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159. Implementation of Condition Based Maintenance at Al-Noor Medium Density Fiber (MDF) Board Company

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Abstract

This Study is mainly focused on the implementation of condition based maintenance (CBM) on critical rotating machines, in Al-Noor MDF. The major rotary machines in Al-Noor MDF are identified to forced draft fans induced draft fans that transport flue gasses and fiber. Condition monitoring equal to the health monitoring, like taking blood pressure, monitoring the signal from heart, and testing blood, we can perform test of machines to determine their health. When a machine fails or break down the consequences can range from annoyance to financial disaster or personal injury and possible loss of life. For this reason early detection, identification and correction of machinery problem are paramount to anyone involved in the maintenance of industrial machinery to insure continuous, safe and productive functioning.We have focused on estimating the savings from reducing the defects in rotary machines and finding the potential of energy savings from the proper functioning of machines. For these objectives of vibration of sensitive rotary machine was measured using vibration analyszer (Detector-3). Data analysis is done on the basis of spectral plot, amplitude against frequencies with the help of detector 3. A comparison of vibration reading was carried out with the experimental actions under the vibration severity standards. The defective machines were rectified using proper equipment and the results before and after rectification were compared. The cost of implementation of CBM was estimated to be PKR 1.2 million. Finally, net saving per year was calculated to be PKR. 5 million and a comparison between the savings and cost of implementation showed that payback period is three months.

1. Introduction

We can make an analogy between human health and machinery health in order to help explain the concepts. Doctors use different methods to determine the condition of human body: temperature, blood pressure, heart pulse rate, even fluid samples.

For plant equipment, the process is similar. During machine running changes in vibration, temperature, lubricants and motor current then machine tell us own condition. So processes are checked…temperature, pressure, fluid, flow, speed, motor current, lubrication analysis and vibration analysis, and more. When the information is gathered, a clear, picture can be built of the machines condition.

Rotating machinery is lot like the human body. And they way many maintenance departments deal with machinery is akin to the way many people deal with their own health.
Some people lead life, drinking, smoking, and working hard. These activities are not good for their body. They ignore the vital signs, and eventually the body gives out. They just have to hope that the fault is repairable. This is akin to break down maintenance.

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Then there are people who like wise may not take good care of themselves, but they will take a few vitamins now and again, and occasionally visit a health farm or fitness center to try and make up for all the wrongs. They periodically try to do the right things, but they will still get sick from time to time. This is akin to preventive maintenance.
Next we have the people who still don't take great care of themselves, but they do regularly go to the doctor. The doctor takes their blood pressure, a few samples of bodily fluids, and listens to their heart. The doctor tires to detect if there are any problems, to determine the person's conditions, and then administers the required drugs or other remedies before the person get to sick. Occasionally a person will allow himself or herself to get sick, but they are going to against their doctor warnings. This is akin to predictive maintenance.

Correction Maintenance or Breakdown Maintenance, to occur suddenly failures, other words runs to failures after face unscheduled maintenance. Preventive maintenance is scheduled maintenance, equipments are repaired before failure occurs& other is a condition based maintenance Or predictive maintenance, CBM is not traditional maintenance that advance maintenance technology reduce the number of unexpected failures. Condition based maintenance huge potential in the industries. Now days CBM is very important role play in industries. Condition monitoring early inform to condition of machines and to identify the need for preventive maintenance, with the help of CBM we extend machine life, reduce unnecessary maintenance, aggressively manage the health of the machines. (R.keith Mobley-2002) Total operating cost of all production plants, one of the big costs of maintenance cost. In generally specific maintenance cost 15% to 60% of the cost good produced. Food industries the average maintenance cost 15% of the cost of good produced and heavy industries the average maintenance cost 60% of the cost of good produced.

Machinery condition life, reliability and accuracy are key factors in any industrial process supporting successful economical plans and outcome. Every day we hear about a new idea or technique contributing to the objective of a successful machinery operation with minimum production lost.

1.1. Problem Statement

I carried out our project at Al-noor MDF (Medium density fiber). I have focused on critical Induced draft fans and Forced draft fans that transport flue gasses. These accessories are having bearings as their major component, these bearings and belts are needed to be replaced frequently. These bearing can fail due to high vibration suddenly that's why there is necessity of vibration analysis so that further damaged can be prevented. Fans during operation consume more energy due to high vibration. We did this analysis using FFT (Fast Fourier Transformation) analysis because it is more accurate and fast method of vibration analysis.

1.2. Objectives

This Research work is exclusively designed by considering predictive maintenance or commonly known as a condition based maintenance in manufacturing industry. This study has adopted the reliable pattern of research which is consisting of site visit, interview and questioners.

Main objectives given below:

- To Study Condition based maintenance/ monitoring technique for determining defects in major rotary machines in Al-Noor MDF (Medium density fiber).
- To evaluate the cost of defective rotary machines in Al-Noor MDF.
- To estimate of possible energy saving from defective rotary machines

1.3. Scope of Studies

Condition based maintenance is most popular and modern maintenance technique. Often the terms "Condition Monitoring" and "Predictive maintenance" are used interchangeably. In reality, they do not mean the same thing. "Condition Monitoring" is the take steps of determining the condition of a machine. We are going out of our way to make this distinction because so many facilities have adopted condition monitoring technologies but have failed to rewrite their preventive maintenance action to take account of the new

technology. One person collects and analyzes vibration data but someone else replaces the bearings because the preventive action came up on the calendar and told them to do so or in other case the analyst knows a critical machine is on the verge of failure, but a large production run is scheduled with no planned outage because the people scheduling the production do not know about the condition of the critical machine. There is no reporting infrastructure in place. Rotating machines tells us about their mechanical condition in a variety of ways, and in most cases, machines will develop problems and wear gradually and give us plenty of warning before they finally fail. How do they tell us what is wrong with them? They get hot, they vibrate, they make noise, they shed particles into their lube oil, the put out high frequency sounds and they have difference responses to electrical currents going through them. Fortunately, there are technologies available that can objectively measures all of these quantities in order to help us diagnose the mechanical condition of our machines. Condition based maintenance is the used by industry to actively manage the health a condition of assets

2. Condition Monitoring of Forced Draft Fan using Vibration Analysis

Dileep et al (2013), In their research they have forced on monitoring of forced draft fan vibration based maintenance. It was noticed that forced draft fan drive end side bearing giving vibration because of long time after few days' vibration was increased and bearing was a failure. After analysis they saw the main shaft of the fan was banded due to bearing failure. It shows that a replacement of bearing would have taken a stoppage of fan but the replacement of the shaft will take a shutdown of the unit. This factor may be rectified during condition monitoring of the forced draft fan.

2.1. Vibration Analysis of Boiler Feed Pump

Babu and Das-2013, In their research they did an implement on condition based maintenance in the thermal plant. They used a very common technique called vibration spectrum to find out the vibration values and the nature of the problem in the boiler feed pump. They feed water pump analyze and diagnose problem is impeller vanes are unbalance and they found more values than the normal values. After modification would able to get required values and also a considerable saving in personal resources. This study concluded that the reason for the frequent increase vibration may cause due to the looseness of foundation bolts, looseness of pump of impeller casing, Unbalance and design faults These problems found with the help of vibration spectrum analysis after rectification the readings were found to be feasible to ISO standard failure and unaccepted breakdown.

3. Machine Faults Signature Analysis

Jayaswal et at (2008), Has worked with vibration analysis on machine fault signature analysis. Many type of fault may be diagnosed through vibration signature analysis. In this modern era May techniques are included in condition monitoring on of the most useful and informative is the vibration analysis of rolling machines. Through vibration analysis all the faults of rotating machine can be arise or already arisen may also be simply diagnosed. Therefore it is a considered as the powerful tool of vibration monitoring analysis. The word signature defines the signal patterns and characterizes the state or condition of the subject which has been analyzed. Signatures are mostly used to find out the faults of mechanical system. After the deep study on machine fault signature analysis it describes the following points.

To avoid the potential failure of machineries the smooth and safe operations are required and to avoid the disastrous failure of machineries property maintenance should be done. Condition based maintenance is the best technique to prevent the futuristic failure of rotating machineries and the vibration signature analysis is most suitable technique to diagnose the different faults.

Rolling contact bearing is needed the more attention towards signature analysis among all machine components. Bearing fault signature has a lot of scope through vibration data for multiple points or generalized faults.

4. Methodology:

This Research work is exclusively designed by considering predictive maintenance or commonly known as condition based maintenance in Al-Noor MDF . This study has adopted the reliable pattern of research which is consisting of site visits, interviews and questionnaire Al Noor MDF is selected to collect the data. Those rotary machines are selected which have high vibration. Intensity of vibration is identified using vibration analyzer (detector -3). Data of defects and the losses in production are collected. Identified defects are analyzed in terms of energy losses. Cost of defects is collected from maintenance department. Total loss (number and time of Defect+ Production loss + Energy loss) due to defects in machines is estimated. The cost of implementation of CBM technique is estimated.

Possible savings using CBM technique are estimated through possible reduction in the number and time of defects, and energy losses**.**

5.1. Results And Discussion

This section consists of nine critical fans as given below:

- Mat trim saw fan
- Fiber relay fan
- Fiber supply fan
- Mat reject fan
- Main vacuum fan
- Scalper exhaust fan
- Scalper vacuum fan
- Impulse air fan
- Dryer fan
- Induced draft fan

Only five machines have been selected for vibration analysis; data collected before defects and after defects with the assistance of maintenance department. Further analysis and estimate the energy losses in terms of kWh and rupees are given below.

5.2 Mat Trim Saw Fan Vibration Measurment

The data collected for values of motor drive end side & fan drive end side vibration due to fan unbalance & misalingment is given below.

Table 5.1: Data collected before rectification

S/No	Location	Reading in Velocity (mm)		
		Vertical	Horizontal	Axial
1	Motor non drive end side	2.794	1.173	
2	Motor Drive End Side	3.595	4.709	8.421
3	Fan Drive end side	8.071	10.34	5.305
4	Fan non drive end side	2.524	7.789	

The following table shows the data of vibration after performing dynamic balancing

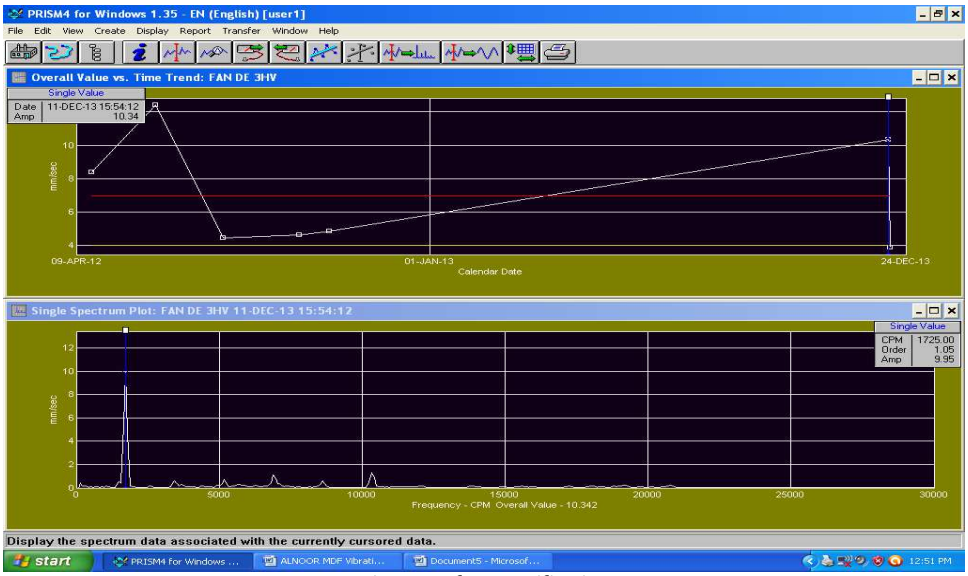

Fig: 5.1 Before Rectification

Fan drive end side at horizontal velocity figure show overall value and single spectrum plot before rectification.

Table 5.2: Data collected after rectification

	Location	Reading in Velocity (mm)		
		Vertical	Horizontal	Axial
1	Motor non drive end side	2.196	1.14	
2	Motor Drive End Side	3.6	1.975	7.08
3	Fan Drive end side	4.1	3.8	4.3
4	Fan non drive end side	1.5	2.7	

After rectification reduced vibration level

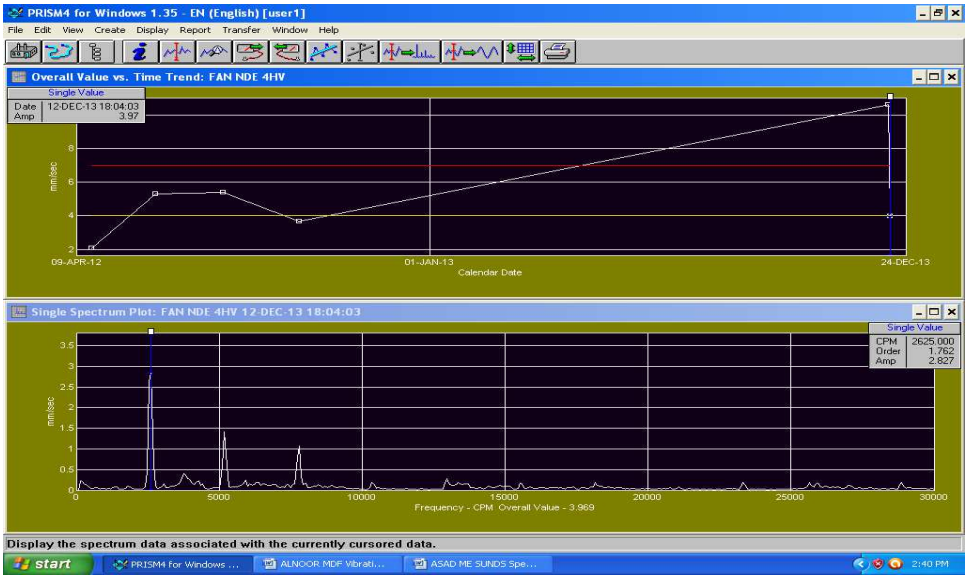

Fig: 5.2 After Rectification

Fan drive end side at horizontal velocity figure show overall value and single spectrum plot after rectification

Following equation is used to calculate energy and power consumption before rectification. (Here I= 90 amperage)

$$P = 1.732*V*I*\text{Power factor} \quad (1)$$

$$P = 1.732*400*90*0.9$$

$$P = 56.1168\text{kW}$$

$$E = P*t \quad (2)$$

$$E = 56.1168*7860\text{hr/year}$$

$$E = 491583.168\text{kWh/year}$$

The Price of energy consumes/ year is calculated at the rate of Rs20/ unit, (Rs20/- unit estimate figure taken from Al-Noor MDF) Rs9,832,000/-.

Following equation is used to calculate energy and power consumption after rectification the value for I is used as 87.5 amperage

$$P=1.732*V*I*P.F$$

$$P=1.732*400*87.5*0.9$$

$$P=54.558\text{kW}$$

$$E=P*t$$

$$E=54.558*7860\text{hr/year}$$

$$E=477928.08\text{kWh/year}$$

The Price of energy consumes/ year is calculated at the rate of Rs 20 / unit= Rs.9558561.6

Table 5.3: Power and energy consumption

Parameter	Before Rectification	After Rectification
Power (kW)	56.1168	54.558
Energy (kWh)	491583168	477928.08
Cost of electricity in Rs.	9800000	9600000

Savings per year Rs. 200000
Simultaneously we analyzed other fans and to calculated before and after rectification

5.3. Energy Cost Saving For One Year

Mat Trim Saw Fan+ Main Vacuum Fan+ Impulse air fan+ Met Reject Fan
200000+200000+200000+200000
Total energy cost saving per year= Rs. 8000000

5.4 Net Cost Of Energy Saving For One Year

Net cost of energy saving= energy cost saving –outsource cost
Outsourcing service cost for vibration analysis of work done during schedule shutdowns they were charged fifty thousand rupees
Net cost of energy saving= 700000-50000
Net cost of Energy Saving= Rs. 700000

Table 5.4: vibration analysis result before rectification and after rectification

S/No	Equipment Name	Fan condition before Rectification	Fan condition after rectification	Remarks
1	Mat trim saw fan	Danger	Normal	No action required
2	Man Vacuum fan	Danger	Normal	No action required
3	Met Reject fan	Danger	Normal	No action required
4	Impulse air fan	Alert	Normal	No action required

5.5 Total Downtime For One Year

Table 5.5: selected critical fans to collected all fans down time

Date	Duration	Nature of Problem
16-May-2013	25mint	Mat trim saw fan belt worn out
17-May-2013	04:30mint	Induced Draft fan High vibration due to unbalance
03-July	30mint	Sclaper vacuum fan Belt worn out
Nov-2013	40mint	Sclaper exhaust fan Belt worn out due to misalignment
10-Oct-2013	2:00mint	Dry fan connection box heat up due to high vibration
13-0ct-2013	9:30mint	Dry fan motor burn out due to high vibration
Jan-2014	3:30mint	Dry fan high vibration due to unbalance
03-feb-2014	30mint	Sclaper exhaust fan belt worn out
26-feb-2014	3:00mint	Fiber relay fan shaft worn out
	24:35mint	

5.5.1. Average of annual production cost lost due to unscheduled down time

One press = 06 minutes
One press = 12 board
One hour = 10 press
10 press* 12 board =120 board
120 board* 24:35 min = 2952 boards
Price of one board Rs.1700
In terms of Rs
2952 boards * 1700 = 5000000

Table 5.6: Downtime machine components failure cost Report from 01-04-2013 to 31-03-2014, (Below data is collected from maintenance department)

S/No	Machine Name	Nature of problem	Machine component failure	Cost of failure component in Rs.
1	Mat Trim Saw fan	Mat trim Saw fan belt worn out	Three belt failure	1800
2	Scalper exhaust fan	Scalper exhaust fan belt worn out	Three belt failure	1960
3	Dry fan	Dry fan motor burn out due to high vibration	Motor winding burn out	500000
4	Fiber relay fan	Fiber relay fan shaft worn out	One shaft two bearing	25414

The given below table show downtime machine components failure cost= Rs. 531274

5.5.2. Downtime labor cost for one year

Table 5.7: Man power and salaries categories

S/No.	Designation	Number 0f person	Per month salary each employ	Per hour salary in Rs.
1	Mechanical engineer	01	40000	166.66
2	Electrical Engineer	01	40000	166.66
3	Mechanics	02	25000	208.33
4	Electricians	02	25000	208.33
5	Fitter	01	16000	66.667
6	Helper	03	12000	150

Downtime labor cost= total salaries per hour* downtime hours
Downtime labor cost= 966.64 per hour*24.85
Downtime labor cost= Rs. 24021 Pak

5.5.3. Total cost savings from avoiding down time

Total cost savings per year= production lost cost + machine component cost + labor cost----- (3)
Put the all value in equation number three
Total cost savings per year (Rs.) = 5000000 + 500000 + 24021
Total cost savings per year (Rs) = 5500000 0r 5524021
They will equipment purchase from Hyder Ali and company equipment cost is Rs. 1220000, they will charge equipment training cost Rs. 25,000, so that training cost I will consider training cost per year equation is given below all values put in this equation
The cost occurred to avoid downtime per year= Labor cost per year+ equipment cost/ warranty year+ training cost per year
= 24021+ 1220000+ 25000
Cost occurred to avoid downtime / year =Rs.1200000
Net cost savings per year =5500000-1200000
Net Cost saving per year = Rs.4200000

5.5.4 Total net cost savings per year

Total net cost savings per year=Energy saving + other savings
= 700000+ 4200000
= Rs.4900000

5.5.5. Payback period

Vibration analyzer and belt pulley alignment tool
Brand Name = FAG
Instrument Name = FAG Detector III
Cost of ownership = Rs.1100000
Brand Name= FAG
Instrument Name= FAG top laser smarty 2
Cost of ownership= Rs. 120000
Payback period = first year total cost of ownership/ annual saving *12 month per year---------- 4
Payback period= 1220000/ 4900000*12
Payback period= 3 month

5.6 Conclusion

With this research work my design was to inform people about the importance of vibration measurements for maintenance helps. Vibration measurements identify individual machines faults and the root cause, determining the correct course of action to rectify the problem. Vibration analysis provides advance warning of developing issue so damage to machines and shutdown can be avoided. It allows you to acquire data about

the condition of the actual machine and prevent replacement of good components. A good vibration monitoring program can be providing substantial savings in consumed energy minimize spare parts used and lost production. Vibration measurement is the most integral test that will give the user and accurate idea of the machine s condition internally.

To achieve my first objective I have contemplated the condition based technique. In condition based technique I selected vibration analysis for my research study.

Further, I studied in detail basic vibration, vibration measuring criteria, importance of vibration, vibration analysis and how to read spectrum recognition.

To accomplish my second objective I calculated downtime, which include production lost cost, component failure cost and labor cost. The total cost incurred due to downtime was Rs. 4 millions

To achieve third objective potential energy cost savings were calculated. The net energy savings in terms of PKR were Rs. 0.8 million. This cost is added is cost due to downtime so total net saving per year becomes Rs. 5 million
In the end payback period was calculated as the ratio of first year total cost of ownership (tool) to annual savings
The payback period was calculated as 3 months

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