Condenser Damage Analysis using FTA And FMEA Methods at PLTU Nagan Raya

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ABSTRACT

Based on observations made at the Nagan Raya power plant. The problem found in the condenser is damaged or blockaged in the condenser pipe which can interfere with the condensate water production process and the water used is seawater as a coolant to condense steam and then become condensate water after hammering the cooling process. Damage that occurs in the dominating scope of work occurs in a leaky or clogged condenser pipe. In this study, it used the FMEA method to find out the highest RPN value and the highest value determines the critical level of a component. Furthermore, the use of the FTA method is to analyze the causes of failures that have the potential to cause damage to the machine or tool. Based on the 5w + 1h table is what (what is the repair strategy), why (why should be repaired), who (who did), where (where is the place of damage), when (when the repair was made), how (how the repair was carried out). The conclusion of data processing on the FMEA method was found to be the highest RPN value in leakage or clogging of condenser pipes by 150 and the lowest value of the lowest RPN in life time of 8. Meanwhile, the FTA method that has the potential to experience damage or the root of condenser damage is that there is sand in the cooling water and ball cleaning work that is not optimal and then results in clogging of the condenser pipe or can cause leaks in the condenser pipe. The purpose of this study is to identify the damage that occurs to the condenser to keep the level of damage or failure of condenser production from continuing. The final results of this study are expected to present the level of risk of condenser stability with the causative factors of each component of the failure.

Keywords: Fault Tree Analysis, Failure Mode Effect Analysis, Kondensor, PLTU

I. Introduction

Pt. PLN (Persero) UPK (Generation Implementation Unit) Nagan Raya is a company engaged in steam power plants (PLTU). Pt. PLN (Persero) UPK (Generation Implementation Unit) Nagan Raya began operating in 2013 and is still operating today. Power on PT. PLN (Persero) UPK (Generation Implementation Unit) Nagan Raya, which is 2 X 110 MW [1]. PLTU has several tools, one of which is a condenser, which is a type of heat exchanger that functions to condense steam fluid. On the steam energy system or rather at the power plant. Using seawater as its coolant [2].

In the condenser, there are 3 operation activities, namely first flowing seawater, secondly water taken from the sea is filtered using a debris filter and then to the ball filter, the three waters that have been filtered are used to cool the remaining steam from the turbine [3]. In the activities that have been mentioned, inspection and maintenance are carried out, to maintain or repair facilities and condenser components [4]. There is damage to the filtering which results in the
erosion of the condenser walls and pipes. As a result, there was a leak. After that, it is expected that condenser activities are in accordance with the conditions that have been established [5]. The problem that occurs when the condenser operates is that the ball cleaning work or taprok ball is not optimal, there is sediment or sand in the cooling water to the condenser, pipes and walls of the condenser which are scoured by the remaining sand from seawater which was previously through filter debris filtering. Because it can disrupt the production process and is likely to reduce seawater production. After maintenance management is carried out which aims to optimize condenser performance [6]. Furthermore, maintenance management is carried out The lower the condenser pressure which means that the higher the vacuum pressure of the condenser, the better the performance of the condenser, and so is the opposite [7].

According to research excerpts [8] who analyzes the discourse on risk management of drinking water compressor systems using the FMEA method, the causes of failures in the compressor system are caused by unstable electric current / short circuit, corrosion occurs in the primary tank of air storage, looseness of bolts in the primary tank, pressure regulation in the engine, damage in the Pressure Indicator, damage that occurs by several series of systems (Cooler Failure Cooling Fan Failure indicator oil line), and damage that occurs in several series of systems (Cooler Failure Cooling Fan Failure indicator oil pump). Meanwhile, according to research [9] with this method FMEA is expected to be able to find out the type of failure or the right maintenance activity actions and plan the right maintenance schedule on machine components [10]. Seeing that it is important for a unit or tool to improve maintenance based on the level of failure risk when operating using the failure mode and effect analysis (FMEA) and fault tree analysis (FTA) methods so that it can incur maintenance costs incurred by the company. According to [11] looking for causes of defects in materials that have been used for a long time (life time) in tubing materials using the FMEA (failure mode and effect analysis) method.

This study aims to identify damage that occurs when the condenser is operating to keep the level of damage or failure of condenser production from continuing. So the inspection and maintenance are carried out, in order to keep each component of the condenser can work optimally [12]. The methods used in the study were FMEA and FTA. The final results of this study are expected to present the level of risk of condenser failure with the causative factors of each component of the failure.

II. The Proposed Method

This research was conducted at PLTU Nagan raya. Its address is at Jalan raya Meulaboh-Tapak Tuan km 8.5 Suak Puntong Village (Nagan Raya), Meulaboh Aceh Province, Indonesia. And this research started in mid-January 2022 [13]. And there are also several stages in this study as follows:

To get things or materials, conduct a survey to the field or interview with the company.

1. The data used in this study are as follows:
   a. Data on the causes of condenser damage
   b. Data damage to condenser components

2. Data collection which is carried out by: Wawancara
   a. Document study
   b. Literature study

3. Data processing
   Using the FMEA and FTA methods where in the FMEA method is a way in which a part or a process that may fail to meet a specification, creates a defect or discrepancy and its impact on the customer if the failure mode is not prevented or corrected [14]. FMEA is a methodology used to analyze and find components that have the highest value and the highest value determines the level of criticality of a component [15]. Risk priority number (RPN) is the result of multiplication between:
   a. rating severity,
   b. detectibility
c. dan rating occurrence: \( \text{RPN} = (S) \times (D) \times (O) \)

Furthermore, the FTA method explains the analytical tool that determines the cause of a failure that has the potential to cause damage to the machine or tool. The FTA method is very effective in determining components that are prone to damage or failure to the machine or tool.

**Table 1. Symbols on the FTA method**

<table>
<thead>
<tr>
<th>Simbol</th>
<th>Arti</th>
<th>Simbol</th>
<th>Arti</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Basic Event" /></td>
<td>basic initiation errors that do not require further developers</td>
<td><img src="image" alt="The expected External Event" /></td>
<td>event appears</td>
</tr>
<tr>
<td><img src="image" alt="Conditioning Event" /></td>
<td>specify conditions that can be applied to various logic gates</td>
<td><img src="image" alt="Gate And" /></td>
<td>manual errors due to all input problems that occur</td>
</tr>
<tr>
<td><img src="image" alt="Undevelopment Event" /></td>
<td>Event that can no longer be developed because information is not available</td>
<td><img src="image" alt="Gateway OR" /></td>
<td>error appears as a result of one of the input problems that occurs</td>
</tr>
</tbody>
</table>

From the table above, there are symbols with an explanation of the FTA method where the symbol is used for the preparation of the FTA.

b. Analysis and discussion

At this stage, it is where to explain what components must be considered at the time of inspection and maintenance if it is at a predetermined time for the tool to function properly.

c. conclusions and suggestions

The result of the conclusion is that the discussion is related to the purpose of this study. While the suggestion is to provide innovations or ideas related to research.

### III. Results and Discussion

**Identifikasi faktor metode FMEA**

In this study, an identification was carried out about the causes of condenser damage and its damage factors. Here are the identification results.

**Table 2. identifying the factors causing the condenser to break down**

<table>
<thead>
<tr>
<th>No</th>
<th>Causative Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Condenser pipe leakage</td>
</tr>
<tr>
<td>2</td>
<td>There is sediment or sand in the cooling water to the condenser.</td>
</tr>
<tr>
<td>3</td>
<td>Life time</td>
</tr>
<tr>
<td>4</td>
<td>Dp debris filter high</td>
</tr>
<tr>
<td>5</td>
<td>Ball cleaning or taprok ball work is not optimal</td>
</tr>
</tbody>
</table>
Some of the causes of damage to the condenser or its damage factors. For this reason, an identification is carried out that affects the performance of the condenser. And get the result of the identification that has been formulated.

FMEA calculation

Table 3. RPN causes damage to the condenser

<table>
<thead>
<tr>
<th>No</th>
<th>Causative Factors</th>
<th>S</th>
<th>O</th>
<th>D</th>
<th>RPN</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Leakage or clogging of condenser pipes</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>150</td>
</tr>
<tr>
<td>2</td>
<td>There is sediment or sand in the cooling water to the condenser.</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>36</td>
</tr>
<tr>
<td>3</td>
<td>Life time</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>Dp debris filter high</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>125</td>
</tr>
<tr>
<td>5</td>
<td>Ball cleaning or taprok ball work is not optimal</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>12</td>
</tr>
</tbody>
</table>

The calculation of the FMEA method determines the severity, accurate, and detection parameters. Based on the severity, frequency of events and the ability to detect the factors causing the damage. Then the risk priority number (RPN) is calculated. From the table above, the highest RPN value results are obtained, namely in the condenser pipe leakage damage mode which is worth 150, and the lowest RPN results are in life time which is worth 8. The result of the calculation of the value (RPN) using the FMEA method on the factors causing condenser damage.

FTA Control

![FTA Diagram](image)

Figure 1. FTA (Fault Tree Analysis) analysis of condenser damage

FTA analysis looks for the problem that caused the condenser to be damaged and looked for the root of the problem.

Table 4. 5W +1H analysis of condenser treatment proposals

Sarjal et al. (Condenser Damage Analysis Using Fta And Fmea Methods at PLTU Nagan Raya)
Types of damage | What (what is the improvement strategy) | Why (why should improvements be made) | Who (who does) | Where (where is the place of damage) | When (when repairs are made) | How (how repairs are made)
--- | --- | --- | --- | --- | --- | ---
Condenser damage | Vibrating the condenser | To minimize the degree of damage to the condenser | hard turbine | Condenser | The time the unit is in operation or before the unit is in operation | By checking or inspecting the condenser unit that is damaged

Based on the results of the analysis of the 5W + 1H table, it is to check the condenser unit that has the cause of the damage then analyzed and the results are obtained that the condenser damage is based on what (what is the repair strategy), why (why should be repaired), who (who did it), where (where is the place of damage), when (when the repair was made), how (how repair is carried out) so that the level of damage can be overcome and the condenser works optimally.

IV. Conclusion

Based on FMEA analysis, the type of damage to the condenser is the highest percentage value of RPN in the condenser pipe section of 150 and the small percentage value in the life time section 8. The cause of the leakage or clogging of the condenser pipe is due to sand from cooling water that is carried away by seawater that passes through the debris filter. Meanwhile, in the FTA analysis and assisted by 5W + 1H, the condenser must be checked or checked and maintained so that it can operate optimally.

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References


Sarijal et.al (Condenser Damage Analysis Using Fta And Fmea Methods at PLTU Nagan Raya)


