Centrifugal Pump Bearing Analysis With Amplitude Indicator Using Vibration Meter

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ABSTRACT

Centrifugal pumps In this company serve to distribute plant waste to wastewater treatment installations in order to reduce waste levels. One component of centrifugal pump on wastewater treatment plant to be aware of is bearing. The treatment has been used corrective maintenance which is when the machine is off or the appliance has a new damage done repair. Unavailability of preventive maintenance scheduling caused undetection of damage factor that occurred on the bearing while operating. The purpose of this research is to know how to identify bearing damage in order to improve the performance of centrifugal pumps and to determine the scheduling of maintenance - preventive. This testing method uses applied research. The result of this research is the identification of damage to the pump obtained the lowest reliability value of 74.2% and the Amplitudo value of 1.91 m/s2. Where the minimum reliability limit is 80% and the maximum amplitude limit is 1.8 m/s2. Bearing conditions indicate damage. The action is derived from the sound of the bearing and vibration testing using vibration meter. So the scheduling of maintenance preventive can be done from daily, weekly, monthly and yearly according to the results of the research.

Keywords: *Bearing, Reliability, Amplitude, Preventive Maintenance*

1. INTRODUCTION

In the present day, in the world of industry does not escape with its name maintenance on the machine. Maintenance is an activity to maintain and maintain a machine in order not to suffer damage, actions carried out including adjustment, lubrication, checking and replacement of the engine spare parts. In the maintenance there are two types namely Planned Maintenance and Unplanned Maintenance. In Planned Maintenance, there are 3 forms of Predictive Maintenance (PdM), Preventive Maintenance (PM), and Corrective Maintenance (CM).

Predictive Maintenance (PdM) is a work done after planning based on machine condition and not solely because it has been scheduled. Preventive Maintenance (PM) is a maintenance activity to prevent the occurrence of unexpected damage and find conditions that can cause the machine to suffer damage at the time of production process. Corrective Maintenance (CM) is a work done to improve and improve the condition of the machine so as to achieve the recommended standards.

With the maintenance, many benefits obtained by the company such as can guarantee operational readiness when it will be used, can extend the performance or the age of the machine, and ensure the optimum availability of equipment be installed for production and to gain maximum profit.

PT. X is a company that handles the management of industrial areas and plant waste water treatment using centrifugal pumps. Where this centrifugal pump is useful to distribute plant waste to wastewater treatment installations to be processed so that the waste rate is reduced and will eventually be streamed to Sungai Tambak Oso.

Centrifugal pumps are a useful pump for the transfer of liquids by utilizing centrifugal force produced by the impeller. This pump serves to remove fluids from low place to higher or from low pressure to higher pressure.

During this time the company only use corrective maintenance system that is when the machine is off or the tool is experiencing new damage done repairs so that it can interfere with the production process that affect the increase in costs down time in the process Ongoing improvements. For maintenance treatment This time it takes to improve i.e. between 2 to 4 days.

When there is damage to one component of centrifugal pumps, it may result in the shutdown of the entire system thereby stopping the production process. This will cause losses to companies that are employee costs, component prices, and production failure losses. Therefore, the appropriate maintenance interval is required. If the component replacement time interval is too long then the machine will stop operating and result in substantial losses. However if the change time interval is short then, the cost of replacement becomes high.

Therefore, it is necessary to keep the preventive maintenance useful to minimize the possibility of dropping the machine and extending the machine lifetime. In this process can be said to consume a lot of high starting cost. But these costs are covered with break-even estimates. This estimate calculates the amount of time or hours of work that must be fulfilled by the equipment to cover the initial costs.

One component of centrifugal pump to be considered in preventive maintenance is bearing, because bearing is a very supportive component in the performance of input and output capacity of centrifugal pump. In this industry bearing maintenance is very poorly noticed and does not take into account how long the bearing power will last.

Through this research will be sought to plan the analysis of bearings on centrifugal pumps using the planned preventive maintenance program at the Waste Water treatment plant in PT. X can serve to improve the performance of inputs and Pump capacity output, knowing how long the bearing will work and easing its maintenance process.

Problem formulation

The problem of problems that can be taken from the limitation of the above is:

- How do I identify the pump damage factor especially on Bearing components to improve and maximize the performance of the input and output centrifugal pumps?
- How does the preventive maintenance scheduling on the bearings in centrifugal pump components?

Research objectives

The objectives of this research are:

- To find out how to identify pump damage factors, especially in Bearing components, to improve and maximize the performance of the input and output of centrifugal pumps.
- To determine the preventive maintenance scheduling on the bearings in the centrifugal pump components.

1.1 Centrifugal Pump

According to Sidiq (2016) "A centrifugal pump is a pump to move liquids by utilizing the centrifugal force produced by the impeller."

1.2 Bearing

A bearing is a machine element that is loaded with a shaft, so the rotation or motion of the bilks can work safely. Bearings also allow the shaft to be able to spin smoothly and remain in place, so that friction losses will also be small.

If the bearing does not work properly, then the entire system work process will decline or may not work properly. Thus, if likened to the building, the bearings in the machining can be likened to the foundations of a building.

1.3 Preventive Maintenance

According to Stephen (2004) "Preventive Maintenance is a maintenance activity undertaken to prevent unexpected damage and find conditions that can cause the machine to malfunction at the time of the production process."

Preventive maintenance is very important because its usefulness is very effective in dealing with machine components that belong to the critical unit, so maintenance tasks can be done with an intensive planning for the Unit The production plan can be achieved with greater number of production results in a relatively short time.

1.4 Reliability

According to Ebelling (1997) "Reliability is a probability whereby when an operation is in a certain environmental condition, the system will demonstrate its capabilities according to the expected function at a certain time interval."

Reliability is expressed with the letter R.

If: $R = 1$; System can work well

$R = 0$; System can not work properly

Good R is generally in the range of 0.6 to 1. While R is said to not work well when it is in the range 0 to 0.6. However, in general companies the value of R used is 0.8 or reliability of 80% which suggests the system can work very well or be at a safe point.

1.5 Vibration Meter

Vibration Meter is a tool to measure the feasibility on the vibration of the machine while operating, using the unit m/s^2 or $inch/s^2$. And this tool will give you a vibration level display (either analog or digital). The results provide quick information that can be used to determine whether the overall vibration level is normal or not.

2. METHOD

2.1 Types of research

This research uses applied research.

2.2 Place and Time research

The research was held at PT. X in the Waste Water Treatment Installation section in January 2019.

2.3 Research Object

The object of the study is to be able to identify damage factors and to conduct maintenance preventive planning on the bearings by calculating the value of reliability and testing the amplitude value.

2.4 Data Collection Techniques

- Field observation Data

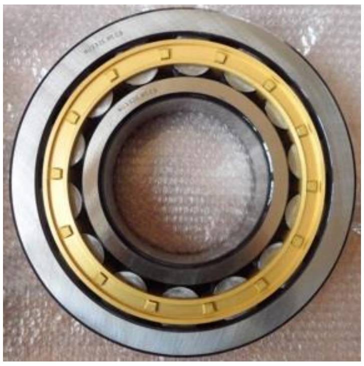

Figure 1. Single Row Cylindrical Bearing

Weight	: 0.9 kg
Inside Diameter (d)	: 45 mm
Outside Diameter (D)	: 100 mm
Width (B)	: 25 mm
Dynamic Load Rating (C)	: 112 kN
Static Load Rating (Co)	: 100 kN
Fatigue Load Rating	: 12.9 kN
Limiting Speed Rating	: 8500 rpm
Reference Speed Rating	: 7500 rpm

- Maintenance Implementation Data
- Amplitude Testing

Figure 2. Vibration Meter

2.5 Data Analysis Methods

The steps analyze the data as follows:

- Calculates bearing life.
- Measuring amplitude by using vibration meter.
- Counting reliability values on bearings.
- Result Data that has been done will be compared to each other to be known damage factor in the bearing.
- Further analyze the comparison results to determine the damage factor of the bearing.
- Plan maintenance preventive so that the bearings can work optimally and minimize damage.
- Conclude the research results.

2.6 Data Analysis Techniques

- Bearing Age Calculation

This age bearing calculation will show how long it can operate and the age is using in hourly units.

Calculation for the bearing age as follows:

$$L_{10h} = \left(\frac{C}{P_0}\right)^b \cdot \frac{10^6}{n.60} \quad (1)$$

C = dynamic load

Po = equivalent load

n = Round Axle

b = 3 for ball bearing and 3.33 for roller bearing cylindrical

Where:

$$P_o = v \cdot x \cdot F_r + y \cdot F_a \quad (2)$$

Fr = radial Style

Fa = axial Force

- Reliability value Calculation

It is a value that can demonstrate how large a machine component can operate properly. Specifying a reliability value can be initiated as follows:

Calculating the failure rate:

$$MTBF = \frac{1}{\lambda} \quad (3)$$

Furthermore calculating time fails to function bearing:

Time fails to function (t)= MTBF)–(L_{10h}) (4)

Lastly, the calculation of reliability values are:

R(t) = 1/(1+ λ t) (5)

If you know the level of reliability can be done calculation of its failure probability value:

F (t) = 1 – R(t) (6)

The following is the range of values indicating the reliability of a machine component:

Table 1. Reliability Level Values

Great Value R (%)	Interpretation
0 – 20	Very Low
20 – 40	Low
40 – 60	A Little Low
60 – 80	Enough
80 – 100	High

- Amplitude

Here are the latest vibration bearing standards:

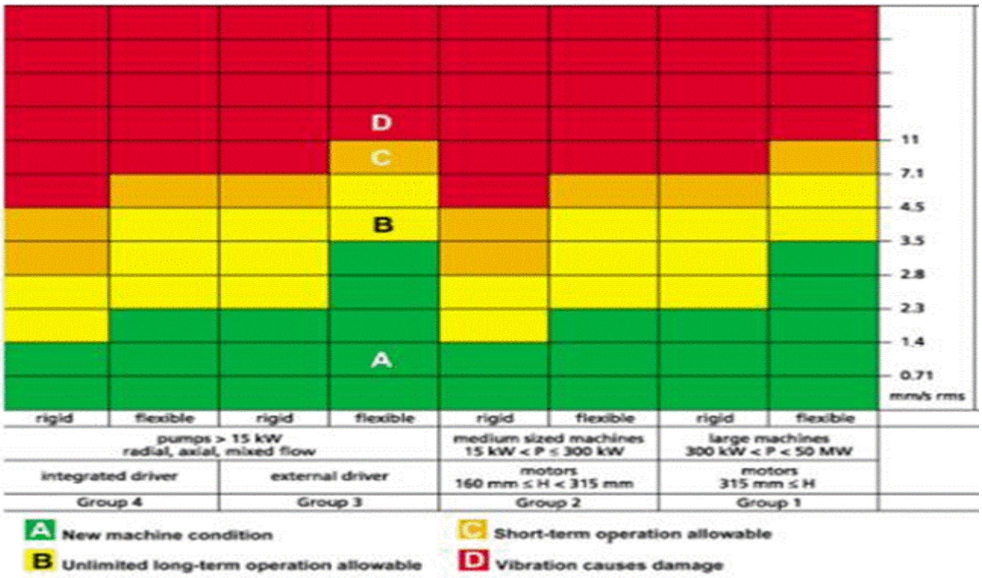

Figure 3. ISO 10816-3, Vibration Standard

3. RESULT AND DISCUSSION

3.1 Bearing Damage Analysis Results

After calculating the reliability and testing value of the bearing vibration. Next connect the two and analyze the damage factor.

It is noted that the best reliability limit is 80%-100%, if the resulting value is lower than that value then the reliability will be reduced and will cause rapid damage. As for the safe limit of amplitude is 0 m/s^2-1.8 m/s^2. If the value is more than the value then this indicates if the bearing is in a dangerous condition for rapid damage.

Here is the result:

- Bearing on the 1st pump

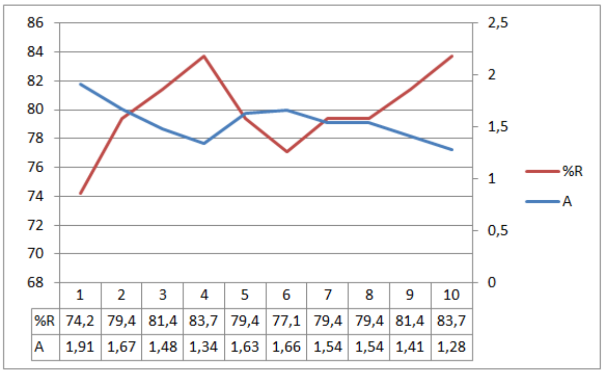

Figure 4. Graph of Reliability and amplitude relationship

Based on the results of the graph, it can be noted that the reliability or reliability of bearings obtained by the lowest value of 74.2% while the value of Amplitude 1.91 m/s^2, occurred in 1st observation. From the above graph explains when the reliability value is low it will cause the value of Amplitude increasingly so that the vibration that will be experienced by the bearing is higher and the bearing will be quickly eroded and wear.

Based on the chart is also known the reliability value or reliability bearing with a high value of 83.7% while the value of Amplitude 1.28 m/s^2, occurs in the 10th observation. From the above graph explains when the reliability value is high it will cause the value of amplitude smaller so that the vibration will be experienced by the bearing in the safe sphere and the bearing will not quickly eroded and long for the occurrence Wear.

- Bearing on the 2nd pump

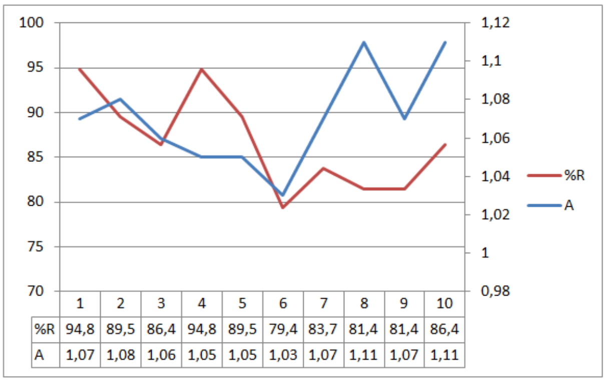

Figure 5. Graph of Reliability and amplitude relationship

Based on the results of the graph, it can be noted that the reliability or reliability of the bearing is the lowest value of 79.4% while the Amplitude value of 1.03 m/s^2 occurs in the 6th observation. While the reliability or reliability value of the bearing with a high value of 94.8% while the value of Amplitude 1.05 m/s^2, occurs in the 5th observation. From the chart above explains that the resulting average is very good because the reliability value is mostly above the recommended limit is 80% and the amplitude value is at the safe limit under 1.8 m/s^2. This results in the occurrence of damage such as rapid eroded and the duration for very small wear.

- Bearing at 3rd pump

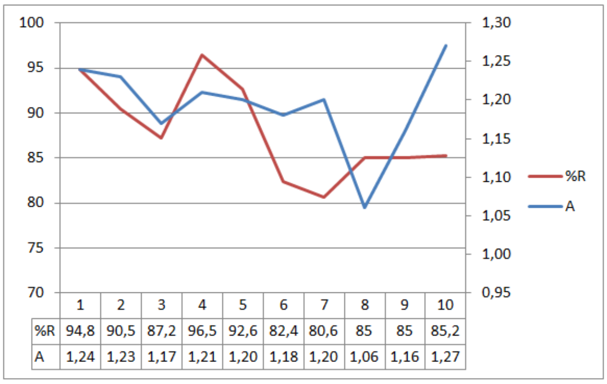

Figure 6. Graph of Reliability and amplitude relationship

Based on the results of the graph, it can be noted that the reliability or reliability of bearings obtained by the lowest value of 80.6% while the value of Amplitude 1.20 m/s^2, occurred in the 7th observation. While the reliability or reliability value of the bearing with a high value of 96.5% while the value of Amplitude 1.21 m/s^2, occurred in the 4th observation. From the chart above explains that the resulting average is very good because the reliability value all above the recommended limit of 80% and the amplitude value is at the safe limit under 1.8 m/s^2. This results in the occurrence of damage such as rapid eroded and the duration for very small wear.

- Bearing on the 4th pump

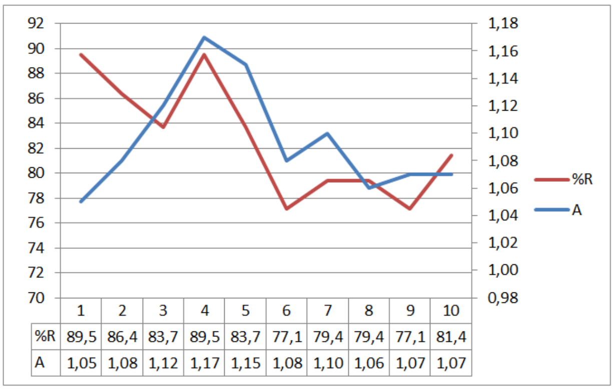

Figure 7. Graph of Reliability and amplitude relationship

Based on the results of the graph, it can be noted that the reliability or reliability of the bearing is the lowest value of 77.1% while the Amplitude value of 1.08 m/s^2 occurs in the 6th observation. While the reliability or reliability value of the bearing with a high value of 89.5% while the value of Amplitude 1.05 m/s^2, occurs in 1st observation. From the chart above explains that the resulting average is very good because the reliability value is mostly above the recommended limit is 80% and the amplitude value is at the safe limit under 1.8 m/s^2. This results in the occurrence of damage such as rapid eroded and the duration for very small wear.

3.2 Preventive Maintenance Analysis Results

Preventive Maintenance analysis is used to anticipate the rapid occurrence of damage that will be caused by the following bearing is the result:

Table 2. Design of maintenance activities

Daily	Weekly	Monthly	Yearly
- Air discharge Monitoring - Pump Performance Monitoring*	- Pump condition Monitoring	- Monitoring Bearing Conditions - Vibration check on bearings - Bearing Maintenance with lubrication-granting	- Monitoring Bearing Conditions - Vibration check on bearings - Bearing replacement

Description:

* Performance of the pump depends on the discharge of water, when the discharge of water is at the minimum limit or water there is a mixture of other chemicals such as foam then automatic pumps will be turned off useful to keep the pump from damage.

* * Monitoring is done such as checking the sound of the bearing on the pump.

This design emphasizes the maintenance of lubrication done every 1 month, monitors the bearing conditions by checking the performance sound and vibration bearing conditions as one indicator causes damage. To identify vibration on bearings should be done every 1 month using the vibration meter.

4. CONCLUSION

Based on the results of research and discussion, it is obtained that the identification of bearing damage to the 1st pump obtained the lowest reliability value of 74.2% will cause the value of Amplitude is greater than 1.91 m/s^2. Where the minimum limit of reliability is 80% and the maximum security limit of amplitude is 1.8 m/s^2, so the vibration that will be experienced by the bearing is higher and the bearing will be quickly eroded and wear. As for the 2nd to 4th pumps in good condition. Maintenance is carried out from daily, weekly, Monthly and Yearly. As well, there are checking condition of bearing conditions in the form of sound checking, oil lubrication and vibration testing using vibration meter. It should be done every month in order to minimize the occurrence of faster damage to the bearing.

RECOMMENDATION

Based on the results of research and discussion, the following advice is obtained:

- The result of calculation until determination of bearing age can be used as one consideration in the policy of determining bearing maintenance.
- The research process is only done within a month, therefore it is recommended that similar research to conduct research in a minimum of 3 months.
- Design preventive maintenance for other pump components can be done such as maintenance on this research.
- Can be continued with the research of temperature testing and cavitation corrosion test to determine the cause of bearing damage for more granular results.

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