Condenser Tube Leakage Effects on Alfa Laval JWP-26-C80 Fresh Water Generator Performance

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ABSTRACT

This *study* aims to determine the effect and relationship of leaks in the condenser tube on the performance of the fresh water generator on the Gas Soechi XXVIII ship. The research method used is a quantitative method with data collection techniques through observation, documentation, and literature study. Data analysis is carried out using normality test, Spearman correlation test, simple linear regression test, coefficient of determination test, and hypothesis test using SPSS version 27 application. The research results show that leakage in the condenser tube has a significant effect on the performance of the fresh water generator with a significance value of 0.001 < 0.05. In addition, the results of the Spearman correlation test show a correlation coefficient value of 0.580 with a Sig. value of 0.012 < 0.05, indicating a relationship in the fairly strong category. The test results of the coefficient of determination obtained an R Square value of 0.483, which means that leaks in the tube condenser are able to explain the influence on the performance of the fresh water generator by 48.3%, while the remaining is influenced by other factors outside the study.

Keywords : Leakage, Condenser Tube, Fresh Water Generator.

Introduction

Water is an essential requirement for life on this planet, and the need for fresh water is extremely important. This also applies on board ships, especially during voyages between ports that are separated by significant distances. To ensure smooth ship operations, reliable machinery systems are required, including the Main Engine and various auxiliary equipment, one of which is the Fresh Water Generator.

The function of a Fresh Water Generator is to convert seawater into fresh water. Fresh water is indispensable for the daily needs of the crew and for maintaining the performance of machinery that uses fresh water, such as the cooling systems of the main engine, auxiliary engines, and other purposes such as cargo tank cleaning.

Modern ships are generally equipped with equipment capable of converting seawater into fresh water. One such device is known as a Fresh Water Generator, which converts seawater into fresh water through evaporation and condensation processes. The general operating principle of a Fresh Water Generator is to pump seawater into an evaporator and heat it to a temperature ranging from 78°C to 89°C.

A Fresh Water Generator (FWG) is a vital piece of equipment on board a ship that is responsible for producing fresh water from seawater through evaporation and condensation.

The fresh water produced by the FWG serves as a basic necessity for the crew, both for consumption and for operational purposes on board.

There are several types of Fresh Water Generators used on ships, including high-pressure and low-pressure Fresh Water Generators. High-pressure Fresh Water Generators utilize heat directly from steam generated by a boiler, while low-pressure Fresh Water Generators use heat from the Main Engine Cooling Water system. After the evaporation process, the hot seawater vapor is cooled in a condenser, forming water droplets that are then drawn by a distillate pump and transferred to the fresh water tank.

One of the key components in the FWG system is the condenser tube, which plays an important role in cooling seawater vapor and converting it into fresh water. These condenser tubes are susceptible to leakage caused by various factors, such as corrosion, pressure, or wear resulting from intensive use.

Leakage in the condenser tubes can have a serious impact on the overall performance of the FWG. A decline in FWG performance due to such leakage may result in insufficient fresh water production to meet the crew's needs, which can disrupt various shipboard activities and potentially jeopardize safety.

Therefore, ships generally require equipment capable of producing fresh water from seawater, such as a Fresh Water Generator, to meet fresh water demands during voyages and to prevent the risk of running out of fresh water, which could adversely affect various onboard operations.

To address this issue, modern ships are typically equipped with equipment capable of converting seawater into fresh water. However, during the author's sea training period, a significant decline in fresh water production was observed in this equipment. Under normal conditions, the unit was capable of producing up to 30 tons of fresh water per day; however, its output decreased dramatically to only 2 tons per day.

Therefore, this study aims to analyze how leakage in condenser tubes affects the performance of the Fresh Water Generator and to determine the direction and strength of the relationship between condenser tube leakage and Fresh Water Generator performance on board ships. The results of this study are expected to serve as a guideline for conducting regular and consistent maintenance of the condenser in order to maintain and improve the performance of the Fresh Water Generator.

Research Method

In this study, a quantitative approach was employed using data obtained through surveys, data analysis, and the presentation of data in the form of diagrams. The researcher carefully analyzed the data to ensure that the results were accurate, reliable, and accountable.

The variables examined consisted of an independent variable (X), namely condenser tube leakage, and a dependent variable (Y), namely the performance of the Fresh Water Generator, which is influenced by the independent variable.

Data were collected using several techniques. First, direct observation was conducted to obtain an accurate understanding of the actual conditions in the field. Second, questionnaires were used to collect responses based on the respondents' actual conditions, experiences, and

opinions. The questionnaires were distributed to ship crew members, particularly those in the engine department, who are directly involved in the operation of the Fresh Water Generator. The questionnaires were administered both directly and through online platforms such as Google Forms, enabling the researcher to reach respondents despite differences in their work locations. Third, documentation was utilized as a means of collecting supporting data, which were subsequently analyzed.

The sample for this study was drawn from the engine room crew of the Gas Soechi XXVIII vessel using a purposive sampling technique, whereby respondents were selected based on specific considerations relevant to the objectives of the study.

Several data analysis techniques were employed in this research. Descriptive statistical analysis was used to describe and summarize the questionnaire responses obtained from the ship crew regarding the operation of the Fresh Water Generator. The results were then presented in the form of tables and simple numerical data. In addition, inferential statistical analysis was applied to draw conclusions about the population based on the sample data. This process involved hypothesis testing and the estimation of population parameters from the sample data. This technique is particularly appropriate when the sample data have been collected from a clearly defined population.

Results and Discussion

Based on the results of the simple linear regression analysis, the following regression equation was obtained:

$$Y = 3.472 + 0.725X$$

The results can be interpreted as follows:

The constant value of 3.472 indicates that when the condenser tube leakage variable (X) is equal to zero, the performance value of the Fresh Water Generator (Y) is 3.472. The regression coefficient of the condenser tube leakage variable is 0.725, indicating that leakage in the condenser tube has an effect on changes in the performance of the Fresh Water Generator on board the ship.

Furthermore, the significance test results showed a significance value of 0.001, which is lower than the significance level of 0.05 (0.001 < 0.05). Therefore, it can be concluded that condenser tube leakage has a statistically significant effect on the performance of the Fresh Water Generator.

Table 1. Simple Linear Regression Test Results

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	3,472	10,150		,342	,737
	Kebocoran Pada Tube Condesor (X)	,725	,188	,695	3,863	,001

a. Dependent Variable: Kinerja Fresh Water Generator (Y)

Based on the results of the coefficient of determination test presented in Picture 4.11, the R Square value obtained was 0.483. This indicates that the condenser tube leakage variable (X) is able to explain 48.3% of the variation in the performance of the Fresh Water Generator (Y). Meanwhile, the remaining 51.7% is influenced by other variables that were not examined in this study.

Table 2. Coefficient of Determination Test Results

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,695[a]	,483	,450	4,173

a. Predictors: (Constant), Kebocoran Pada Tube Condesor (X)
b. Dependent Variable: Kinerja Fresh Water Generator (Y)

Based on the results of the Spearman correlation test presented in the picture above, the relationship between the condenser tube leakage variable (X) and the Fresh Water Generator performance variable (Y) has a correlation coefficient value of 0.580 with a significance value of 0.012. Since the significance value is less than 0.05 (0.012 < 0.05), it can be concluded that there is a statistically significant relationship between condenser tube leakage and the performance of the Fresh Water Generator.

The correlation coefficient value of 0.580 indicates that the relationship between the two variables falls within the moderately strong category. This finding suggests that condenser tube leakage is associated with changes in the performance of the Fresh Water Generator on board the ship.

Table 3. Spearman Correlation Test Results

Correlations

			Kebocoran Pada Tube Condesor (X)	Kinerja Fresh Water Generator (Y)
Spearman's rho	Kebocoran Pada Tube Condesor (X)	Correlation Coefficient	1,000	,580*
		Sig. (2-tailed)	.	,012
		N	18	18
	Kinerja Fresh Water Generator (Y)	Correlation Coefficient	,580*	1,000
		Sig. (2-tailed)	,012	.
		N	18	18

*. Correlation is significant at the 0.05 level (2-tailed).

Discussion

Based on the results of the study, it was found that condenser tube leakage has a significant effect on the performance of the Fresh Water Generator on board the Gas Soechi XXVIII vessel. This is indicated by the results of the simple linear regression test, which obtained a significance value of 0.001, where this value is lower than 0.05 (0.001 < 0.05).

In addition, the regression equation obtained was $Y = 3.472 + 0.725X$. This regression equation shows that the condenser tube leakage variable has an influence on changes in Fresh

Water Generator performance. The higher the level of leakage occurring in the condenser tubes, the more the operating condition of the Fresh Water Generator will be disrupted, resulting in less optimal fresh water production.

Based on the results of the coefficient of determination test, an R Square value of 0.483 was obtained. This indicates that the condenser tube leakage variable is able to explain 48.3% of the variation in Fresh Water Generator performance, while the remaining 51.7% is influenced by other variables outside the scope of this study.

The Spearman correlation test results show a correlation coefficient of 0.580 with a significance value of 0.012. Since the significance value is lower than 0.05 (0.012 < 0.05), it indicates that there is a statistically significant relationship between condenser tube leakage and the performance of the Fresh Water Generator on board the Gas Soechi XXVIII vessel. The correlation coefficient of 0.580 indicates that the relationship between the two variables falls into the moderately strong category.

This relationship indicates that the condition of the condenser tubes is related to the performance of the Fresh Water Generator in producing fresh water. If leakage occurs in the condenser tubes, the condensation process becomes less optimal, which can affect both the quality and quantity of fresh water production.

Leakage can also lead to an increase in salinity levels due to the mixing of seawater with the distilled water, resulting in the fresh water production process not operating at maximum efficiency.

Conclusion

Based on the research conducted regarding the relationship between tube condenser leakage and the performance of the fresh water generator on board the Gas Soechi XXVIII, as well as the analysis and discussion presented, it can be concluded that tube condenser leakage has a significant effect on the performance of the fresh water generator. This is evidenced by the results of the simple linear regression test, which yielded a significance value of 0.001 (< 0.05). Leakage in the tube condenser causes the condensation process to operate inefficiently, resulting in a decrease in both the quality and quantity of fresh water produced by the fresh water generator.

There is a significant relationship between tube condenser leakage and the performance of the fresh water generator on board the Gas Soechi XXVIII. This is demonstrated by the results of the Spearman correlation test, which produced a correlation coefficient of 0.580 with a significance value of 0.012 (< 0.05). The correlation coefficient indicates a moderately strong relationship between the two variables. Therefore, the condition of the tube condenser is closely associated with the effectiveness of the fresh water generator's performance during ship operations.

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