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OPTIMIZATION OF COMPRESSOR PERFORMANCE ON THE SHIP KM. PUSRI INDONESIA

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ABSTRACT

The KM. Pusri Indonesia is a bulk carrier owned by PT. Pupuk Indonesia Logistik, specifically designed to distribute fertilizer from producers to various locations throughout Indonesia. Based on the survey results, this study aims to identify factors causing performance decline and implement optimization measures for the compressor. Air compressors play a vital role in providing pressurized air to various ship machinery systems, so decreased performance can hamper operations.

The results of this study indicate that the air cylinder filling time increased from the standard specification of 2.4 to 5 minutes to 7.4 to 10 minutes. The main contributing factors are piston ring wear, scale buildup on the low and high pressure valves, and leaks in the cooling pipes. To address this issue, optimization steps that can be taken include replacing worn piston rings, cleaning scale on the valves, and welding leaking cooling pipes. After corrective action, the filling time returned to the normal range of 2.8 to 4.9 minutes. This study emphasizes the importance of compressor maintenance in accordance with the manual and recording maintenance results for evaluation purposes.

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1. INTRODUCTION

Ships are a vital mode of transportation, considered effective and efficient in supporting national development in various sectors. Given their role as the backbone of global transportation, the number of ships sailing has undoubtedly increased significantly. Simply providing a large number of ships is not enough; they must also be ensured for operational readiness. The condition and performance of machinery must be considered, as ship operations are highly dependent on its functionality. One of the essential auxiliary machinery on board ships that supports the operation of the main engine is the compressor.

A compressor is a machine that produces pressurized air by compressing a fluid (air or gas) from a lower pressure to a higher pressure. This pressurized air is stored in an air tank and then used as starting air for the main engine during maneuvers and for starting the air generator. It is also used to clean machinery components such as filters, for cleaning auxiliary motors, and for air services above deck, such as for cleaning accommodations.

The use of compressed air can certainly help ship operations run smoothly. However, compressor operation often encounters obstacles and problems due to suboptimal engine performance. Research conducted by (Andi, 2021) analyzed one of the factors causing reduced compressed air in compressors, namely malfunctioning suction and pressure valves due to cracks on the valve surfaces. (Sallihima, 2020) believes that efforts that can be made include improving periodic maintenance according to the instruction manual and conducting routine checks such as replacing worn piston rings and cleaning (lapping) the pressure and suction valves.

Referring to the causal factors and efforts to optimize compressor performance, the researcher underlines the urgency of conducting research related to efforts to optimize compressor performance to ensure ship operations continue to run smoothly. As experienced by the researcher on March 17, 2025, when the ship was about to dock at Panjang Port, the compressor experienced trouble indicated by the long duration of filling the air tank which hampered the one-hour notice process. Therefore, the researcher intends to conduct a study entitled "Optimizing Compressor Performance on the KM. Pusri Indonesia Ship".

2. RESEARCH METHODS

The research was conducted on the KM Pusri Indonesia ship, one of the bulk carrier ships owned by PT. Pupuk Indonesia Logistik which is specifically designed to distribute fertilizer from producers to various locations throughout Indonesia. Starting from sign on on July 24, 2024 until sign off on July 24, 2025. The type of research used by the researcher is a quantitative descriptive method that aims to provide answers to the compressor optimization analysis in order to determine the causes, impacts, and solutions to problems in compressor performance on the KM. Pusri Indonesia Ship.

Data were obtained through two data collection techniques, namely primary data and secondary data. Primary data was taken based on direct observation of the declining performance of the compressor. The data obtained was in the form of comparative data on the duration of filling the air cylinder when the compressor was normal and when it was troubled. Also through documentation with the resulting data in the form of schedules and reports of overhaul and maintenance activities on the compressor. Secondary data was taken from the Instruction Manual Book data archive regarding specifications, operating instructions, compressor maintenance, and compressor spare part data. The research instruments used were a mobile phone for stopwatch and documentation collection, and a thermometer to measure the compressor temperature.

The results of the author's research are presented in tables, graphs, or diagrams as descriptive data presentations. The researcher's activities included analyzing factors that caused the decline in compressor performance by comparing changes in air tank filling duration before and after the overhaul and identifying optimization efforts to improve compressor performance.

3. ANALYSIS AND DISCUSSION

3.1 ANALYSIS

Inspection results on compressor number 1 revealed several conditions affecting overall engine performance. The data presented below shows the specifications of the compressor and air tank on board the KM. Pusri Indonesia.

Table 3.1 Specifications of the KM. Pusri Indonesia air compressor

No.	Parameter	Specification
1.	*Type*	*Vertical 2-stage water cooled*
2.	*Model*	TCAX15/8
3.	*Stroke*	80 mm

4.	*Speed*	720 min-1
5.	*Capacity*	30 M3/h
6.	*Del. Pressure*	2.45 MPa
7.	Volume of the Cylinder	2 x 600 liters

a. Analysis of factors causing decreased compressor performance on the KM. Pusri Indonesia ship among others:

1) Leak in the cooling pipe

The function of the compressor cooling system is to maintain the ideal operating temperature of the compressor, thus preventing overheating, maintaining optimal engine performance, and extending the life of the compressor components. If a leak occurs in the cooling pipe, cooling efficiency will be compromised, ultimately triggering a series of problems. Some indicators that can indicate a leak in the cooling pipe are corrosion and wear due to vibration. Corrosion can be seen in the cooling pipe due to dirt, mud, or scale adhering to it.

2) Crust or dirt on the valve

Scale on valves, especially low-pressure and high-pressure valves, is a buildup of dirt that can interfere with valve performance, reduce efficiency, and even cause leaks. Air particles contaminated with dust and oil will adhere to the valve and eventually form scale. Furthermore, without regular cleaning, the scale that begins to build up won't be removed and will continue to thicken, reducing valve performance and even causing it to seize.

3) Wear on piston rings

*Piston ring*Piston rings play a crucial role in maintaining pressure within the cylinder. If these rings wear out, compressor performance will drastically decrease. Indications of piston ring wear include insufficient lubrication, as this lubricant reduces friction between the piston ring and the cylinder wall. Inadequate lubrication drastically increases metal-to-metal friction, potentially accelerating wear.

b. Analysis of the impacts caused by the decline in compressor performance on the KM. Pusri Indonesia ship includes:

1) The compressor cooler is overheating

Leaks in the cooling system are a serious problem that directly impacts compressor performance, primarily because they gradually cause overheating. Because heat cannot be absorbed properly, the air temperature inside the compressor cylinder increases dramatically. As a result, the compressor must work harder to compress the hot, lower-density air. This increased workload further exacerbates the temperature rise. Overheating is not simply a high temperature, but a condition where the operating temperature exceeds the safe limits set by the instruction manual.Upon observation, the output temperature on the thermometer reached 46°C. This indicates the compressor is experiencing trouble, with the coolant supply temperature around 32°C and the output temperature around 40°C during operation.

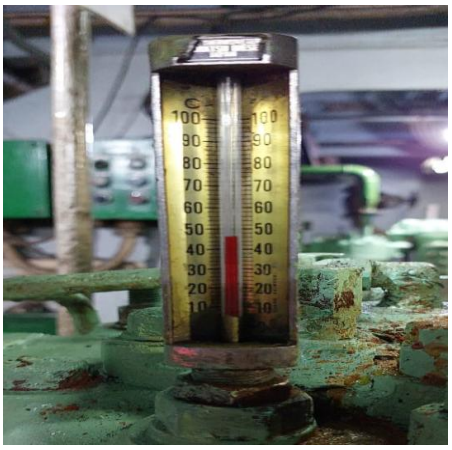


Figure 3.1The Compressor Cooler is experiencing*overheating*

2) *Pressure gauge*on the compressor decreases

Scale on the valve directly causes internal leaks, which leads to a decrease in air pressure at each compression stage (first and second stages). As a result, the air pressure in the first and second stages cannot rise and maintain the required pressure. Furthermore, this condition can trigger overheating, which causes a decrease in lube oil pressure. All of these indicators indicate a problem with the compressor's efficiency.

Figure 3.2 *Compressor pressure gauge decreases*

3) The duration of filling the air cylinder

Piston ring wear causes internal leakage (blow-by), which is when the gap between the ring and the cylinder wall widens. This gap allows some of the compressed air to leak out. As a result, the compressor takes longer to fill the air cylinder to the specified pressure. This not only wastes time but also increases energy consumption and accelerates wear on other components.

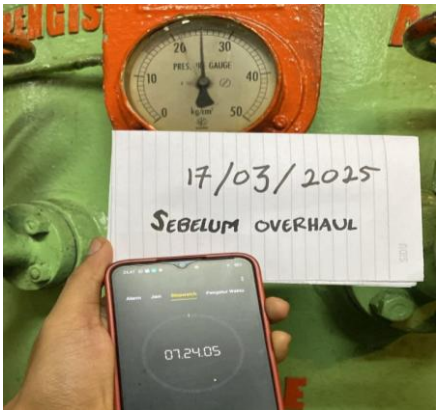


Figure 3.3The duration of filling the air cylinder

A longer filling time in the air tank indicates a problem with the compressed air system produced by the compressor. According to specifications, the compressor is capable of operating for 2.4 to 5 minutes, producing compressed air. minutes. However, when trouble occurs, the air tank filling time becomes longer, between 7.4 and 10 minutes.

Table 3.2 Duration of filling the air cylinder

No.	Date	Normal Charging Duration	Charging Duration during trouble	Information
1.	01-16-2025	2.4 - 5 minutes	7.4 minutes	Longer charging duration
2.	02-20-2025		10 minutes	
3.	03-17-2025		8.2 minutes	
4.	04-21-2025		9.7 minutes	

The conditions in Table 3.2 indicate a decrease in compressor performance in producing optimal pressurized air.This condition not only affects engine performance, but also has a negative impact on the overall operation of the ship, even causing delays in ship maneuvers.

3.2 DISCUSSION

In this discussion, the author provides an explanation of the presented data and takes key points to answer the research problem formulation. From all inspections, it was found that the factors causing the decline in compressor performance were leaks in the cooling pipes, scale or dirt on the valves, and wear on the piston rings. This resulted in the compressor cooling system overheating, a decrease in the compressor pressure gauge, and a longer duration of air tank filling. Then, optimization efforts were carried out in the form of repairs to the cooling pipes by welding, cleaning scale on the valves, and replacing the piston rings.

Table 3.1Results of efforts to optimize compressor performance

Date	Normal Charging Duration	Duration before Treatment	Duration after Treatment	Optimization Efforts
01-16-2025	2.4 – 5 minutes	7.4 minutes	2.8 minutes	Piston ring replacement
02-20-2025		10 minutes	4.9 minutes	Cleaning scale on the valve
03-17-2025		8.2 minutes	3.5 minutes	Repairs to the cooling pipes
04-21-2025		9.7 minutes	4.4 minutes	Cleaning scale on the valve

Based on Table 3.3, efforts to optimize compressor performance on the KM. Pusri Indonesia ship include:

a. Welding on leaking coolant pipe

Once you discover a leak in the coolant piping, the first step in optimization is to inspect and repair the leak. Perform regular visual inspections and pressure tests on all coolant piping lines, including connections and hoses. Any leaks, no matter how small, should be repaired immediately by welding or even replacing the component.

b. Cleaning scale or dirt on the valve

In subsequent inspections, maintenance was performed on the low- and high-pressure valves to improve compressor performance. If a valve malfunctions, it can result in an inability to close properly, resulting in insufficient air flow to the air tank. The primary cause is scale or dirt adhering to the low- and high-pressure valves. To resolve this issue, the valves must be cleaned using a brush, sandpaper, or soaked in diesel fuel for approximately 15 minutes to remove the scale or dirt.

c. Piston ring replacement

After an overhaul, the piston rings were found to be worn. To restore compressor performance, the worn piston rings must be replaced. This will restore optimal compressor performance, as outlined in the Instruction Manual, for optimal operation. Piston rings prevent compressed air from escaping or leaking into the crankshaft, ensuring optimal air compression.

After various optimization efforts, the compressor's performance was successfully restored. Regular repairs and maintenance have been proven to support the compressor in producing optimally compressed air, according to the Instruction Manual, with a duration of 2.8 to 4.9 minutes. A comparison of these durations can be seen in the figure.

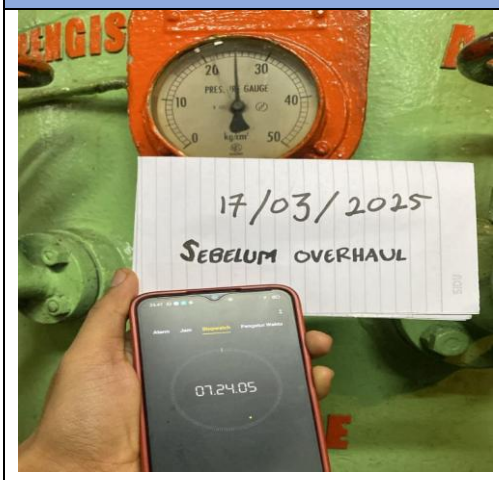
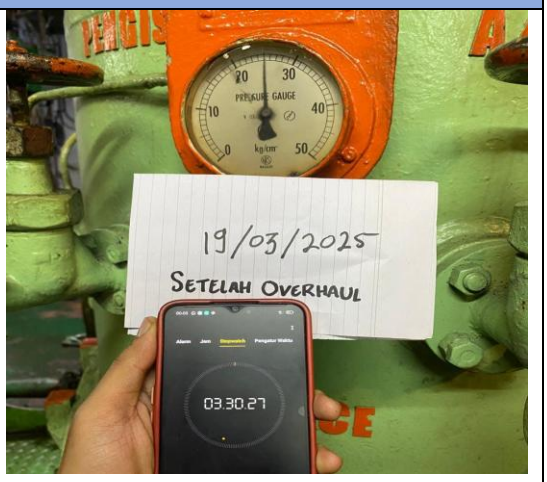
Charging Duration before Overhaul	Charging Duration after Overhaul
	

Figure 3.4Comparison of air cylinder filling duration

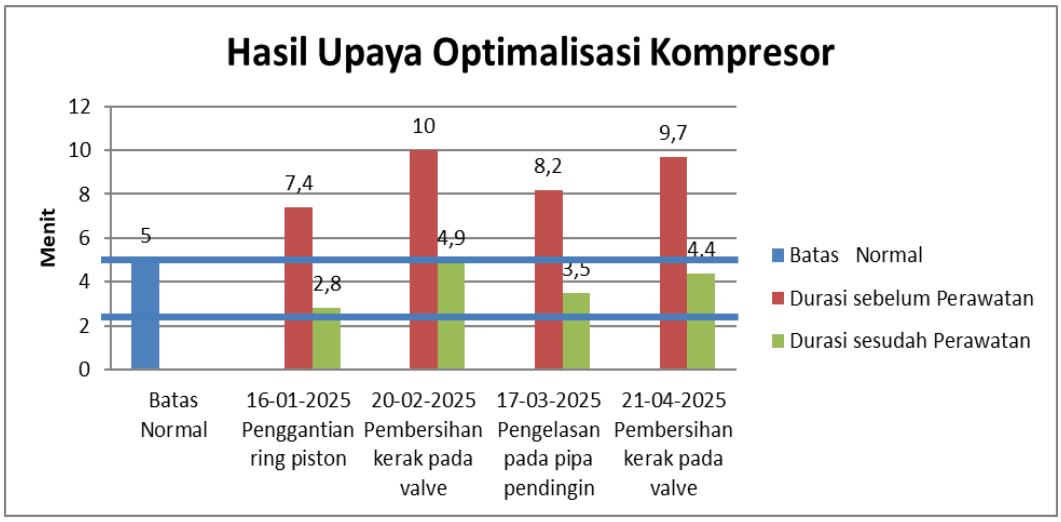


Figure 3.5Diagram of the results of compressor optimization efforts

Overall, this series of activities restored the compressor to optimal performance. This is demonstrated by the diagram in Figure 3.5, which compares the air tank filling times before and after maintenance on four different schedules.

4. CLOSING

4.1 Conclusion

Based on the results of observations and analysis conducted by researchers on compressor performance during sailing practice on the KM. Pusri Indonesia, the following conclusions can be drawn:

1. The decrease in compressor performance is caused by leaks in the cooling pipes, deposits of scale or dirt on the low pressure valve and high pressure valve, and wear on the piston rings.

2. The impact of decreasing compressor performance is that the compressor cooler overheats, the pressure on the pressure gauge decreases, and the duration of filling the compressed air in the air cylinder is longer.
3. Efforts to optimize compressor performance include repairing the cooling pipes by welding, cleaning scale or dirt on the valves, namely the low pressure valve and high pressure valve, and replacing worn piston rings.

4.2 Suggestion

Based onalternative solutions to the problem, then the researcher suggests several things related to compressor problems to prevent the problem from recurring and the solution to the problem is as follows:

1. To prevent a decline in compressor performance, it is crucial for those on duty in the engine room to inspect the compressor's surroundings and perform maintenance according to the instructions in the Instruction Manual. This helps identify potential problems and take appropriate action immediately. Failure to properly perform inspections and maintenance will result in the compressor's system not functioning optimally.
2. To address issues with decreased compressor performance, it's important to regularly clean the valves, especially the low-pressure and high-pressure valves, to prevent scale buildup, which can degrade compressor performance. Perform repairs and maintenance on the compressor's internal components, such as the piston, and inspect the piping system to identify which components are still serviceable. Often, the primary cause of engine failure is inadequate or non-compliant spare parts.
3. Archiving maintenance and repair data as a reference for future compressor performance evaluations. This aims to identify appropriate modification alternatives to optimize compressor performance.

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