RESEARCH ARTICLE OPEN ACCESS

Performance Monitoring of Vibration in Belt Conveyor System

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Abstract
We are always using some kind of machines in our daily life starting from fan, refrigerator and washing machines at home. In case of industries of industrial machinery items condition monitoring is important to know onset impending defects. There are so many types of indicating phenomenon such as vibration, heat, debris in oil, noise and sounds which emanate from these in efficiently running machines. This paper presents the vibration related fault identification and maintenance of belt conveyor systems (BCS). After analyzing the spectrum and vibration readings, it was observed that a combination of parallel and angular misalignment between motor & gear box was present causing high axial and radial vibration. The defect was rectified by mechanical maintenance activities and latter the vibration was found reduced within limit. Also the vibration readings were taken after rectification. The above results are presented in this paper.
Keywords: Gear box, Peak amplitude, Vibration Spectrum, Monitoring, Analysis

I. History & back ground of condition based monitoring systems

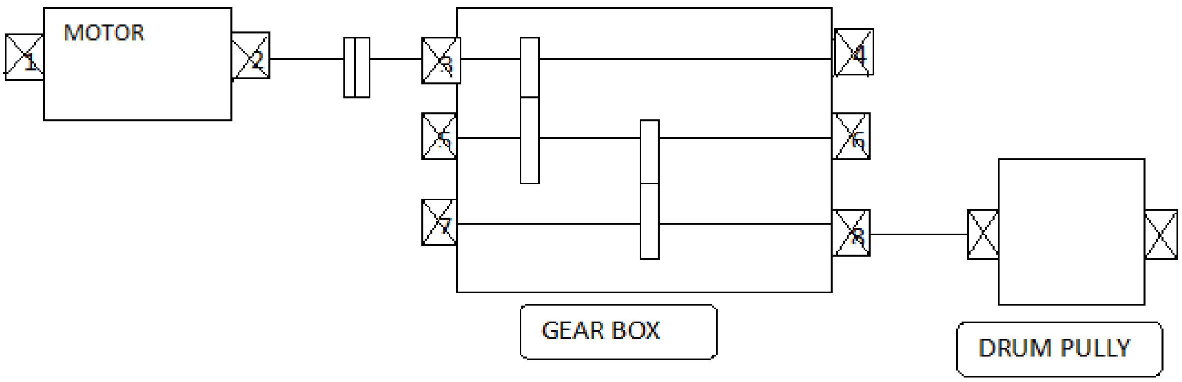
Condition monitoring of machinery is the measurement of various parameters related to the mechanical condition of the machinery (such as vibration, bearing temperature, oil pressure, oil debris, and performance), which makes it possible to determine whether the machinery is in good or bad mechanical condition. If the mechanical condition is bad, then condition monitoring makes it possible to determine the cause of the problem.1,2 Condition monitoring is used in conjunction with *predictive maintenance*, i.e., maintenance of machinery based on an indication that a problem is about to occur.
Predictive maintenance of machinery:

- Avoids unexpected catastrophic breakdowns with expensive or dangerous consequences.
- Reduces the number of overhauls on machines to a minimum, thereby reducing maintenance costs.
- Eliminates unnecessary interventions with the consequent risk of introducing faults on smoothly operating machines.
- Allows spare parts to be ordered in time and thus eliminates costly inventories.
- Reduces the intervention time, thereby minimizing production loss.
- Because the fault to be repaired is known in advance, overhauls can be scheduled when most convenient.

Condition monitoring systems are of two types: periodic and permanent. In a *periodic monitoring system* (also called an *off-line condition monitoring system*), machinery vibration is measured (or recorded and later analyzed) at selected time intervals in the field; then an analysis is made either in the field or in the laboratory. In a *permanent monitoring system* (also called an *on-line condition monitoring system*), machinery vibration is measured continuously at selected points of the machine and is constantly compared with acceptable levels of vibration .The principal function of a permanent condition monitoring system is to protect one or more machines by providing a warning that the machine is operating improperly and/or to shut the machine down when a preset safety limit is exceeded, thereby avoiding catastrophic failure and destruction. In a permanent monitoring system, transducers are mounted permanently at each selected measurement point. For this reason, such a system can be very costly, so it is usually used only in critical applications where: (1) no personnel are available to perform measurements (offshore, remote pumping stations, etc.), (2) it is necessary to stop the machine before a breakdown occurs in order to avoid a catastrophic accident, (3) an instantaneous fault may occur that requires machine shutdown, and (4) the environment (explosive, toxic, or high-temperature) does not permit the human involvement required by intermittent measurements. Before a permanent monitoring system is selected, preliminary measurements should be made periodically over a period of time to become acquainted with the vibration characteristics of the machine. This procedure will make it possible to select the most appropriate vibration measurement parameter, frequency range, and normal alarm and trip levels. This paper focuses on critical gear box which is most important feature for power transmission by the help of toothed member and the faults fall into five categories: imbalance, bearings defective, shaft fault, misalignment and resonance. When faults occur in gear box, the vibration readings are monitored in six ways.

II. A case study of vibration monitoring

Monitoring of vibration was taken in belt conveyor system (BCS) in the component of motor and gear box located in Rourkela steel plant. Motor shaft is coupled with gear box input shaft which are toothed members, transmit the power between two shafts by meshing without any slip. Hence gear drives are also called positive drives. In any pair of gears, the smaller one is called pinion when it act as a driver, results in step down drive in which output speed decreases and torque increases. On the other hand larger one called gear when it act as a driver it result in step up drive in which the output speed increases and torque decreases.



1-MOTOR NON DRIVING END
2-MOTOR DRIVING END
3-GEAR BOX I/P DRIVING END
4-GEAR BOX I/P NON-DRIVING END
5-GEAR BOX INTERNAL DRIVING END
6-GEAR BOX INTERNAL NON DRIVING END
7-GEAR BOX OUTPUT DRIVING END
8-GEAR BOX OUTPUT NON DRIVING END

The motor shaft is placed in two bearings, and the gear box is consisting of 3 shafts placed in two bearing each, out of which three are at driving and three at non driving end respectively. In order to know the correct vibration, the vibration readings are monitored on casing of motor and gearbox at respective bearing points. Readings are taken at motor driving end, non driving end and gear box input driving end, non driving end, and intermediate shaft driving end, non internal driving end, output shaft driving end and output non driving end.

III. Device used for vibration monitoring-

Vibration readings are monitored by using SPM A30 analyser. The instrument SPM A30 is a analysts suite software of SKF technology. It is a fully developed of portable type, route based vibration data analyser and collector.

IV. GEAR BOX SPECIFICATION-

TYPE-HZ 355 CW
SRL NO-HG 1744 SP
RATIO- 20.9/1 P1

V. SPECIFICATION OF MOTOR-

MAKE- Kirloskar Electric Co. Ltd.
TYPE- 3 PHASE INDUCTION
SPEED- 1485 RPM
RATED POWER - 250 KW
VOLTAGE- 415V
CURRENT- 412A
FREQUENCY- 50HZ

Table 1: Amplitude reading of motor and gear box

SL. NO	POSITION	DATE—28/5/2014 AMPLITUDE (MM/S-PEAK)			**DATE—7/6/2014** AMPLITUDE (MM/S-PEAK)		
		A	H	V	**A**	**H**	**V**
1	MNDE	35.585	32.974	4.749	3.458	3.097	**0.436**
2	MDE	70.429	26.281	53.949	**2.458**	**1.349**	**3.223**
3	GB-IP- DE	23.019	34.346	42.203	**1.406**	**1.048**	**1.378**
4	GB-IP- NDE	19.699	17.865	21.569	**0.870**	**0.892**	**0.429**
5	GB-INT-DE	26.022	37.120	26.110	**1.665**	**0.1295**	**1.595**
6	GB-INT-NDE	23.141	29.373	15.657	**2.138**	**2.835**	**1.115**
7	GB-OP-DE	39.079	30.016	16.620	**2.373**	**0.982**	**2.455**
8	GB-OP- NDE	35.711	25.249	25.349	**2.143**	**2.88**	**1.951**

Where
MNDE: Motor non- driving end
H: Horizontal
MDE: Motor driving end
V: Vertical
GB-IP-DE: Gear box input driving end
A: Axial
GB-IP-NDE: Gear box input non driving end
GB-INT-DE: Gear box internal driving end
GB-INT-NDE: Gear box non driving end
GB-OP-DE: Gear box output driving end
GB-OP-NDE: Gear box output non driving end

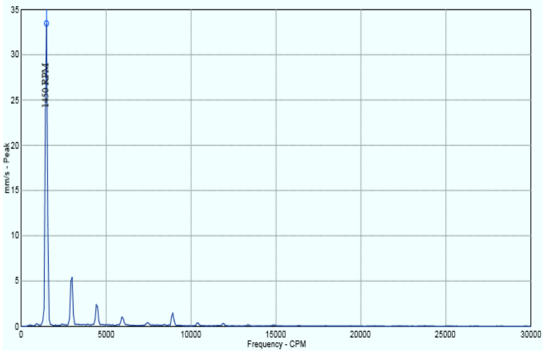
The following are limits for vibration amplitude

Good operation up to 2.5 mm/sec
Normal working 2.5 to 6.0 mm/sec
Still acceptable 6.0 to 10.0 mm/sec
Deteriorating 10.0 to 16.0 mm/sec
Unacceptable 16.0 to 25.0 mm/sec
Failure imminent above 25.0 mm/sec

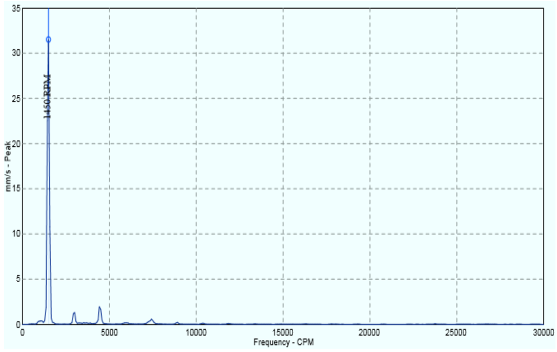
ISSN : 2248-9622, Vol. 4, Issue 7(Version 6), July 2014, pp.22-31

<u>Vibration Spectrum Readings</u> **28/5/2014- TAKEN BEFORE**

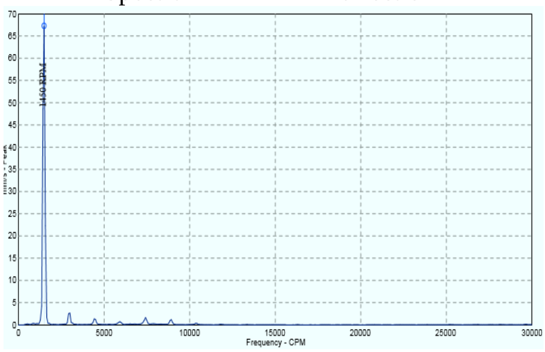
Spectrum in MNDE AXL direction



Spectrum in MNDE HOR direction



Spectrum MDE AXL direction



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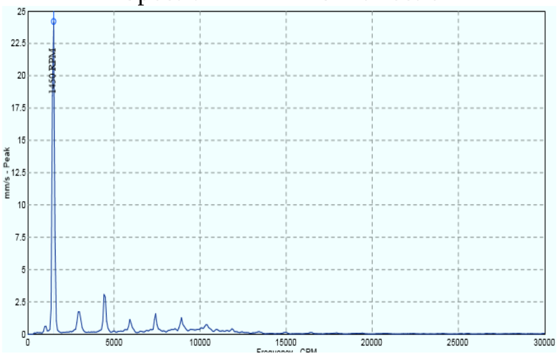
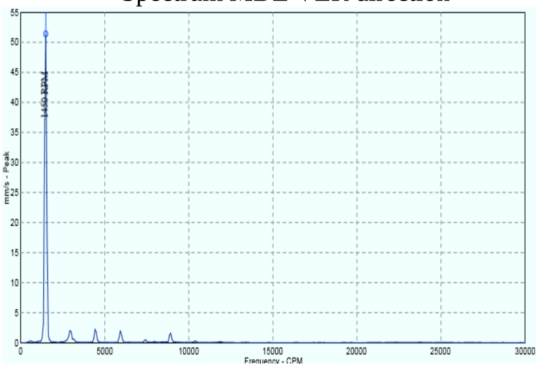


Spectrum MDE VER direction



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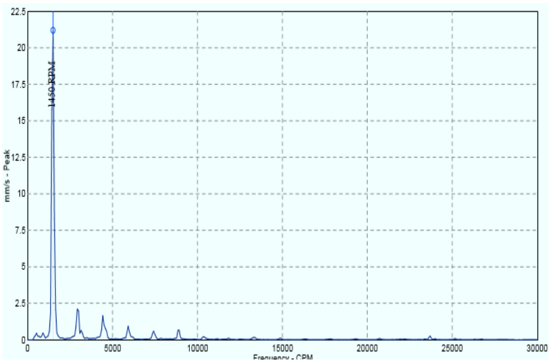

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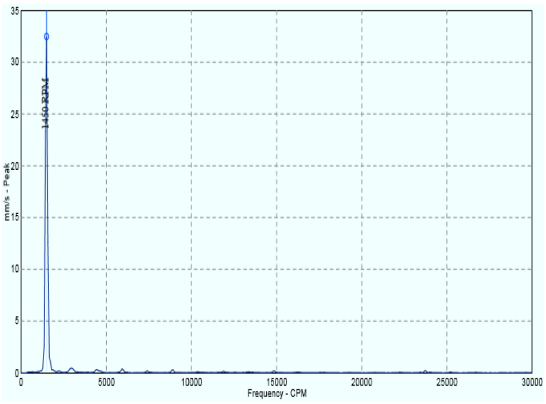

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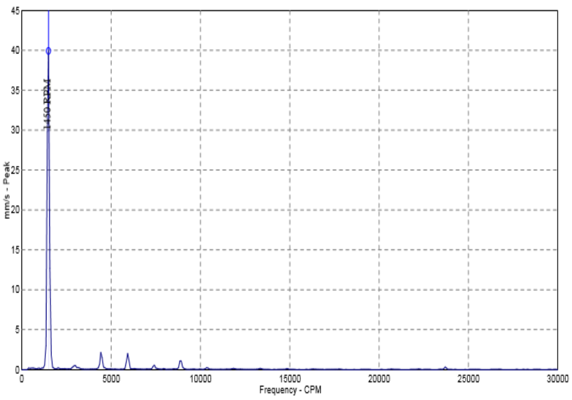

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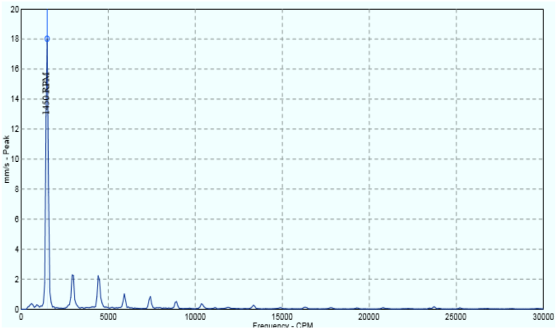

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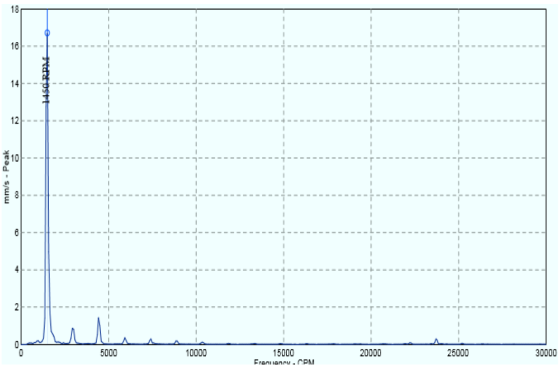
GB-IP-NDE VER direction



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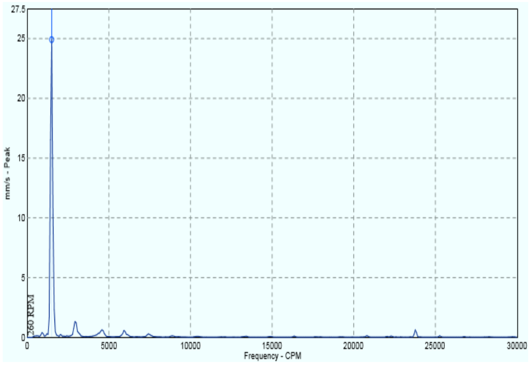

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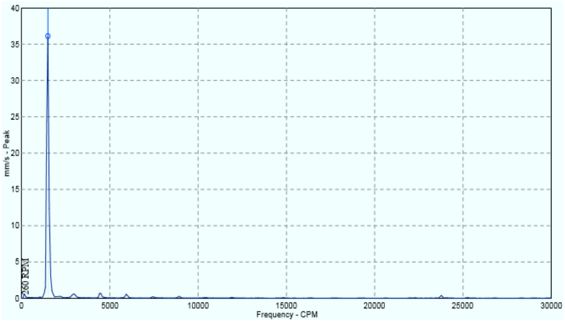

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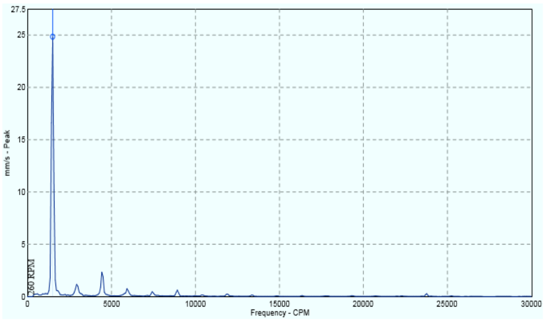

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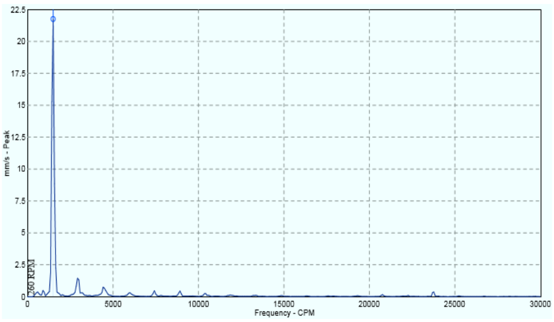

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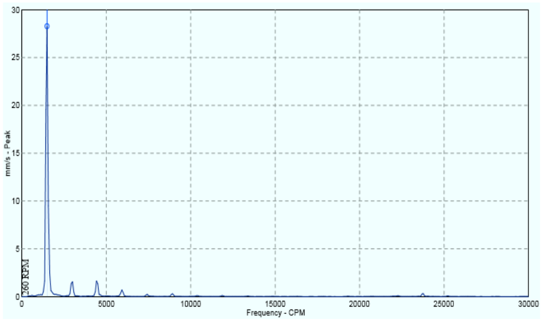

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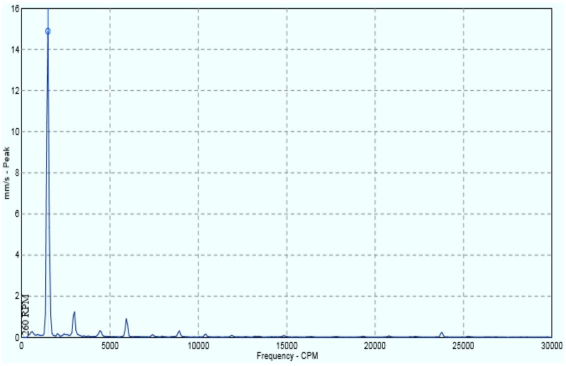

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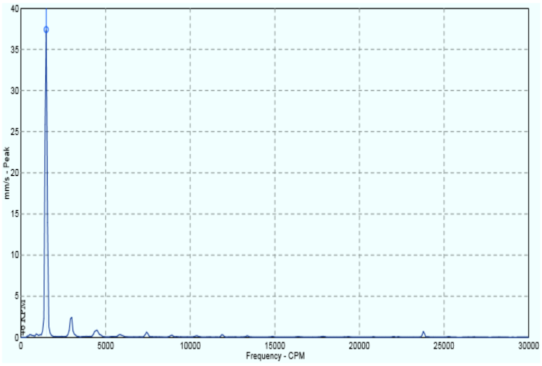

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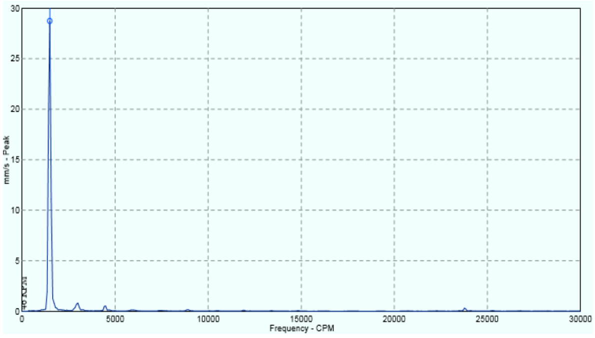

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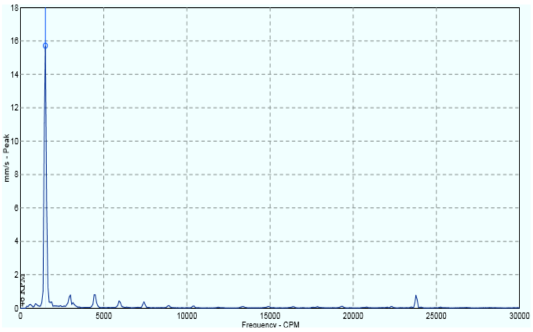

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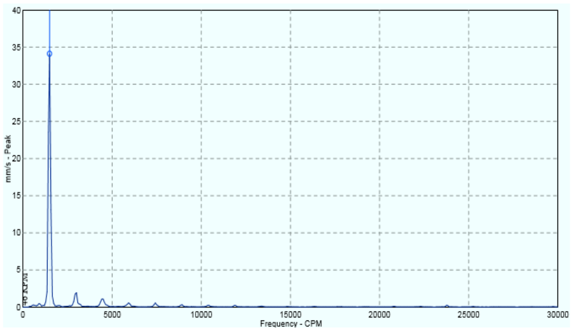

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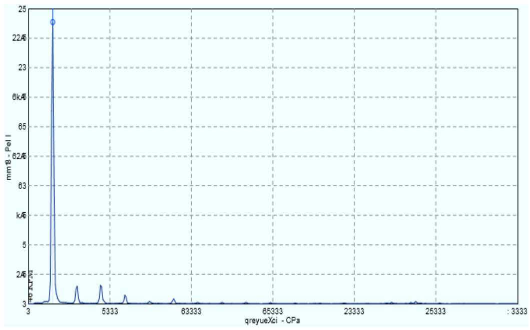

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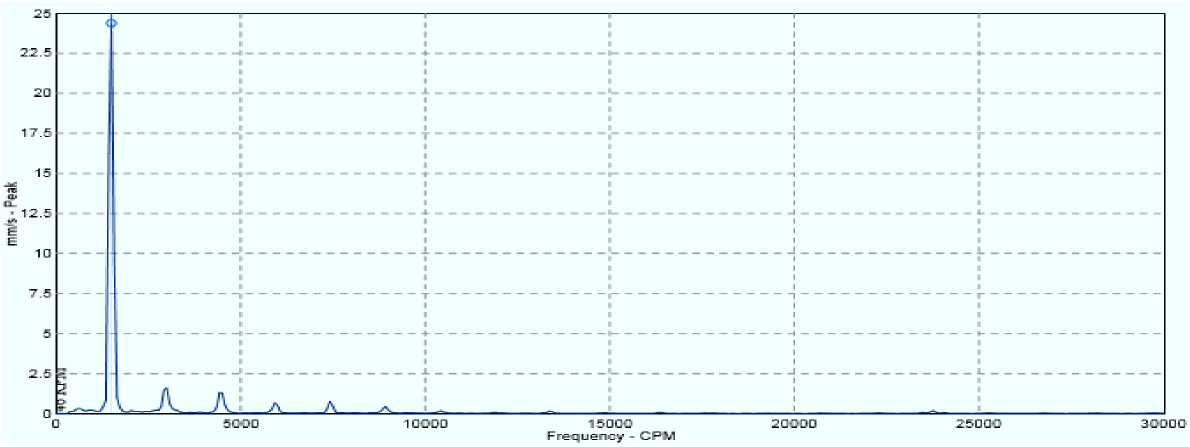


Observation and analysis of spectrum

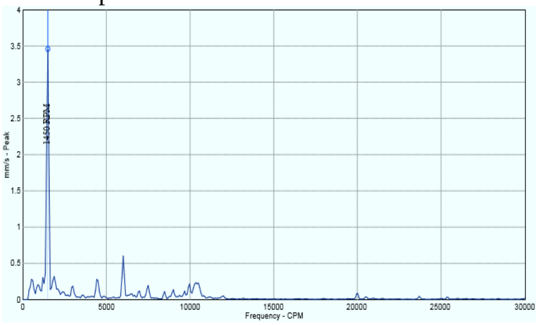
- On date 28/5/2014 it was seen through regular inspection that the vibration level of motor and gear box assemblies was very high. So the help of condition monitoring team was availed and the vibration measurement was taken.
- The measurement report showed high axial, radial vibration at all bearing points of motor and gearbox.
- Through spectrum analysis of vibration readings, it was diagnosed that there was combination of parallel and angular misalignment between motor and gear box, also structural looseness of motor and gear box assemblies was detected**.**

Rectification-

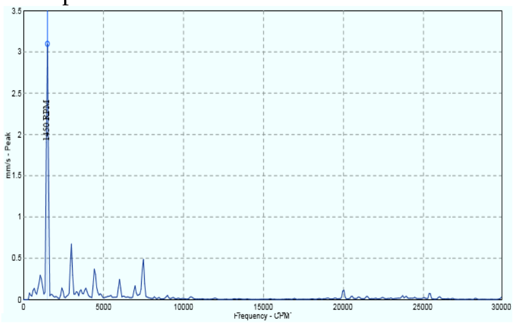
- Mechanical maintenance team of the concerned department addressed the above problems of misalignment, structural looseness and maintenance activities were undertaken.
- After the rectification, the vibration levels reduced within the acceptable limit and machine was in good running condition**.**

<u>7/6/2014 – TAKEN AFTER CORRECTIVE ACTION</u>

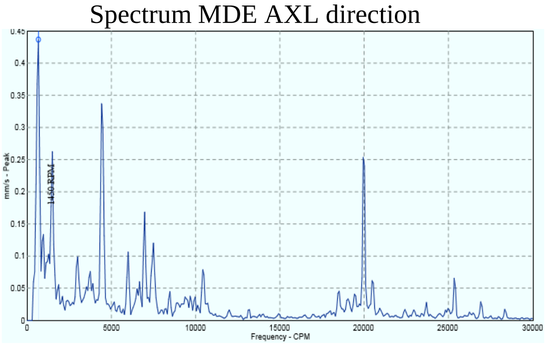
Spectrum in MNDE AXL direction



Spectrum in MNDE HOR direction



Spectrum MDE AXL direction



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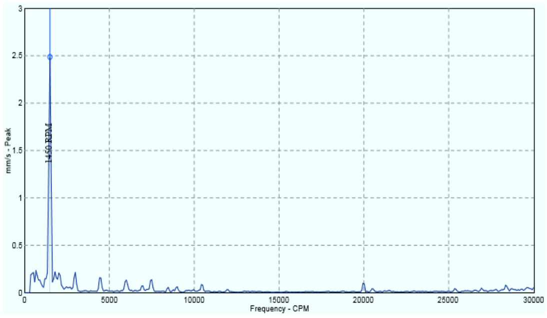

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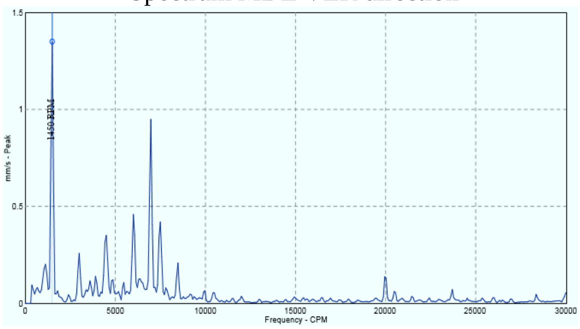
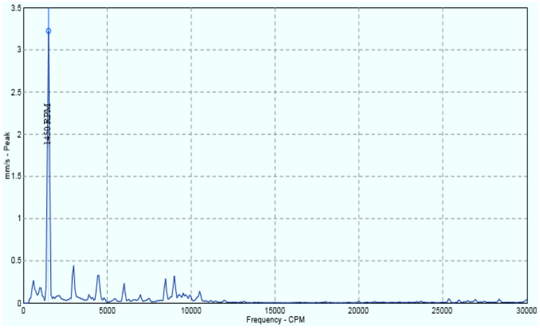


GB-IP-DE AXL direction



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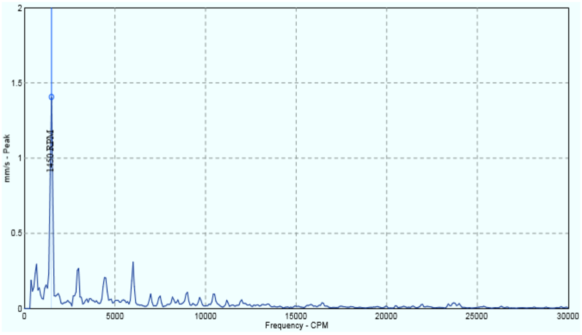

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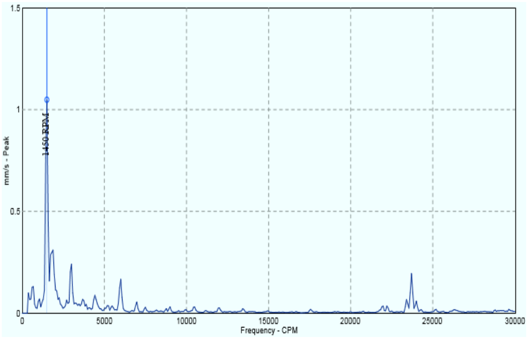

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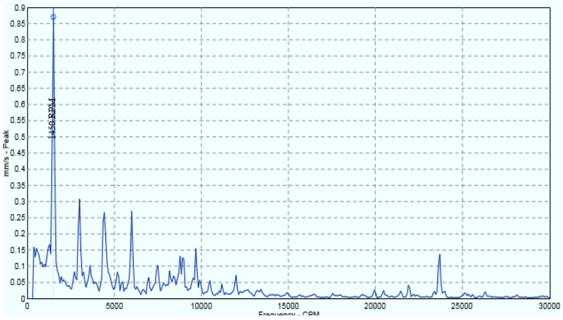

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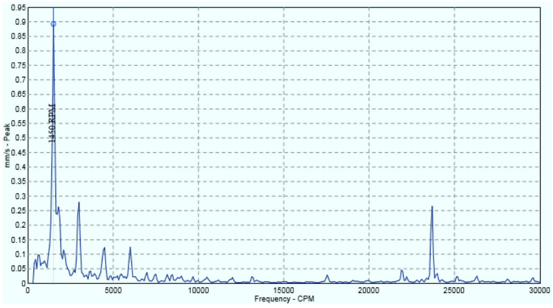

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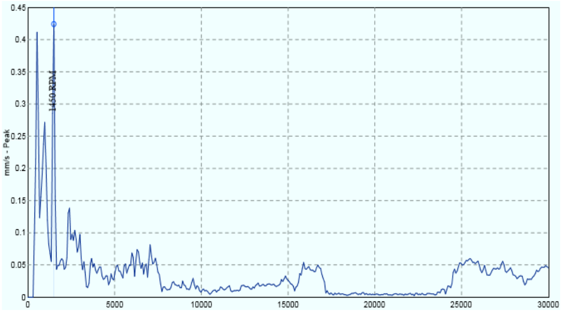

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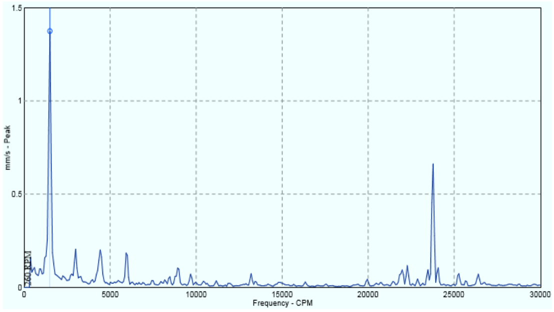

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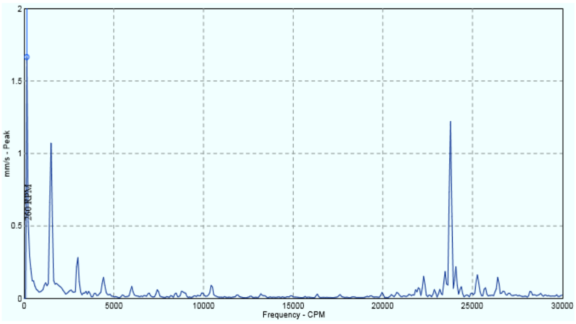

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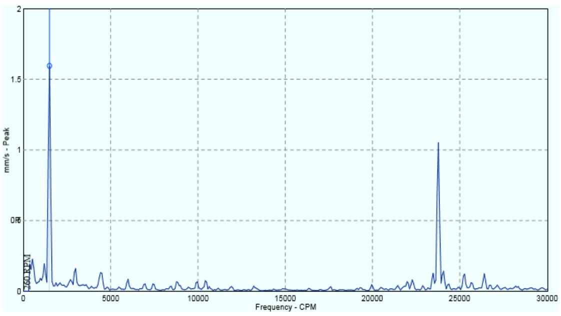

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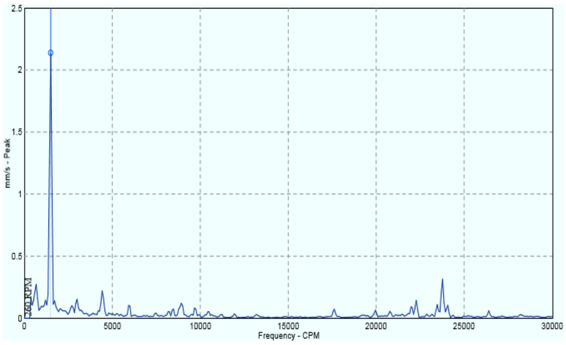

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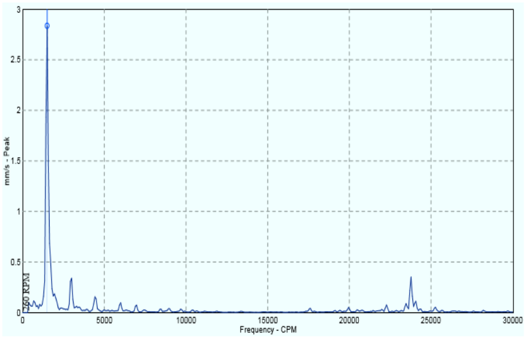

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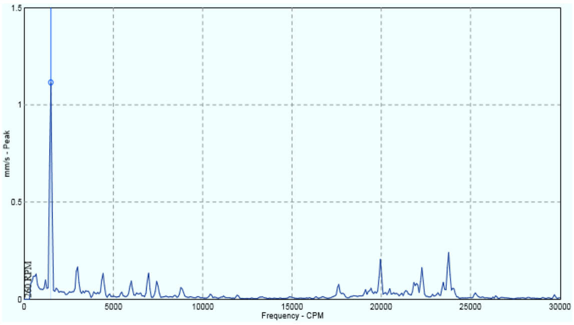

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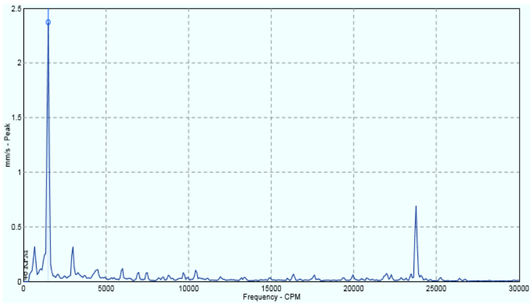

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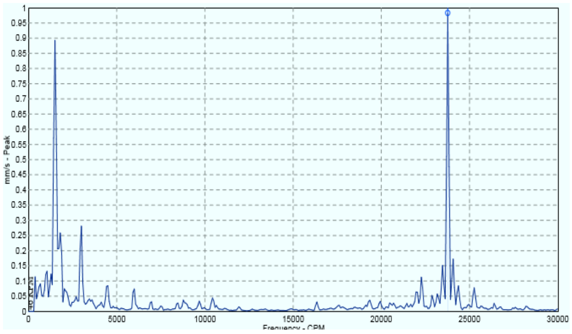

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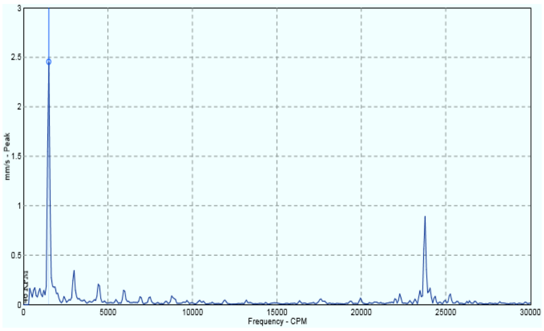

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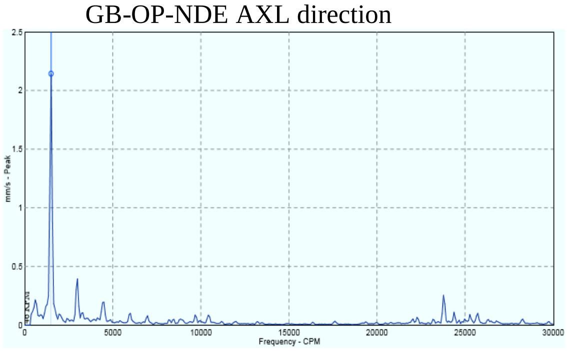

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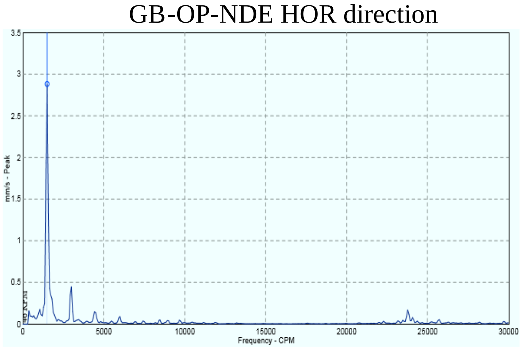

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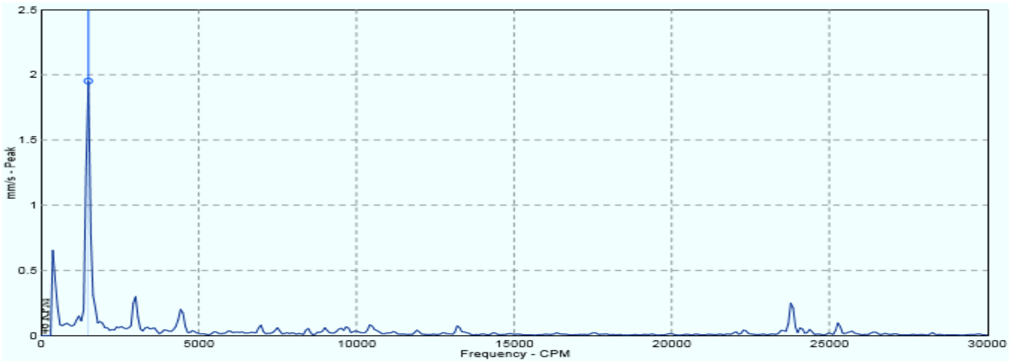

VI. Conclusion –

- Monitoring with the help of vibration analyzer machine is the one of the best and quick maintenance technique for all rotating machines such as turbines, pumps and fans etc.
- For knowing the exact fault of gear box and motor system the vibration spectrum was diagnosed and indicates misalignment and structural looseness.

VII. Acknowledgement

The authors would like to thank DEPT.OF CBMS in the Integrated Steel Plant unit of Steel Authority of India Limited at Rourkela, India for giving the opportunity and providing a good environment and excellent facilities for case study and experiment throughout the entire duration of this research.

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