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Intelligent Maintenance Management System A Predictive Maintenance Tool

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Abstract:

Monitoring and predicting machine components' faults play an important role in maintenance actions. Developing an intelligent system is a good way to overcome the problems of maintenance management. In fact, several methods of fault diagnostics have been developed and applied effectively to identify the machine faults at an early stage using different quantities (Measures or Readings) such as current, voltage, speed, temperature, etc. The threat of failing processes is always present, so that it is necessary to install proper maintenance measures to control the development of failure and ensure the performance of the system throughout its service life. Typical machines include motors, pumps, fans, gear boxes, compressors, turbines, conveyors, rollers, engines, and machine tools that have rotational elements. The rotating elements of these machines generate vibrations at specific frequencies that identify the rotating elements. The amplitude of the vibration indicates the performance or quality of machine. An increase in the vibration amplitude is a direct result of failing rotational elements such as bearings or gears. Considering the above figure in our mind we had introduced Intelligent Maintenance Management System (IMMS) which will predict well in advance when machinery will require the maintenance. So that everything can be planned in advance. In Advance if condition of machinery can be judged and can predict the life of a machine then this will become easy for the industry to plan the maintenance schedule. This system is condition based system. This will first monitor the condition of any machine then will tell the fault of that machine on the basis of the present condition. This is basically a vibration based technology which monitors the vibrations and then analyses those vibrations. This system uses a piezoelectric accelerometer to generate a signal related to machine condition and fault type. Those signals will then feed to Vibscanner and then Vibscanner read those signals and convert them in the form of a spectrum. Those spectrums are used to analyse the vibration amplitude.

Keywords— vibration; maintenance; condition monitoring, predictive maintenance

I. INTRODUCTION

Now a days Maintenance plays a major role in any Industry. This has become a backbone of any industry.

Prior to this; In the period of pre-World War II, people thought of maintenance as an added cost to the plant which did not increase the value of finished product. Therefore, the maintenance at that era was restricted to fixing the unit when it breaks because it was the cheapest alternative. That was called breakdown Maintenance. Basically breakdown maintenance is no maintenance at all. Equipment is simply allowed to operate until it fails or become inefficient to give the desired output. This type of Maintenance has given a lot of problems for the Industry. Like

1. Failure is most untimely. No one can judge when the equipment is going to be fail. At a certain process stops and effects the production which is the direct loss of any Industry.
2. Machines allowed to run to failure generally require more extensive repair than would have been necessary if the problem had been detected and corrected earlier. This is again the loss of money and time.
   Some studies shows that on an average it costs about three times more to repair a machine that has been allowed to run to total failure compared to the cost to repair the machine before failure.
3. Using this type of maintenance, the occurrence of a failure in a component can cause failures in other components in the same equipment, which leads to low production availability.

During and after World War II at the time when the advances of engineering and scientific technology developed, people developed other types of maintenance, which were much cheaper such as preventive maintenance. In addition, people in this era classified maintenance as a function of the production system. Preventive Maintenance (PM) is a set of activities that are performed on plant equipment, machinery, and systems before the occurrence of a failure in order to protect them and to prevent or eliminate any degradation in their operating conditions.

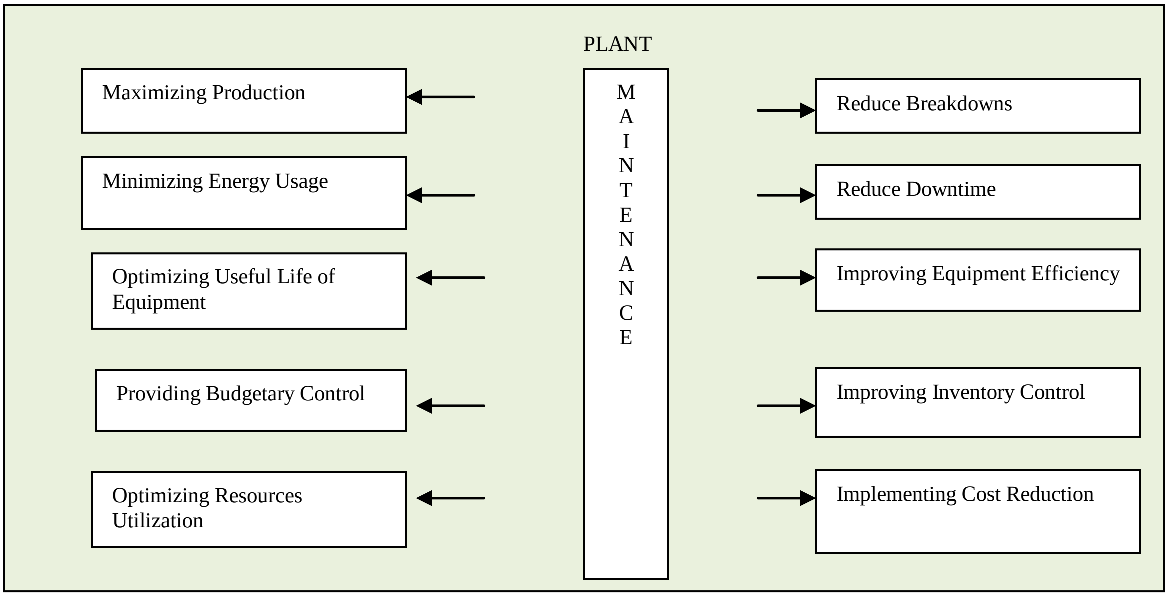
There are some factors which affects the efficiency of this type of maintenance:

1. The need for an adequate number of staff in the maintenance department in order to perform this type of maintenance.
2. The right choice of production equipment and machinery that is suitable for the working environment and that can tolerate the workload of this environment.
3. The required staff qualifications and skills, which can be gained through training.
4. The support and commitment from executive management to the PM programme.

5. The proper planning and scheduling of PM programme.
6. The ability to properly apply the PM programme.

Maintenance Objective

- 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.



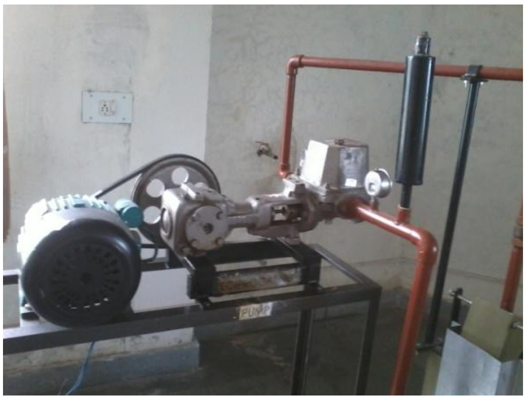
Maintenace Objective

II. LITERATURE REVIEW

Condition monitoring is essentially a screening process in which measurements and other data are compared to pre-established norms for the purpose of recognizing abnormal variations. A machine seldom breaks down without warning. The signs of impending breakdown are almost present long before the catastrophic failure. Vibration signals define the dynamic property of the machine including various faults of machine like bearing instability, unbalance, coupling misalignment, looseness, rubs, etc. Vibration characteristics also define early indication of defects on components such as rolling element bearing and gears. Complex systems like aircrafts, space shuttles, nuclear power stations, and some complicated process industries operate under high reliability and safety requirements due to the complicated technology involved and hazardous consequences to the larger community in case of failures. The maintenance regime of complex systems most often consists of a variety of maintenance strategies, like preventive maintenance, corrective maintenance, and condition-based maintenance and so on. It is well-known that vibration analysis is a powerful tool for the condition monitoring of machinery. This especially applies to rotating equipment such as pumps. Through the years a variety of vibration-based techniques have been developed and refined to cost-effectively monitor pump operation and the onset of failures. This paper is an overview of a variety of vibration-based condition monitoring techniques for pumps. In some instances these techniques are also applicable to improve the operation and efficiency of pumps. Specific aspects to consider when taking vibration measurements on pumps are for instance where to take readings, which type of probe to use, what frequency range should be used, what the settings on the analyser should be, etc.

III. SET UP

We had taken a problem of reciprocating pump which is producing vibrations. Pump is directly coupled with the motor by belt. Here the problem was to find out the component, which is creating problem and to rectify that problem. The reciprocating pump is a positive displacement type pump and consists of a piston working inside a cylinder. The cylinder has two valves, one allowing the water into the cylinder from the suction pipe and the other discharging water from the cylinder into the delivery pipe. Second thing we have the accelerometer, which is a measuring tool. Accelerometers are used to measure the motion and vibration of a structure that is exposed to dynamic loads. Dynamic loads originate from any source like from the vibration of motor or any engine, etc. The basic part of our vibration monitoring tool, it's an electromechanical device that measures acceleration forces, these might be static or dynamic forces caused by moving or vibrating objects. The accelerometer gives a voltage reading that corresponds to the level of vibration, the accelerometer



we are using has a 1000mV=g sensitivity which means that for every 1000mV change in the voltage reading there is a 1g(9:8m=s2) change in the acceleration of the object being sensed. Third is the VIBSCANNER. It is a multi-meter and data collector for the offline monitoring of machine conditions. With its comprehensive measurement and analysis functions and convenient joystick navigation, this handy instrument is ideal for daily measurement and inspection rounds. In conjunction with the OMNITREND PC software, it provides an important contribution in avoiding unplanned machine standstills and expensive loss of production within the framework of a foresighted maintenance program.

IV. DESIGN

In our engineering life we have to deal with a lot of machines and in those machines, a number of problems can exist. So this is not possible to adopt one maintenance procedure for all types of problems and all types of machines. Taking all these constraints into account, under IMMS we have a design a common procedure which can be applied on different machines where we have a rotary motion.

Procedure

1. *Collection the data*: This is the very first step of our design procedure. In this step firstly we have to record the initial data of the machine. As we consider a new machine will run smoothly and generate minimum vibrations. So taking that condition as ideal condition we can fix our benchmark as the machine in good condition.
2. *Analyze the Data*: After collecting the data, then the next step is to analyze the data. We will get the data in the form of spectrum. Following the sample of spectrum:

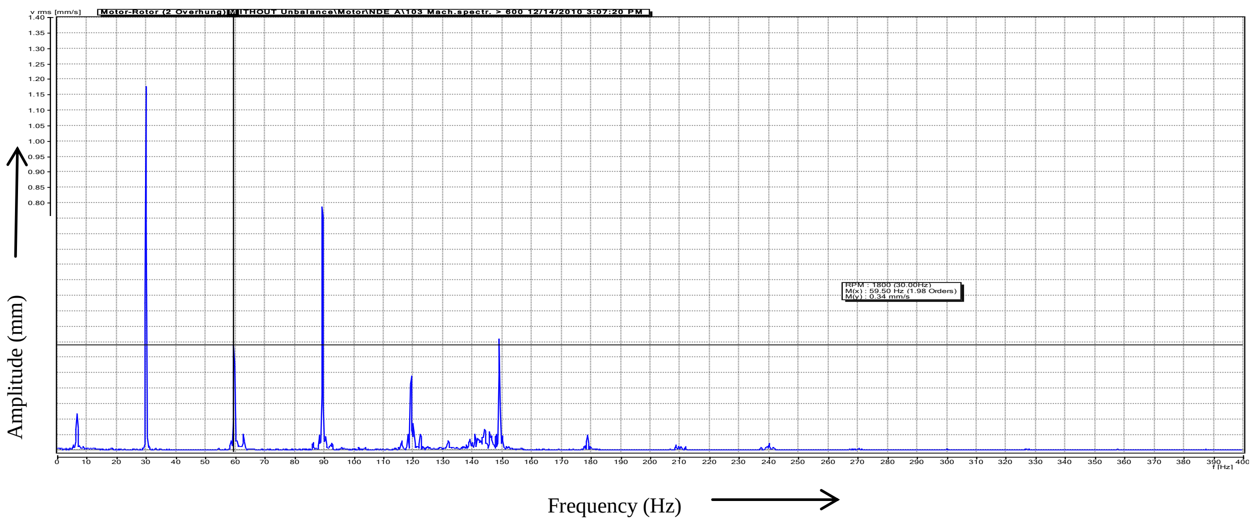


Fig. Sample of spectrum

i. *Analysis based upon frequency:* Here we have some peaks and valleys in the spectrum. We have to find out the peaks and the frequency (against which peaks is formed). That peak will show the amplitude of vibrations and that particular frequency will show the defective part of machine.

Procedure:

a) Find out the maximum amplitude made on spectrum.

b) Check the frequency against which that amplitude has been noted down.
c) Now analyze with whose frequency, that measured frequency is matching. That will be the defective part.

ii. *Analysis based upon amplitude:* also here we can find out the defective part with the help of amplitude. In this case we have to collect the amplitudes of different parts and relate that amplitude with each other. Whose amplitude will be maximum; defective will be that part.

3. *Modifications:* then according to the frequency and amplitude noted we have to do the necessary modifications in the machine parts.
4. Then again after modifications check the amplitude and frequency of that part, whether vibrations have been decreased or not.

V. Observation

Here we had observed this setup under three different conditions

1. Original condition
2. After first modification
3. After second modification

We had first analysed this setup under the condition as it is. Then we had made modifications according to the requirements. In every set up four readings has been taken by mounting the accelerometer in four different positions. Those are; vertical and axial positions of pump and motor.

In the original position we get the following data

Equipment	Direction	Amplitude during original position
Pump	Axial	7.6 mm
	Vertical	5.5 mm
Motor	Axial	6.5 mm
	Vertical	6 mm

Then from the above data and analysis of spectrums we come to the result that there is a defect of unbalancing of pump. So then we had changed the pulley of pump for the balancing purposes. This way we had balanced the pump.
After balancing of pump we had again run the equipment for some time and again revised the procedure, then we get the following data:

Equipment	Direction	Amplitude during original position	Amplitude after balancing (first modification)
Pump	Axial	7.6 mm	6.1mm
	Vertical	5.5 mm	4.5 mm
Motor	Axial	6.5 mm	4.25 mm
	Vertical	6 mm	3.2 mm

Then again we had analysed the data and come to the result that now the problem is looseness of some parts. So in the third modification we had tightened the loose parts.

Now After tightening the loose parts, again we had run the equipment for some time and recorded the following data:

Equipment	Direction	Amplitude during original position	Amplitude after balancing (first modification)	Amplitude after tightening (second modification)
Pump	Axial	7.6 mm	6.1mm	2.7 mm
	Vertical	5.5 mm	4.5 mm	1.65 mm
Motor	Axial	6.5 mm	4.25 mm	1.5 mm
	Vertical	6 mm	3.2 mm	0.074 mm

VI. Result

After every recording we had noted down the result of the observations. After recording the original position; we had collected all the spectrums from the readings. In the analysis part, we have to find out the maximum peak of the amplitude and the frequency against which that amplitude has been drawn on the spectrum. We also have the frequencies of different rotating parts. Then we will match the recorded frequency with the frequencies of equipment's. With which frequency it will matched that will be the defected part of the equipment and we have to work upon that part.

Same way while recording the original position we got that the frequency was matching the frequency of pump and the magnitude was 1X; the fault is unbalancing. Because we know when the recorded frequency will be 1X then the fault will be unbalancing.

Then after the balancing of pump again we had analysed the equipment. That was the second modification. After the second modification again when we had recorded the position; then we got that frequency was matching with the equipment. Then we got that the defect is loosing of the part because the magnitude was 10X. Then we had tightened the parts. After tightening again it was analysed. In every modification it was noted that the there is a decrease of amplitude of vibration. Means vibrations are reducing; this also has been shown in the above table.

VII. CONCLUSION

This is very much important to run the machine smoothly and properly. In these days this is the prime need of every industry. In every industry to run the machines smoothly is the challenging task for the workers. High production always remains the challenge for the industry and a lot of things has been done for the better production. Machines here are not allowed to stop or for rest. Even breakdown is always avoided.

Here with the help of Intelligent Maintenance Management System (IMMS), we can easily find out the defects in the machine without stopping them. Because maintenance on the cost of production will never accepted by the industry. So this will never allowed maintaining the machine after stopping them. IMMS helps us to find out the defects in the machine without stopping them and production will never suffer in this way.

The reason for the frequent increase in vibration was found mainly the unbalancing and looseness of equipment. When we had balanced the equipment we had noted a decrease in amplitude, then after second modification we had further noted the decrease in amplitude.

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