CONDITION MONITORING OF DUMP MILL OF A BANBURY MACHINE

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ABSTRACT

Competition in an increasingly global and marketing has created new techniques of Maintenance in order to upkeep their performance in terms of quality, productivity and cost. One such recent technique is condition monitoring. Condition monitoring is nothing but checking the condition of the machine by using parameters like vibration. The detection of incipient faults in machinery is very important in achieving unhindered production in any plant. Condition monitoring if properly used can indentify most if not all of the factors limiting the effectiveness and efficiency of the total plant. One of the most promising techniques of condition monitoring is based on the analysis of vibration signals. In this work vibration is selected as the parameter to assess the health of Dump Mill of a Banbury machine 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 machines with the help of Rio-Vibro Meter in different location and analysis carried out in order to find the defective components in the machine and the corrective actions were also proposed at the end.

Keywords: Maintenance; Condition Monitoring; Dump Mill; Banbury; Vibration Monitoring:

INTRODUCTION *(HEADING 1)*

The term ‘maintenance’ [01] means to keep the equipment in operational condition or repair it to its operational mode. Main objective of the maintenance is to have increased availability of production systems, with increased safety and optimized cost. Maintenance management involves managing the functions of maintenance. Maintaining equipment in the field has been a challenging task since the beginning of industrial revolution. Since then, a significant of progress has been made to maintain equipment effectively in the field. As the engineering equipment becomes sophisticated

and expensive to produce and maintain, maintenance management has to face even more challenging situations to maintain effectively such equipments in industrial environment. The maintenance management includes maintenance strategies, functions of maintenance department, maintenance organization and elements of maintenance management. 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 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.

Significant amount of work has been done in the field of condition monitoring. Recent developments in the condition monitoring of rolling bearings and some case studies on the failure diagnosis and quality assessment of ball bearns have been discussed by P Rajendran and Dr Prabhu B S [02]. 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..

MAINTENANCE

Maintenance can be defined [04] as a set of actions which are carried out to replace, repair and service an identifiable set of manufacturing components, so that the plant continues to operate at a specified level of availability for a specified time. The main objective of Maintenance is to control the availability. Maintenance of machine means efforts directed towards the upkeep and the repair of that machine.

Objective of Maintenance

Maintenance objectives [05] should be consistent with and subordinate to production goals. The relation between maintenance objectives and production goals is reflected in the action of keeping production machines and facilities in the best possible condition.

- Maximising production or increasing facilities availability at the lowest cost and at the highest quality and safety standards.
- Reducing breakdowns and emergency shutdowns.
- Optimising resources utilisation.
- Reducing downtime.
- Improving spares stock control.
- Improving equipment efficiency and reducing scrap rate.
- Minimising energy usage.
- Optimising the useful life of equipment.
- Providing reliable cost and budgetary control.
- Identifying and implementing cost reductions

A. *Maintenance Strategies*

Any organization which is involved in machinery, plant and facilities [06] must have a clear cut maintenance policy in order to ensure its well being, however each individual organization using of highly advanced or simple technology must choose that maintenance system which best meets its individual needs in implementing policies.

The different types of maintenance strategies are followed in different plants depending on the size of the plant, equipment, capital invested management policies etc. 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 different Maintenance strategies are as follows, Capital Replacement, Breakdown Maintenance, Schedule Maintenance, Preventive Maintenance, Condition Based Maintenance, Designed Out Maintenance, Opportunistic Maintenance, Total Productive Maintenance and Terro Technology.

CONDITION MONITORING

Condition monitoring is a management technique [07] that uses the regular evaluation of the actual operating condition of plant equipment, production systems and plant management functions to optimize total plant operation. The main factors in a condition monitoring program are as follows, State of the art instrumentation and monitoring methods, Skilled analysis, Information system allowing easy data retrieval, Flexible maintenance organization allowing for an easy operations or maintenance interface and Ability to perform online analysis.

A. *Steps in Setting up a Vibration Monitoring Program*

The seven basic steps in setting up a vibration monitoring program are as follows

- Selection of Critical Machines to be included in the program.
- Establishing acceptable levels of machinery vibration.
- Determining each machine condition and normal vibration levels.
- Selecting vibration pickup points.
- Selecting the interval for periodic vibration checks.
- Start a simple data recording system.
- Training personnel to carry out the program.

B. *Defects Diagnosed by Vibration Monitoring*

Defects diagnosed by vibration monitoring are [08] shaft and rotors defects, rolling element bearing defects, gears defect, defects of machines with blades or impellers, journal bearing defects, defects in belt drives etc. Vibration is the motion of a machine or machine part back and forth from its position of rest. It is the mechanical problems associated with machinery operation which cause vibration. Some of the common problems which are known to produce vibrations are imbalance of rotating parts, eccentric components, misalignment of couplings and bearings, bent shafts,

component looseness, worn or damaged gears, bad drive belts and drive chains, electromagnetic forces, aerodynamic forces, hydraulic forces, resonance etc.

C. *Measuring Instruments*

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 BANBURY

There are 5 Banbury machines in a selected Tyre manufacturing industry. Normally these machines work throughout the year and are used to mix synthetic and natural rubber. After mixing it has to pass through number of mills and also these machines are critical, the breakdown of these machines effect the production. Hence observation of these machines are carried out. Vibration monitoring technique was used in order to monitor the condition of the Dump Mill of a Banbury machine by selecting vibration velocity and displacement as a parameter. The vibration amplitudes Velocity (V) and Displacement (D)have been measured in triaxial i.e. Horizontal(H), Vertical(V) and Axial (A) directions at 8 different locations (bearing points) and the readings are recorded in table-1.

Table I. Vibration Data Sheet for Dump Mill of a Banbury Machine.

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***	***12.4***	***132***	***11.3***	***110***	***15.2***	***122***	***19.8***	***152***	***15.4***	***198***	***14.1***	***191***
	V	***15.2***	***175***	***14.7***	***160***	***16.6***	***155***	***18.6***	***135***	***15.7***	***146***	***13.9***	***141***
	A	***10.3***	***153***	***9.9***	***135***	***9.3***	***132***	***8.6***	***95***	***7.8***	***68***	***6.6***	***62***
2	***H***	***14.1***	***193***	***19.1***	***205***	***14.3***	***213***	***12.5***	***86***	***17.1***	***203***	***18.2***	***213***
	V	***20.4***	***197***	***14.9***	***210***	***18.5***	***242***	***25.9***	***193***	***24.4***	***235***	***23.2***	***242***
3	***H***	***22.6***	***198***	***14.7***	***150***	***26.6***	***143***	***38.2***	***125***	***25.4***	***290***	***22.1***	***233***

	V	***16.6***	***103***	***18.8***	***128***	***20.3***	***129***	***26.1***	***128***	***17.8***	***130***	***15.3***	***138***
	A	***19.5***	***122***	***21.7***	***192***	***27.2***	***183***	***31.5***	***180***	***26.6***	***135***	***21.5***	***145***
4	***H***	***24.8***	***220***	***14.8***	***215***	***16.3***	***202***	***17.4***	***295***	***20.8***	***245***	***21.1***	***231***
	V	***12.5***	***80***	***22.6***	***128***	***20.1***	***122***	***19.4***	***105***	***18.2***	***135***	***17.5***	***123***
	A	***19.7***	***135***	***21.6***	***149***	***21.4***	***141***	***21.3***	***153***	***16.8***	***152***	***15.1***	***143***
5	***H***	***12.3***	***79***	***24.2***	***78***	***18.8***	***205***	***14.1***	***115***	***16.2***	***118***	***26.1***	***208***
	V	***28.5***	***214***	***31.2***	***230***	***23.9***	***242***	***25.1***	***180***	***24.2***	***170***	***23.4***	***209***
6	***H***	***12.5***	***135***	***21.7***	***120***	***19.8***	***274***	***14.2***	***202***	***16.3***	***180***	***28.9***	***232***
	V	***24.8***	***95***	***19.1***	***85***	***14.1***	***208***	***13.3***	***68***	***17.5***	***65***	***22.9***	***260***
	A	***31.8***	***216***	***34.2***	***201***	***30.1***	***230***	***15.8***	***140***	***16.5***	***132***	***19.6***	***242***
7	***H***	***8.1***	***169***	***15.4***	***68***	***9.8***	***220***	***12.6***	***240***	***14.2***	***212***	***17.1***	***232***
	V	***12.1***	***58***	***16.3***	***280***	***13.6***	***106***	***18.6***	***135***	***16.4***	***125***	***14.5***	***59***
	A	***38.9***	***260***	***40.1***	***76***	***28.6***	***270***	***19.2***	***180***	***20.2***	***172***	***26.1***	***220***
8	***H***	***4.4***	***48***	***7.7***	***42***	***5.4***	***98***	***7.5***	***78***	***8.2***	***69***	***9.8***	***122***
	V	***12.6***	***152***	***18.8***	***150***	***23.6***	***280***	***20.3***	***85***	***19.2***	***80***	***16.7***	***178***

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

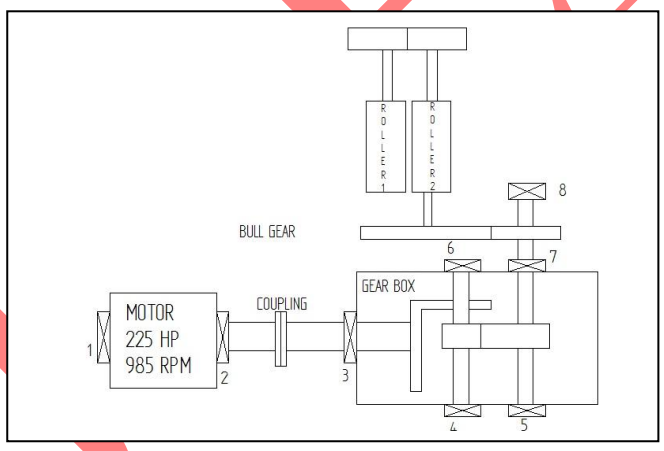

Figure 1. Line Diagram of Dump Mill (Banbury Machine).

The line diagram of Dump Mill of a Banbury Machine is shown in the Figure-1 in which all the bearing points were shown. The readings are taken from all 8 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 6 months. The Graph is plotted number of days verses velocity in mm/s for all the bearing points identified as shown in Graph- 1 to 8. The normal level of amplitude of vibration was fixed from the Manuals, Manufacturers Catalogues and some Standards of Vibration. The analysis is carried out in order to find the defective components in the machine and the corrective actions were proposed.

Observing the trend Graph (1 to 8) of Dump Mill, as in graph 1 and 2, that is location 1 &2. We can see that the horizontal and vertical vibration is more when compared with the axial vibration, which is showing decreasing trend and vertical vibration shows severe vibration and this includes loose motor mounting bolts and motor shows 1X Rpm frequency, this indicates that the problem is

a electrical problem and also observing graph 3 & 4 at location 3 &4. Based on this the maintenance action suggested are

- Check for loose motor bolts.
- Check and correct the electrical problem in motor.
- Check the bearing and grease the bearing.

Also observing graph 5, 6 and 7 at location 5, 6 and 7 shows that gear box has more vibration level. This indicates the problem is misalignment. Based on this maintenance action suggested are

- Check the alignment between motor and bear box.
- Check the tightness of gear box fixing bolts.
- Check the running clearance of rollers and meshing of bull gear.

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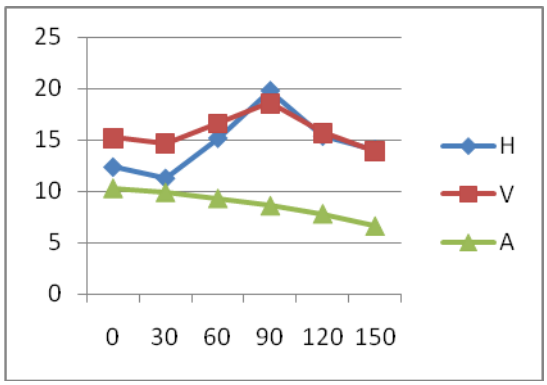
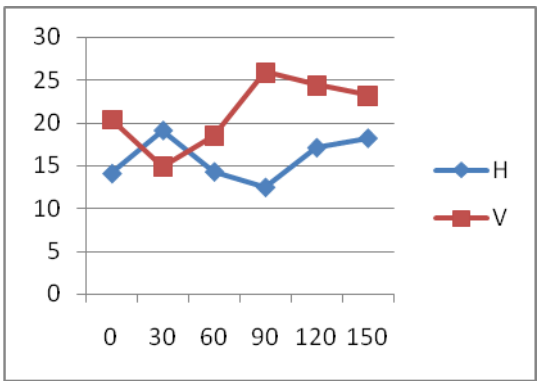
If the maintenance is carried out in time the catastrophic failure can be prevented, thereby increasing the machine availability and reducing maintenance cost. The present condition monitoring studies have demonstrated that vibration monitoring and analysis is very much helpful for diagnostic maintenance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

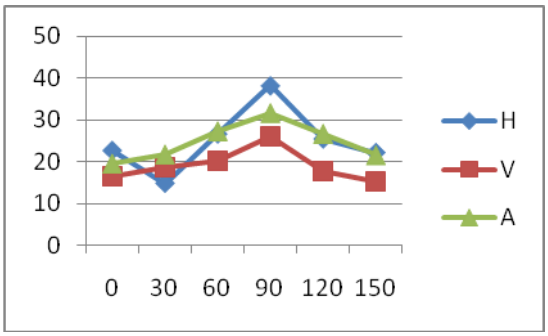
Graphs – Number of Days versus Velocity in mm/s



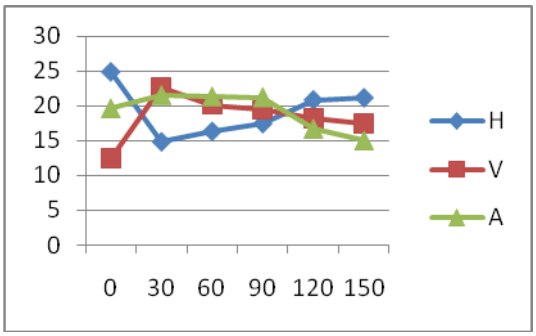
Graph 1 – Location 1



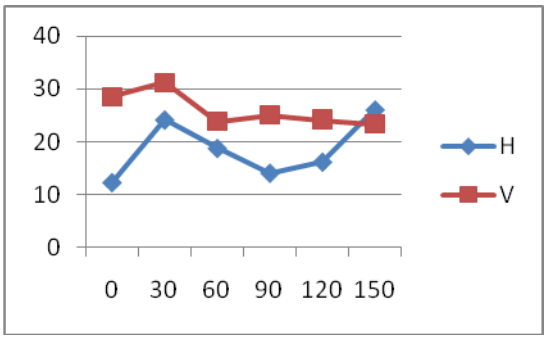
Graph 2 – Location 2



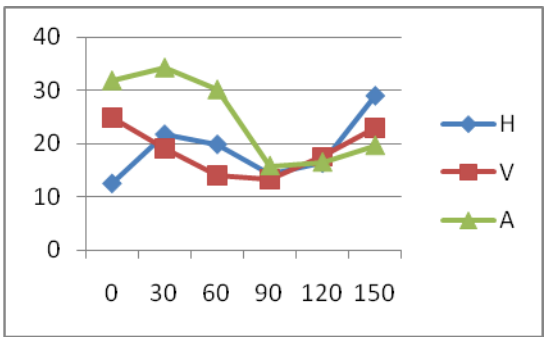
Graph 3 – Location 3



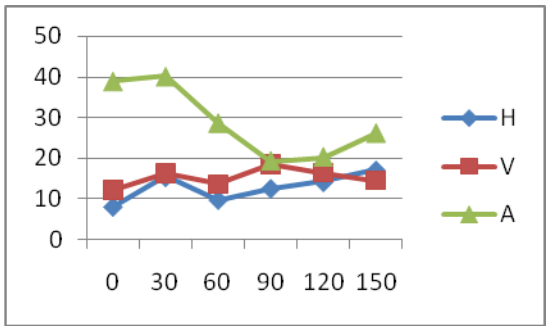
Graph 4 – Location 4



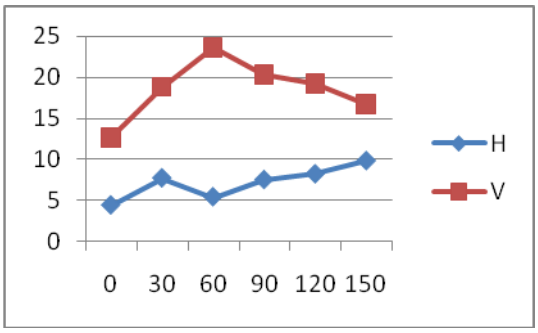
Graph 5 – Location 5



Graph 6 – Location 6



Graph 7 – Location 7



Graph 8 – Location 8

CONCLUSIONS

Condition Monitoring is a powerful diagnostic method to predict the performance of machinery under different conditions. Vibration parameter 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 which is a part of condition monitoring has been successfully performed with a practical approach on Dump Mill of a Banbury Machine. In this faults has been indemnified and analysis have confirmed to the actual fault present in the equipment. Vibration level 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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