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VIBRATION MONITORING OF BLOWER IN A TYRE MANUFACTURING INDUSTRY

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ABSTRACT

The major causes of low productivity are poor maintenance and low productivity of equipment and machinery in operation of an industry. Competition in an increasingly global economy has created new benchmarks against which our performance is assessed. Developing successful efforts to continuously improve performance is becoming a key responsibility of top leaders and managers in all organizations. Recent studies have shown that maintainability has got great impact on the overall profitability of the organizations. Vibration monitoring if properly used can indentify most if not all of the factors limiting the effectiveness and efficiency of the total plant by the analysis of vibration signals. In this work amplitude of vibration is selected as the parameter such as Displacement and Velocity to assess the health of Blower in a tyre manufacturing industry. In most of the cases bearing points were selected to assess the vibration level. The normal level was fixed from the Manuals, Manufacturers Catalogues and some Standards of Vibration. The vibration data were taken from the Blower with the help of Rio-Vibro Meter in different location and analysis carried out in order to find the defective components in the Blower and the corrective actions were also proposed at the end.

Keywords: Tyre Industry; Blower; Displacement; Velocity; Vibration Monitoring:

INTRODUCTION

All the machines are liable to deterioration in their performance level [01] with respect to time due to the wear and tear etc. maintenance is necessary to keep the performance level at desirable level with advantage on new maintenance techniques, maintenance engineering is gaining more and more importance in recent years. It is realized that maintenance results in economy, increased rate of production of improved performance level and reduction in probability of accidents. Today with the development of special purpose and sophisticated machines, equipments and machinery costs more and their downtime has made maintenance a critical factor in any modern industry. The importance of maintenance is not readily seen as that of production, but nevertheless its function are equally important to the continues well being of the industry. The need for maintenance has been of primary importance due to the increased complexity and cost of modern equipments. In highly competitive industrial environment, it is required to ensure better operating efficiency. This

calls for effective plant equipment maintenance of plant and machinery.

The objective of maintenance [02] is to upkeep all the plant equipment facilities and service to the required performance conditions. By systematic maintenance it is possible to achieve substantial savings in money, material and manpower as every effort is directed towards avoiding catastrophic failures. With the development of new manufacturing techniques and sophisticated machinery's the pressure is on the maintenance function to upgrade its technology to suit the rapid changes taking place in manufacturing system and to overcome the deficiencies of previous techniques, to avoid the cost of lost production, cost of labor and spare parts. The factors which directly influence the development of maintenance technology are Reliability requirements, Life cycle costs, Quality and Economy.

Significant amount of work has been done in the field of condition monitoring. Damilare T. Onawoga, B.Sc. and Olasunkanmi O. Akinyemi, M.Sc [03] have shown that, a good and suitable part designed by an engineer should be worthwhile and serve till the end of its useful life but maintenance is due to anything subjected to continuous use; this work believes that with the developed maintenance strategy, undue equipment stoppage, untimely failure and undue replacement would be greatly minimized if not completely avoided. Recent developments in the condition monitoring of rolling bearings and some case studies on the failure diagnosis and quality assessment of ball bearings have been discussed by P Rajendran and Dr Prabhu B S [04].

VIBRATION MONITORING

Vibration which is technically defined as the oscillation of an object [05] about its position of rest if mass is set in to motion it will move back and forth between some upper and lower limits. This movement to mass through all its positions and back to the point where it is ready to repeat the motion is defined as one cycle of vibration. The time taken to complete this cycle is called as period of vibration. The number of cycles in a given length of time is frequency of vibration, frequency is usually expressed in cycles/min (CPM) or cycles/sec (CPS) or as a multiple of the rotative speed of the machine (1x RPM, 2x RPM etc). frequency is one of the basic characteristics used to measure and describe vibration.

The condition monitoring of plant and machines are being done through the measurement and analysis of many living symptoms of individual machines. Machinery vibration analysis is gaining topmost priority in this area because of this fact that

- All operating machines vibrate.
- Machines vibrate because of imperfections. When the imperfection is more, we say it as a defect. Therefore machines vibrate because of defects.
- Different defects produce vibrations of different characteristics.

Vibration analysis is the best and most common technique [06] consists of acquiring the vibration signals and using them as information carriers. Of all parameters that can be measured non-intrusively in industry, the one containing the most information is the signature analysis.

Vibration is essentially lost energy caused by rotational problems of component imbalance, misalignment and mechanical looseness which are common to all plant. Experiences have shown that vibration is an important indication of condition of machines during normal operation. Proper functioning machines like blowers, motors, compressors and turbines emit a specific vibration signal or signature. Excessive vibration has a destructive effect on rotor bearings, seals, piping walls, foundations and other structures. Operating personnel may be adversely influenced too. High noise levels from vibration may exceed health and safety limitations and cause permanent bearing damage.

A. *Objective of Vibration Monitoring*

Vibration measurement and analysis [07] provides a quick and relatively inexpensive way to detect and identify minor mechanical problems before they become serious and force costly unscheduled shutdowns. The intervals between regularly scheduled maintenance shutdowns can be optimized if sufficient information about the condition of the equipment is known. The two main objectives of vibration monitoring and analysis are as follows

- To give an indication that the machine health is deteriorating.
- To identify the actual source of trouble to locate the defective components of the machine.

B. *Criteria for setting up a Vibration Monitoring Program*

The following criteria may be considered while setting up a vibration monitoring program

- Presence of vibration signals powerful enough to be classified as "Prognostic Characteristic".
- Availability of suitable instrumentation to measure vibration signals.
- Predictability of equipment failure based on vibration data.
- Availability of skilled personnel to carry out vibration monitoring.
- Failure rate of machine under consideration not too high.
- Cost effectiveness.

C. *Factors Affecting Aplications of Vibration Monitoring*

The following are some of the circumstances which favor the applications of vibration monitrong [08] in industries are

- Continuous process plants, where breakdown of any intermediate unit leads to stoppage of the whole plant.
- Where a catastrophic failure is likely to happen upon breakdown of machinery.
- Where accurate and advanced planning of maintenance is essential due to safety, risk, complexity, legislation etc.
- Where plant and equipment is of recent design and teething programs yet to overcome.
- Expensive and complex equipment where manual detection of faults are difficult.

D. *Instruments used to Measure Vibration*

The vibration amplitude is measured in terms of [09] Displacement, Velocity and Acceleration. For measuring vibration electronic instruments are used, the heart of the measurement system is a transducer. A transducer is a sensing device which converts one form of energy (mechanical vibration) into an electrical signal. The measurement locations generally selected are the bearing housings of a machine because it is through these housings that the vibration forces of the rotating elements are transmitted. The measurements are made in vertical, horizontal and axial directions when thorough vibration analysis is being conducted.

There are different kind of instruments which are used for condition monitoring o machines such as vibrometer, SPM(shock pulse meter), Riovibro Meter, FFT Vibration Analyzer, Bering Analyzer, IRD Mechanalysis, Sound Level Meter etc. Riovibro Meter is a pocketable vibration meter which is best suited for onsite measurement. Features of Riovibro Meter are

- It is a hand held instrument, vibration & digital display are assembled in a single piece without any cable.
- Maximal simplicity in operation, only one button controls measurement.
- Measurement in three key factors such as Displacement (0.001 to 1.999 mt P-P), Velocity (0.01 to 19.99 mt/sec RMS) and Acceleration (0.1 to 199.9 mt/sec^2 Peak).

VIBRATION MONITORING OF BLOWER

A lot can be learnt about the machines conditions and mechanical problems by noting its vibration characteristics [10]. The three characteristic that are required to define any vibration are, Amplitude, Frequency and Phase. Here for our study the vibration amplitude is considered, the term amplitude is used to describe “how much” in whatever measurement parameter it being used. Vibration amplitude is measured in three main engineering units such as Displacement, Velocity and Acceleration. The measurement locations generally are the Bearing housings of a machine because it is through these housings that the vibration forces of the rotating elements are transmitted. Sometimes, frames of the machines are also chosen for measurement because they also absorb the forces of the moving parts.

The details of the Blower selected in a Tyre manufacuring industry for vibration monitoring are as shown in Table 1.

Table I. Details of Blower.

Number of Vanes in the Impeller	***16***
RPM of Blower	***800***
Diameter of Driver Pulley	***50 cm***
Length of Belt	***120 cm***
Bearing number of Blower	***22319K***
Type of Bearing	***Double row Ball & Roller Bearing Motor (3-Phase) 56 KW***
RPM of Motor	***1470***
Deep Grove Ball Bearing	***6313K***
Diameter of Driver Pulley	***30 cm***
Operating Temperature Range of Blower	***: 150^0 C to 260^0 C***

Vibration Monitoring technique was used in order to monitor the condition of the Blower. Selecting amplitude of vibration such as Velocity (V) and Displacement (D) as a parameter. The vibration amplitudes have been measured in triaxial i.e. Horizontal(H), Vertical(V) and Axial (A) directions at 4 different locations (bearing points) and the readings are recorded in a Table-1, by using Rio-Vibro meter. Based on the level of vibration, location and its direction the maintenance action will be suggested and also the vibration trends are observed using trend graph for a period of 150 days to analyze the cause of vibration and condition of machine. Based on this maintenance action were suggested at the end of the period.

Table II. Vibration Data Sheet for a Blower.

DATE		***12TH OCT***		***5TH NOV***		***3RD DEC***		***4TH JAN***		***6TH FEB***		***1ST MAR***	
Bearing Points		***V***	***D***	***V***	***D***	***V***	***D***	***V***	***D***	***V***	***D***	***V***	***D***
1	***H***	***7.8***	***150***	***6.4***	***120***	***7.9***	***125***	***3.9***	***68***	***4.4***	***152***	***5.2***	***112***
	V	***9.9***	***220***	***6.8***	***218***	***8.7***	***176***	***6.4***	***1.2***	***7.1***	***165***	***7.5***	***128***
	A	***5.6***	***162***	***8.8***	***175***	***8.1***	***165***	***8.4***	***170***	***7.9***	***172***	***7.4***	***190***
2	***H***	***7.4***	***152***	***9.7***	***260***	***7.2***	***135***	***4.9***	***81***	***6.9***	***165***	***7.2***	***148***
	V	***6.7***	***185***	***7.8***	***175***	***9.9***	***240***	***5.6***	***120***	***7.8***	***187***	***8.1***	***172***
3	***H***	***7.7***	***152***	***6.3***	***102***	***7.4***	***178***	***3.7***	***72***	***8.2***	***132***	***8.5***	***122***
	V	***9.5***	***165***	***9.6***	***235***	***11.7***	***242***	***8.6***	***105***	***7.1***	***148***	***6.8***	***135***
	A	***6.9***	***69***	***6.3***	***42***	***7.8***	***152***	***8.9***	***89***	***7.5***	***172***	***7.2***	***162***
4	***H***	***8.3***	***145***	***8.1***	***142***	***8.9***	***140***	***4.8***	***140***	***6.3***	***150***	***6.5***	***141***
	V	***8.7***	***206***	***7.6***	***155***	***13.9***	***225***	***8.6***	***168***	***8.3***	***141***	***7.9***	***132***
	A	***9.8***	***82***	***7.9***	***132***	***9.6***	***138***	***11.5***	***142***	***10.5***	***128***	***10.1***	***112***

A. *Data Analysis, Data Interpretation and Maintenance action Suggested for Blower*

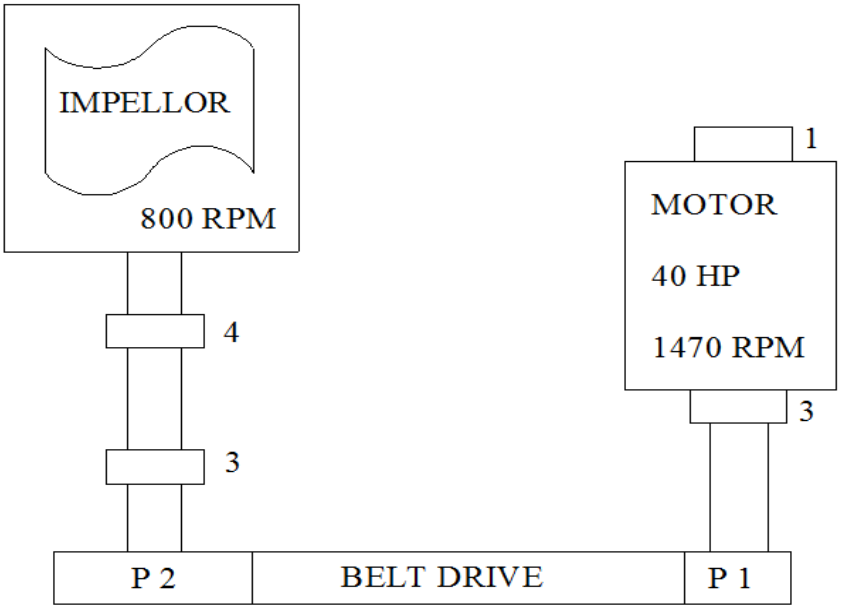
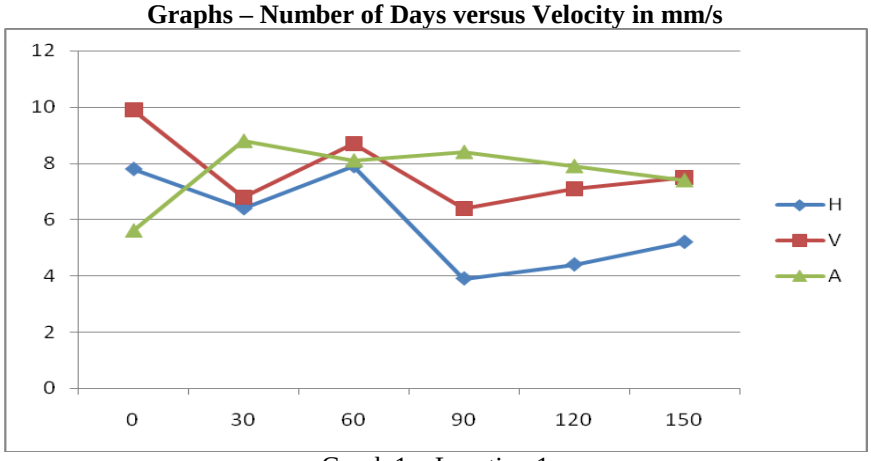


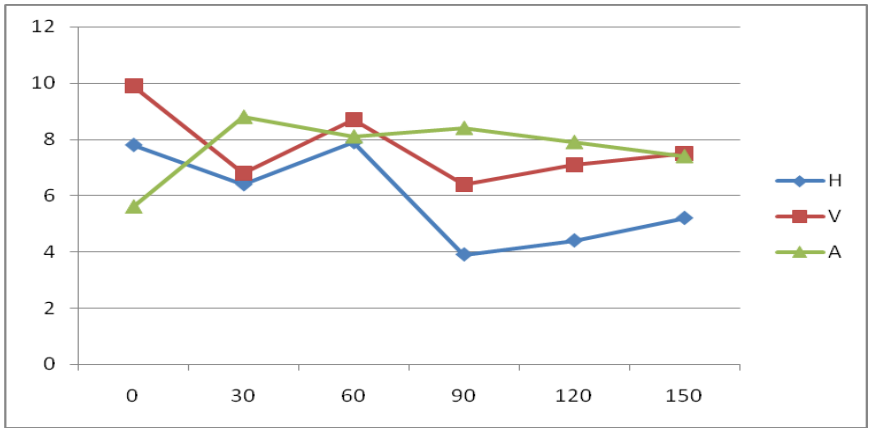
Figure 1. Line Diagram of Blower.

The line diagram of Blower is shown in the Figure-1 in which all the bearing points were shown. The Blower has motor of 50 KW mounted without any special foundation. The readings are taken from all 4 identified bearing points in Horizontal (H), Vertical (V) and Axial (A) directions. The vibration amplitude such as Displacement (D) and Velocity (V) are measured with the help or Rio-Vibro Meter for a fixed interval of 30 days, for a total period of 150 days. The Graph is plotted number of day's verses velocity in mm/s for all the bearing points identified as shown in Graph- 1 to 4. The normal level of amplitude of vibration was fixed from the Manuals, Manufacturers Catalogues and some Standards of Vibration. It is a medium class machine and is categorized as class-II machine according to ISO-2372. The maximum tolerable limit of vibration amplitude is 10 mm/sec (Peak). The analysis is carried out in order to find the defective components in the machine and the corrective actions were proposed.

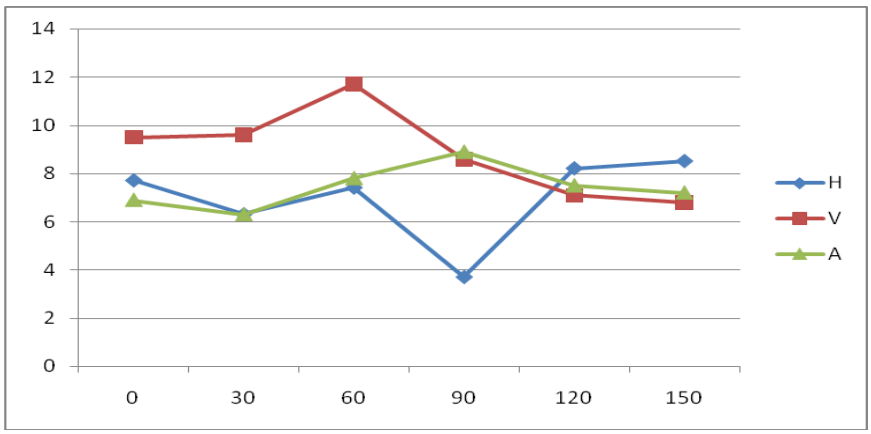
Graphs – Number of Days versus Velocity in mm/s



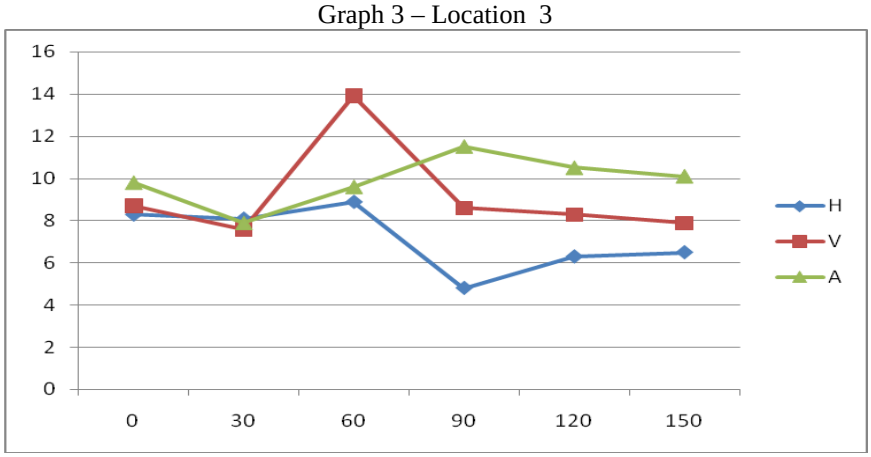
Graph 1 – Location 1



Graph 2 – Location 2



Graph 3 – Location 3



Graph 4 – Location 4

Observation – 1 (15th October): Observing to first set of readings of Blower, Graph (1 to 4) it is found that the vibration is normal hence routine preventive maintenance was suggested.

Observation – 2 (12th November): Observing to second set of readings of Blower, Graphs shows steady vibration trend, hence routine preventive maintenance was suggested.

Observation – 3 ()10th December): Observing to second set of readings of Blower, Graphs shows increased abnormal vibration in vertical direction at location 2, 3 and 4. However Horizontal and Axial direction shows normal vibrations levels. Also these show dominant frequency at 1X RPM, hence the problem of unbalance in rotor was suspected and impeller vibration is excessive showing 1S RPM frequency. The bearing at location 4 is under bad condition. Based on this the maintenance action suggested is as follows

- Check for unbalance in Rotor Blades.
- Check the bearing at location 4 for any damage and grease the bearing.

Observation – 4&5 (7th January & 4th February): The Graphs show clear indication of decreasing trend of vibration due to the corrective actions taken and the improved condition of machine.

If the maintenance is carried out in time the catastrophic failure can be prevented, thereby increasing the machine availability and reducing maintenance cost. The present condition monitoring studies have demonstrated that vibration monitoring and analysis is very much helpful for diagnostic maintenance of machinery. The application of vibration monitoring were found effective in improving the quality of product and improved in reliability of the machinery.

CONCLUSIONS

Vibration Monitoring is a powerful diagnostic method to predict the performance of machinery under different conditions. Vibration parameter i.e. amplitude of vibration is chosen for criterion for estimating the performance of machines. The amplitude of vibration is found to be decisive factor in evaluating the condition of the machine. All the parameters are represented in a plot so that relative variation can be read easily. From this plot the vibration level which is abnormal should be given immediate attention. Vibration monitoring has been successfully performed with a practical approach on s Blower. In this faults has been indemnified based on the Manuals, Manufacturers Catalogues and some Standards of Vibration. The analysis have confirmed to the actual fault present in the equipment. Vibration levels have come down considerably after the recommended maintenance activities were undertaken. Application of vibration monitoring were found effective in improving the quality of product and improved in reliability of machinery.

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