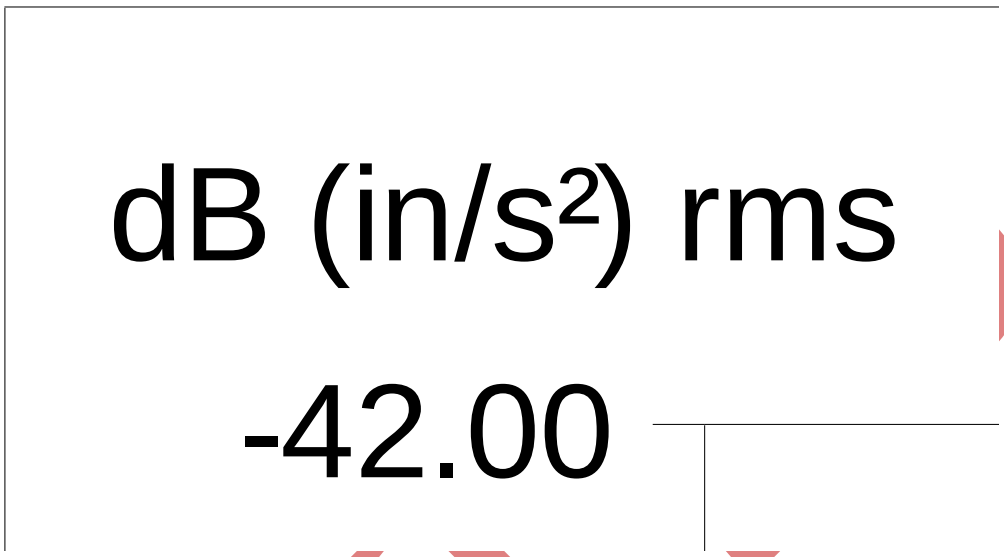
GRAPH EXPLANATION

From above graph accelerometer radially to the ID fan bearing casing there are no fluctuations in the graph. So we come to conclusion that there are no unwanted vibrations in the ID fan bearing means bearing is in good condition.



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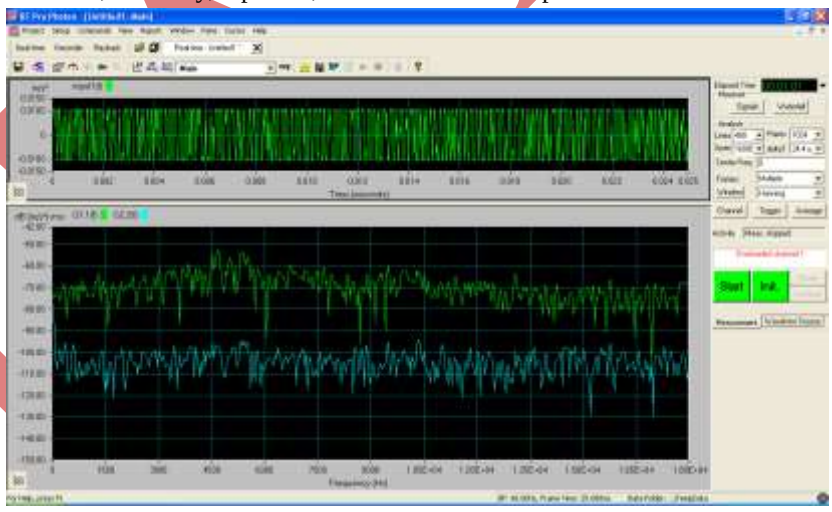

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Real Time Screenshot Of FFT Analyzer (ID Fan)

VIII. CONCLUSION:

Accelerometer fitted axially and radially to the ID fan bearing casing there are no fluctuations in the graph. So we come to conclusion that there are no unwanted vibrations in the ID fan bearing means bearing is in good condition. From the

graph accelerometer fitted axially and radially to the feed pump bearing casing there are fluctuations in the graph which occurred at regular intervals then shaft is imbalance so there is no need of replacing the bearings only there is need of repairing the shaft. It is most important to determine the cause of any bearing failure and carry out the prescribed correction before installing the new bearing. Doing so will minimize the possibility of a bearing failure and will work towards maximizing the probability of attaining normal bearing life.

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