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The Effect of Leaks in the L.O Cooler Tube on Temperature Increase in the Auxiliary Engine of KM. Wilis

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ABSTRACT

The auxiliary engine is one of the most important systems in ship operation, which depends on the stability of the lubrication and cooling systems to maintain engine performance. One of the vital components in this system is the L.O Cooler (Lube Oil Cooler), which functions as a heat exchanger to keep the lubricating oil temperature within safe operating limits. This study aims to analyse the causes, impacts, and technical solutions for the temperature increase caused by leaks in the L.O Cooler Tube. The research was conducted on the KM Wilis ship, owned by PT Pelayaran Nasional Indonesia, using a qualitative descriptive approach. The methods used included direct observation, technical interviews with ship engine personnel, and visual documentation of the L.O Cooler and related cooling systems. Lubricant temperature and oil pressure data were also analysed to support technical interpretation. The results of the study show that leaks in the L.O Cooler Tube cause cooling water to mix into the lubrication system, resulting in a decrease in oil viscosity and disruption to the lubrication function. This condition causes the lubricant temperature to rise beyond the safe threshold and increases the risk of wear on components such as bearings and pistons. The solutions implemented include replacing the Tube, cleaning the cooling lines, and periodically monitoring the temperature through sensors and recording machine operations.
Keywords: L.O Cooler, Auxiliary Engine, Leakage

ABSTRAK

Auxiliary Engine merupakan salah satu sistem penting dalam pengoperasian kapal, yang bergantung pada stabilitas sistem pelumasan dan pendinginan untuk menjaga performa kerja mesin. Salah satu komponen vital dalam sistem ini adalah L.O Cooler (Lube Oil Cooler), yang berfungsi sebagai penukar panas untuk menjaga suhu oli pelumas tetap berada dalam batas operasi yang aman. Penelitian ini bertujuan untuk menganalisis penyebab, dampak, dan solusi teknis atas kenaikan suhu yang terjadi akibat kebocoran pada Tube L.O Cooler. Penelitian dilaksanakan di atas kapal KM. Wilis, milik PT. Pelayaran Nasional Indonesia, dengan menggunakan pendekatan deskriptif kualitatif. Metode yang digunakan mencakup observasi langsung, wawancara teknis dengan personel mesin kapal, serta dokumentasi visual terhadap L.O Cooler dan sistem pendingin terkait. Data suhu pelumas dan tekanan oli juga dianalisis untuk mendukung interpretasi teknis. Hasil penelitian menunjukkan bahwa kebocoran pada Tube L.O Cooler menyebabkan terjadinya pencampuran air pendingin ke dalam sistem pelumas, yang

berakibat pada penurunan viskositas oli dan gangguan pada fungsi pelumasan. Kondisi ini menyebabkan kenaikan suhu pelumas hingga melewati ambang batas aman, serta meningkatkan risiko keausan komponen seperti Bearing dan Piston. Solusi yang diterapkan mencakup penggantian Tube, pembersihan jalur pendingin, serta pemantauan suhu secara berkala melalui sensor dan pencatatan operasional mesin.
Kata kunci: *L.O Cooler, Auxiliary Engine, Kebocoran*

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1. INTRODUCTION

To maintain sailing safety, ensure smooth ship operations, and ensure that engines function efficiently, serious efforts are required in managing the engine system. Safe, comfortable and punctual sailing can only be achieved if all ship equipment, especially engines, are in optimal condition. One important factor that must be a top priority in supporting ship performance is the implementation of regular and procedural maintenance and repair of engines on board. In the maritime world, Auxiliary Engines (AE) play an important role as a source of electrical power that supports ship operational activities. Within the AE system, there is a main component called the Lube Oil (L.O) Cooler, which functions to maintain temperature stabilitylubricant to remain within normal limits. However, a leak in the

L.O Cooler Tube can result in reduced cooling capacity, causing an increase in lubricant temperature and negatively impacting the overall performance and durability of the engine. One important part of the lubricant cooling system is the Lube Oil Cooler, which plays a major role in controlling the oil temperature to remain within the appropriate range to maintain engine efficiency. If the oil temperature exceeds the specified limit, the lubrication quality will decrease, causing increased friction between components and resulting in faster wear. This condition can shorten the service life of the Auxiliary Engine and cause potential severe damage. Therefore, the stability of the Lube Oil Cooler's performance directly affects the reliability and safety of the ship's machinery system. A common problem with L.O Cooler systems is leakage in the tube section. This condition can cause the cooling water to mix with the lubricating oil, resulting in a decrease in the cooling capacity of the system. Contamination between these two fluids also changes the

chemical characteristics of the lubricant, causing deposits, corrosion, and a decline in lubricant quality. The impact of this can be clearly seen through an increase in the temperature of the Auxiliary Engine, which has the potential to cause overheating, sudden engine shutdown, and even the risk of fire if not handled properly immediately. While conducting sea trials aboard the KM. WILIS, researchers discovered a problem when the ship was about to depart from Kupang Port to Kalabahi Port on 25 June 2024. During the voyage, there were indications of an increase in lubricating oil temperature (L.O Temperature) when the auxiliary engine was operated. While the ship was moving, the demand for electrical power was greater than usual to support operational activities that required the engines to be turned on and off as needed for the voyage.

After an inspection by the Third Engineer and the engine crew, a leak was found in the Tube L.O Cooler of the auxiliary engine. This incident was the main reason behind the author's choice of research this topic, with study aims to examine the causes of leakage and preventive measures. This study is intended to analyse the contributing factors and find technical solutions to leakage in the tube L.O Cooler of auxiliary engines. By understanding the main causes of leakage, it is hoped that this study can provide preventive recommendations so that similar incidents do not recur in the future. In recent years, cases of leakage in the Tube Lube Oil Cooler of auxiliary engines have often occurred on commercial ships operating in Indonesian waters. This condition not only causes financial losses due to high repair costs, but also has the potential to threaten shipping safety and disrupt the accuracy of ship operational schedules.

On that basis, this study is expected to make a real contribution to expanding technical understanding of the Tube L.O Cooler system, as well as providing a scientific basis for the implementation of preventive and corrective measures in the field.

2. METHOD

This study adopts a qualitative descriptive approach, which aims to provide an in-depth understanding of the phenomenon of leakage in the Tube Lube Oil Cooler (L.O Cooler) of the auxiliary engine on the KM Wilis ship. This approach was chosen because it was considered most relevant for describing in detail the factual

conditions in the field through direct observation, technical documentation, and interviews with engine personnel involved in ship operations and maintenance. Conceptually, this method emphasises inductive analysis, in which researchers attempt to interpret empirical findings into a structured and meaningful form of knowledge. The main focus of the research was to identify and analyse the factors causing leaks in the Tube L.O Cooler, along with their impact on the performance and stability of the Auxiliary Engine. The descriptive approach allowed the researcher to systematically explain the cause-and-effect relationship between cooling system malfunctions and increased lubricant temperature. In addition, this study applies a case study method, with a single object in the form of the L.O Cooler Auxiliary Engine of the KM Wilis ship, which showed signs of leakage. Through the application of case studies, researchers can gain a comprehensive understanding of the context of the problem, covering technical, operational, and maintenance aspects. Data collection was carried out through direct observation on board the ship, structured interviews with engine officers, and documentation of operational data such as lubricant temperature and pressure records before and after the incident. Data analysis was carried out through a process of reduction, presentation, and conclusion drawing based on empirical observations. Through this method, it is hoped that the study can provide an applicable contribution to improving the effectiveness of auxiliary engine cooling system maintenance and serve as a technical reference in efforts to prevent L.O. Cooler leaks in the future.

3. RESULTS AND DISCUSSION

3.1 Research Results

After conducting a study on indications of increased temperature in the Auxiliary Engine obtained through observation and interviews with the ship's engine officers, the author presents the field data and supporting documentation collected during the sea trial on KM Wilis. The information presented includes direct visual observations of the L.O Cooler components, particularly the Tube section, as well as a thorough inspection of the cooling lubricant circulation system. The purpose of presenting this data is to reinforce the results of the analysis described earlier, in which a leak in the L.O Cooler Tube was identified as the main cause of the increase in lubricating oil temperature, which then led to an increase in the Auxiliary Engine's

operating temperature. Visual documentation, such as images of the tubes showing signs of cracking or corrosion, as well as temperature and oil pressure data records before and after the incident, were used as supporting evidence for these findings. Based on direct observations in the field, it was found that several tubes in the L.O. Cooler showed damage in the form of micro-cracks and internal corrosion, indicating fluid leakage. This leakage allowed coolant to mix with the oil, causing a significant decline in lubricant quality. As a result, the oil's ability to absorb and conduct heat decreased, leading to excessive heat accumulation in the internal components of the engine. This phenomenon is clearly evident from data showing an increase in lubricant temperature and a decrease in oil pressure during a certain period of operation. The data presented in this subsection aims to provide a factual and empirical description of the condition of the L.O Cooler and Auxiliary Engine at the time of the incident. Thus, readers can understand the pattern of damage that occurred due to system disruption. lubricant cooling. In addition, this presentation is also expected to clarify the causal relationship between leaks in the Tube L.O Cooler and increased auxiliary engine operating temperatures.

1) Visual Documentation of Research Objects

During the sea practice on board the KM. Wilis, the author made direct observations of the actual condition of the Lube Oil Cooler (L.O Cooler) on the Auxiliary Engine, which showed indications of leakage in the Tube section. The documentation process was carried out systematically, including visual inspection of the outer surface and inner parts of the L.O Cooler, identification of the location of the damaged Tube, and evaluation of the supporting cooling system function, including the fluid distribution pattern through the Cooler Plate.

Through this documentation process, visual data was obtained that described the actual physical condition of the components, such as corrosion, micro cracks, and discolouration in certain areas that indicated leaks. The documentation results formed the basis for further analysis of the causes of damage and its relationship to the increase in lubricating oil temperature in the Auxiliary Engine.

Figure 1. General View of the L.O Cooler on the Auxiliary Engine

This image shows the position and physical form of the L.O Cooler installed in the Auxiliary Engine lubricant cooling system. The L.O Cooler functions to reduce the temperature of the lubricating oil through heat transfer with a cooling medium (seawater).

Figure 2. Leaking L.O Cooler Tube

This image shows the condition of the inside of the Lube Oil Cooler (L.O Cooler), which shows corrosion on the surface of the tube. This corrosion is suspected to be the starting point of the leak in the cooling system. This damage allows cooling water to enter the lubricating oil line, causing the two fluids that should be separate to mix. As a result, the efficiency of the heat transfer process decreases significantly and causes the lubricant temperature to rise during engine operation. This condition further impacts the Auxiliary Engine's operating temperature and reduces the quality of engine component lubrication.

2) Comparison Table

To reinforce the field findings regarding indications of increased temperature in the Auxiliary Engine caused by a leak in the Tube L.O Cooler, the following data presents the results of observations of lubricant (Lube Oil) temperature and cooling water outlet (Fresh Water Cooler) temperature. This data was obtained through direct observation during sea trials aboard the KM. Wilis and was used to analyse the comparison of engine conditions before and after the leak occurred. The following table shows the lubricant and cooling water temperatures under normal conditions, i.e., when the cooling system is functioning properly and no indications of leakage have been found in the Tube L.O Cooler.

Table 1. L.O Cooler Temperature under Normal Conditions (Before Leakage).

No.	Watch	Unit	Temp. L.O Inlet (°C)	Temp. L.O Outlet (°C)	Pressure L.O (Bar)	Sea Water Inlet Temperature (°C)	Sea Water Outlet Temperature (°C)	Sea Water Pressure (bar)	Note
1	08:00 – 12:00	°C/bar	65.3	58.3	3.2	30.2	36.0	1.8	Normal
2	12:00 – 16:00	°C/bar	68.5	60.0	3.1	30.3	36.2	1.8	Normal
3	16:00 – 20:00	°C/bar	70.2	62.4	3.0	30.5	36.5	1.7	Normal

Table 2. L.O. Cooler Temperature under Abnormal Conditions (Indicating a Leak)

No.	Shift	Unit	Temp. L.O Inlet (°C)	Temp. L.O Outlet (°C)	Pressure L.O (Bar)	Sea Water Inlet Temperature (°C)	Sea Water Outlet Temperature (°C)	Sea Water Pressure (bar)	Note
1	08:00 – 12:00	°C/bar	74.4	65.9	2.8	30.0	32.5	1.9	Abnormal
2	12.00 – 16.00	°C/bar	78.6	69.6	2.6	30.1	32.1	2.0	Abnormal

3	16:00 – 20:00	°C/bar	80	75.0	2.5	30.0	31.8	2.1	Abnormal

Based on the observations shown in Table 1 and Table 2, there is a significant difference between normal conditions (before the leak) and abnormal conditions (after the leak) in the lubricating oil cooling system (Lube Oil Cooler) in the Auxiliary Engine of KM. Wilis. Under normal conditions, as shown in Table 4.1, the inlet temperature

L.O Inlet temperature ranges from 65.3°C to 70.2°C, while the L.OThe outlet temperature ranges from 58.3°C to 62.4°C. This temperature difference indicates that the heat transfer process from the oil to the cooling seawater is proceeding optimally. The stable lubricating oil pressure in the range of 3.0–3.2 bar indicates that there are no flow obstructions in the system. Meanwhile, the seawater temperature on the inlet and outlet sides is relatively stable, ranging from 30.2°C to 36.5°C, with a pressure of 1.7–1.8 bar. These conditions indicate that the cooling flow rate is still sufficient to maintain heat transfer efficiency. However, different conditions are seen in Table 2, when the system shows signs of leakage in the Tube L.O Cooler. The L.O Inlet temperature increased significantly to 80.0°C, while the L.O Outlet temperature also rose to 75.0°C. This increase indicates that heat transfer effectiveness has declined sharply due to disruption of fluid separation between the oil and cooling water. The lubricating oil pressure also decreased from 3.2 bar to 2.5 bar, indicating a possible internal leak resulting in pressure loss in the system. In addition, although the seawater temperature on the inlet side was relatively constant (around 30°C), the seawater outlet temperature decreased from 36°C under normal conditions to around 31–32°C after the leak occurred. This phenomenon reinforces the assumption that the rate of heat transfer from the oil to the seawater decreased due to the formation of a layer of contamination or fluid mixing in the tube section. With the decrease in cooling efficiency, some of the heat was not completely absorbed by the cooling water and remained trapped in the lubrication system.

3.2 Discussion

As a result of this mixing, the viscosity of the lubricating oil decreases, and the oil's ability to absorb and release heat is reduced. This has a direct impact on the increase in temperature in the lubrication system and triggers overheating in engine components that have a high workload. This phenomenon shows that leaks in the L.O Cooler tube not only reduce cooling efficiency but also have the potential to cause Secondary damage to internal engine components, if repairs and replacement of damaged parts are not carried out immediately. Systemically, the mechanism of temperature increase in the Auxiliary Engine due to leakage of the L.O Cooler tube can be explained through the following stages:

1) The L.O Cooler tube leak causes higher pressure seawater to enter the lubrication line.
2) The lubricating oil becomes contaminated, resulting in a decrease in viscosity and heat transfer efficiency.
3) Heat transfer from the oil to the seawater is disrupted, causing the oil temperature to rise.
4) The lubrication system temperature rises significantly, causing uneven heat distribution within the engine.
5) This condition causes an increase in the temperature of the main engine components, accelerating wear and tear and potentially causing mechanical failure if not addressed immediately.

Based on the above stages, it can be concluded that the main cause of the temperature increase in the Auxiliary Engine KM. Wilis is the decline in L.O Cooler performance due to a leak in the tube. This disruption causes an imbalance in pressure and flow rate between the lubrication system and the cooling system, so that heat is not properly transferred and accumulates in the lubricant circuit. Therefore, routine cleaning and inspection of the L.O Cooler tubes are very important steps to ensure that the cooling system functions optimally and to prevent similar conditions from recurring in the future.

4. CONCLUSION

Based on the results of research and analysis of the causes of temperature increases in the Auxiliary Engine due to leaks in the L.O Cooler tube on the KM. Wilis ship, it can be concluded that this problem stems from a decline in the

performance of the lubricant cooling system due to damage to the tube components. This study also shows the importance of implementing preventive maintenance and monitoring measures to maintain stable engine operating temperatures.

a. The main factor causing leaks in the Tube L.O Cooler auxiliary engine on the KM Wilis ship is corrosion and cracking of the tube material due to exposure to corrosive cooling water. This damage allows cooling water (fresh water) to enter the lubrication system, causing the fluids to mix. As a result, the viscosity of the lubricant decreases, the oil's ability to absorb and release heat is reduced, and heat transfer efficiency decreases dramatically. Operational data shows that the oil temperature increased from a normal range of 60°C to more than 76°C under abnormal conditions, indicating a significant decline in cooling system performance. These findings reinforce the hypothesis that the temperature increase in the auxiliary engine was caused by lubricant contamination due to a leak in the L.O Cooler Tube.
b. Efforts to mitigate and prevent L.O Cooler leaks have proven effective when carried out through regular maintenance and operational monitoring programmes. Technical measures such as cleaning the cooling water lines of scale and dirt, pressure testing (hydrostatic test), and regular monitoring of lubricant temperature and pressure, are able to restore the stability of the auxiliary engine's operating temperature. The implementation of these measures has been proven to reduce the risk of overheating and extend the service life of the cooling system. Therefore, the operational sustainability of the Auxiliary Engine is highly dependent on the disciplined implementation of inspections and preventive maintenance of the L.O Cooler.

Overall, it can be concluded that the temperature increase in the Auxiliary Engine of KM. Wilis is a direct result of the L.O. Cooler leak and the reduced efficiency of the lubricant cooling system. Preventing similar incidents in the future must be achieved through the implementation of disciplined maintenance management, regular inspections of cooling components, and data-based monitoring of operational conditions.

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