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Identification the Cause of Decreased Main Air Compressor Performance in Relation to the Duration of Air Bottle Filling at MT. Giat Armada 01

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ABSTRACT

Damage to the compressor often causes compressed air production to decrease, which can cause greater damage, thus disrupting the smooth operation of the ship. The aim of this research is to determine the causal factors, the impact of the decline in the performance of the Main Air Compressor (MAC) on filling air bottles, as well as efforts that can be made to overcome this problem. The research method is descriptive qualitative with the RCA (Root Cause Analysis) 5 why data analysis technique in order to obtain root cause results from the research conducted. The results of the research show that the decrease in compressor pressure is caused by a broken spring delivery valve low pressure, and the impact of this factor is that the pressure on the low pressure delivery valve is too low so that the pressure on the low pressure pressure delivery valve is too low making filling the air bottle too long resulting in a high pressure delivery valve temperature too high. The effort to overcome the broken spring delivery valve low pressure is by replacing the broken spring delivery valve low pressure. For this reason, it is necessary to replace the spring delivery valve low pressure when its service life approaches 1500 working hours, and also clean the valve set every 500 working hours to ensure the valve is still in good and normal condition.

1. Introduction.

According to Miran & Tungkup (2023) ships are a means of sea transportation that can transport people and goods from one place to another. Adequate machinery is required to serve sea transportation. The presence of a compressor on a ship is very important because it is one of the auxiliary aircraft that supports ship operations and has a good work and maintenance system.

An air compressor is a device that sucks and collects air and then stores it in a tube, where the air is used to help operate the ship. According to Adnan et al. (2022), an air compressor is a machine that can produce high pressure air for use as a main engine starter, generator starter, service air, control equipment and safety equipment. To ensure the required air capacity remains met, maintenance is required for the compressor because it produces pressurized air which will be used to start the main engine, auxiliary engines, and work air services in the engine and deck sections. Since the role of the air compressor is very important for the initial starting of the main engine, maintenance must be carried out carefully according to the instructions in the user manual. However, damage to compressor parts often causes reduced compressed air production, which can cause greater damage.

According to Handoyo (2014) routine maintenance of air compressors must be given special attention to ensure that they can be used according to their function on the ship. The condition of the ship is ready to operate according to schedule because the ship is always required to be in prime condition and on time, which reduces unexpected repair costs. Maintenance cannot be carried out as planned if there are no spare parts on

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board.

During sea practice on the ship, there was a problem with the air compressor engine, namely filling the air from the compressor into the air bottle for too long. After observing it, it turned out that the compressor had decreased in pressure, which is normal pressure which should produce 30 kg/cm^2 in approximately 5 - 10 seconds with 2 bar it actually takes around 30 - 40 seconds to fill the air bottle with a pressure of 30 kg/cm^2, this will definitely have an impact on the operation of the main and auxiliary diesel motors. Meanwhile, the decline in air compressor performance will definitely disrupt the smooth operation of the ship.

In previous research conducted by Sallihima (2020) regarding the causes of decreased compression pressure in the main air compressor which was caused by wear on the piston ring (piston ring), lack of maintenance of the air filter (air filter), and leaks in the suction valve and pressure valve. Furthermore, research conducted by Harahap et al (2021) regarding the decrease in compression pressure of the main air compressor when filling air bottles was caused by wear and fracture of the piston ring and leaks in the suction and pressure valves. Then for research conducted by Patrick (2021) regarding the analysis of compression pressure reduction in air compressors caused by leaking suction and compression valves, worn piston rings and lack of maintenance. Of the three studies, the differences in the research are that there are different causes but they have the same symptoms, namely a decrease in compression pressure in the main air compressor which affects the filling of the air bottle. In these three studies, researchers found more fatal causes of damage to the main air compressor.

Based on the background above, researchers want to conduct research with the title "Identification the Cause of Decreased Main Air Compressor Performance in Relation to the Duration of Air Bottle Filling at MT. Giat Armada 01." The aim of this research is to determine the factors that cause a decrease in the performance of the main air compressor regarding the length of time it takes to fill air bottles at MT. Giat Armada 01 activities, the impact of this problem, and the efforts made to overcome it.

2. Research Methodology.

According to Rifa'i (2023) research methods are a series of techniques and procedures used by researchers to collect, analyze and present data or information that is relevant to their research topic. The research method in this study used descriptive qualitative. According to Nurmalasari & Erdiantoro (2020), qualitative descriptive research uses a simple qualitative approach and an inductive flow. Researchers use descriptive qualitative research methods because they will discover and develop theories through field data. The data collected is in the form of words or images and then the data will be confirmed as correct. Apart from that, researchers used this method because the aim was to understand the causes and impacts as well as efforts to solve the problem of how long it takes to fill wind bottles in MT. Giat Armada 01.

This research was carried out on the ship MT. Giat Armada 01 which is owned by the company PT. Indonesian Mini Ship. Researchers conducted this research for 12 months and 12 days starting from August 2 2022 in Gresik, East Java to August 14 2023 in Gresik, East Java.

The data sources in this research consist of primary data and secondary data. Primary data was obtained through observations on main air compressor no. 01, documentation, and direct interviews with the party responsible for the object of research carried out by the researcher, namely Machinist III who was related to the cause of the decline in performance of main air compressor no. 01 which resulted in a long bottle filling time wind. Meanwhile, in this qualitative research, secondary data was obtained through a literature survey using books and online information sources to support analysis and discussion (apart from language and informant behavior). In this research, the secondary data obtained by researchers came from the main air compressor manual book and journals about main air compressors.

Data collection techniques are carried out through observation, interviews and documentation. The observation activity carried out was by observing the problem of the length of time it took to fill the wind bottle. Then the interviews carried out are structured where the researcher already knows what will be asked of the informant. The informant in this research was Machinist III MT. Giat Armada 01. Meanwhile, documentation in the form of data is made in handwriting or in typed form and pictures of parts when researchers encounter problems regarding the causes of decreased main air compressor performance regarding the length of time to fill the air bottle. This documentation can be used by researchers to prove the data. The documentation is relevant and accurate during this research.

The data analysis technique in this research uses the Root Cause Analysis method with Tree Diagrams. According to Peerally et al. (2017) Root Cause Analysis is a method used to identify the fundamental cause of a problem or undesirable event. Researchers use this method because with the RCA (Root Cause Analysis) method, researchers can more easily find the root of the problem of the length of time it takes to fill the air bottle which is caused by a decrease in the performance of the main air compressor. There are several stages for research using the Root Cause Analysis (RCA) method, namely:

2.1. Defining the problem.

Define the problem or unwanted event clearly and specifically to make it easier for the next steps.

2.2. Collect data.

Collect data related to the problem, whether in the form of facts, information, or other evidence that is relevant to the problem being studied.

2.3. Identify possible causes.

In this case, researchers identify the factors that cause these problems to occur.

2.4. Identify the root of the problem.

This step is to find out that the identified root cause is actually the trigger for the problem.

2.5. Propose and implement solutions.

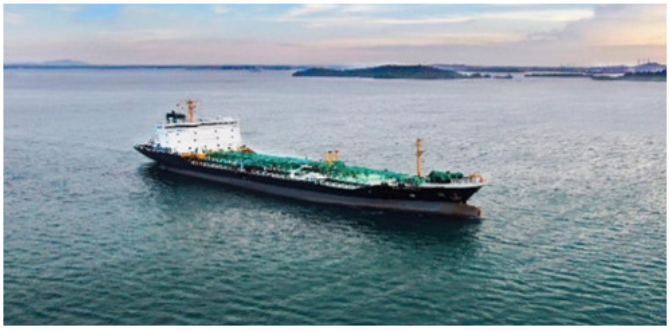
Researchers propose solutions that can be implemented efficiently and effectively so that it will not happen again in the future.

In research, data is tested to ensure the results are valid and trustworthy. This includes credibility, transferability, dependability, and confirmability tests. Researchers used the triangulation method in this research. This triangulation of credibility testing involves checking data from various sources with various methods and times. Source triangulation is a method of testing the validity of data that involves comparing information obtained from various different sources. In this context, triangulation uses observation, interviews and documentation methods. By combining data from these three methods, the research applies source triangulation to strengthen the validity and reliability of the data obtained.

3. Research Results and Discussion.

MT. Giat Armada 01 is a tanker type ship built in 1994 and owned by the company PT. Indonesian Mini Ship. This ship has a crew of 16 crew (9 deck crew and 7 engine crew). When researchers carried out sea practices, this ship was loaded with CPO (crude palm oil).

Figure 1: MT. Giat Armada 01.



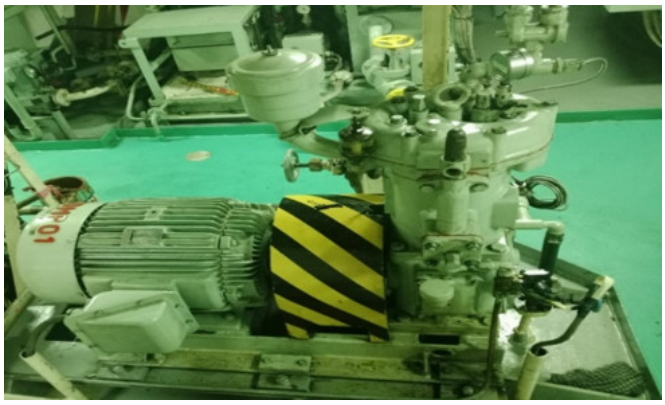
Source: Personal Documents.

Main Air Compressor (MAC) is an auxiliary aircraft on board a ship whose function is to compress air fluid from lower pressure to higher pressure which is used for auxiliary machinery on board both in the engine room and on the deck. The following is data from the compressor on the ship MT. Giat Armada 01.

Maker: Yanmar;
Model: S1ON – TH;
Pressure: 29.4 Kgf/cm^2;
Revolution: 1200 RPM;
Power: 15 KW.

On January 23 2023, when the ship was about to carry out maneuvers, the crew prepared all auxiliary machinery, one of which was the MAC. However, when filling the air bottle, an alarm sounded on the monitor in the engine room which showed that the air bottle pressure had decreased, then Machinist III checked. After checking, Machinist III found the pressure on

Figure 2: Main Air Compressor 01.



Source: Personal Documents.

MAC no. 01 which decreased by looking at the pressure gauge on the low pressure delivery valve which decreased from ± 0.5 bar to ± 0.2 bar in actual MAC No. 01. To identify the cause and repairs require time while the ship must remain operational, the chief engineer ordered Machinist III to start MAC No.02 while still monitoring and checking MAC No. 02 while underway so that the ship can remain operational.

While the researcher carried out observation activities at MT. Giat Armada 01, researchers obtained data related to factors that cause a decrease in the performance of the main air compressor regarding the length of time it takes to fill the air bottle, namely:

3.1. Uneven plate valve surface.

An uneven surface on the plate valve can cause a decrease in MAC performance. This can be caused by various things such as: mechanical wear, contamination by dirt particles, dust, or metal debris entering the compressor, corrosion, and excess pressure. After checking the plate valve, it is still in good and normal condition because the surface of the plate valve still looks flat.

3.2. Damage to the spring delivery valve low pressure.

Damage to the spring valve can cause reduced compressor performance and several operational problems. Some of the main causes of broken spring valves include: excessive heat, this can change the mechanical properties of the spring material, contamination by dirt particles, dust or metal debris entering the compressor, and the limit of service life ring delivery valve low pressure.

3.3. Worn ring piston.

The ring piston on an air compressor has an important function that is crucial to the performance and efficiency of the compressor. Air compressors work by compressing air in two stages to achieve higher pressure, and rings piston help in ensuring this process runs smoothly and efficiently. Rings piston ensure that there is no air leak between the piston and the cylinder wall during the compression process. This is very important to maintain

compressor efficiency, because air leaks will reduce the pressure produced. After observing the ring piston, it looks like it is still in good and normal condition.

3.4. Cylinder liner.

The cylinder liner is where the piston moves up and down to carry out the compression process. Its functions include providing a smooth, wear-resistant surface for the piston to move efficiently and minimizing friction, assisting in the dissipation of heat generated during the compression process to keep the engine running at optimal temperature, and protecting the main cylinder walls from wear and damage caused by friction repeated from the rings piston.

Apart from carrying out observation activities, the researcher also conducted interviews regarding the decline in the performance of the main air compressor regarding the length of time it took to fill air bottles with the informant, namely Engineer III who was on the ship MT. Giat Armada 01. The following are the results of the interview obtained from the informant:

Based on interviews conducted by researchers with Machinist III, the researcher asked "What caused the decline in the performance of the main air compressor regarding the length of time it took to fill the air bottle?", and the informant concluded that there was an identified factor that caused the time it took to fill the air bottle seen from the pressure gauge on the low pressure valve which indicates a decrease in pressure. The length of time it took to fill the air bottle could be revealed when checking at the time of the incident and it was found that the spring delivery valve low pressure was broken, this resulted in a drop in pressure from the low pressure valve.

The researcher asked again "What action should be taken when the spring delivery valve low pressure breaks?" The informant explained that to obtain a solution to the broken spring delivery valve low pressure, the spare part spring delivery valve at MAC No. 01.

Based on researchers' observations and interviews with informants during sea practice, factors were found that caused the decline in the performance of the main air compressor regarding the length of time it took to fill air bottles in MT. Giat Armada 01 activity was that the spring delivery valve low pressure broke. Based on interviews and observations, researchers found the impact of a broken spring delivery valve low pressure namely a leak in the low pressure delivery valve.

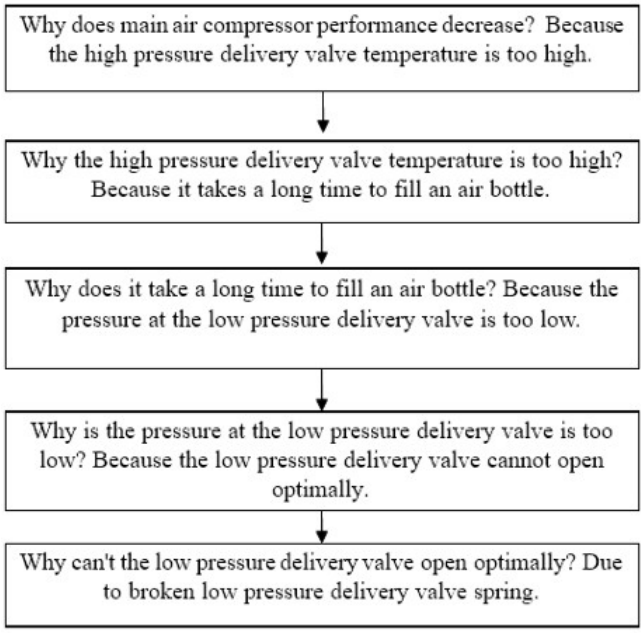
Thus, based on the research results that the researchers presented, these problems can be discussed:

3.5. The factor that causes the performance of the Main Air Compressor to decrease is that the spring delivery valve low pressure is broken.

Based on Figure 3, the researchers obtained the root cause of the decline in MAC No.01 performance against broken spring delivery valve low pressure.

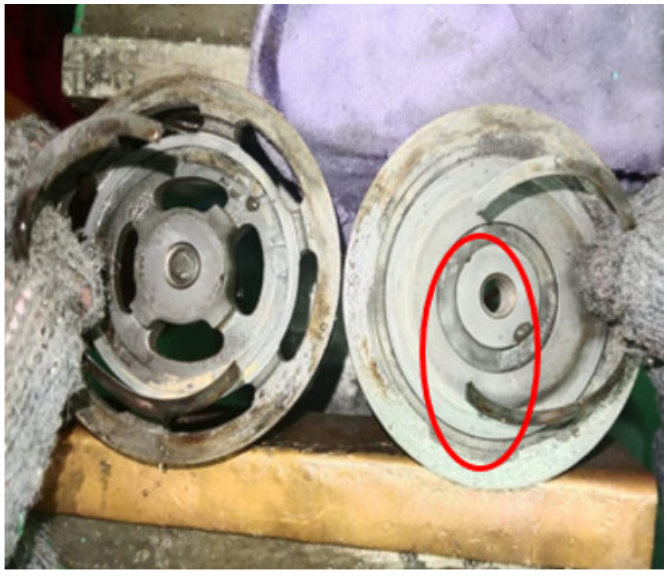
The spring delivery valve plays a role in regulating the air pressure entering the compressor. The incoming air pressure must match the compressor's requirements to produce the required pressurized air. When the air pressure entering the compressor is too low, the spring valve will open to allow air to enter at a higher pressure. Conversely, when the air pressure reaches the desired level, the spring valve will close to prevent air from entering with more pressure.

Figure 3: Analysis of the decline in main air compressor performance.



Source: Researcher Data.

Figure 4: Spring delivery valve.



Source: Personal Documents.

From Figure 4, it can be seen that the spring delivery valve low pressure is broken. Spring valves made from materials that cannot withstand repeated workloads or certain environmental conditions can experience material fatigue and ultimately break. Excessive heat can also cause the spring valve to break if particles of dirt, dust or metal debris enter the valve. in the

compressor it can increase the workload on the valve spring to a greater extent which can result in the valve spring breaking or material that is too stiff or inelastic can become susceptible to fracture due to repeated workloads. And also spring valves that are old or have been used for a long period of time can experience wear or structural damage that causes them to break. In the instruction manual book the spring delivery valve low pressure is replaced after 1500 hours of work/operation.

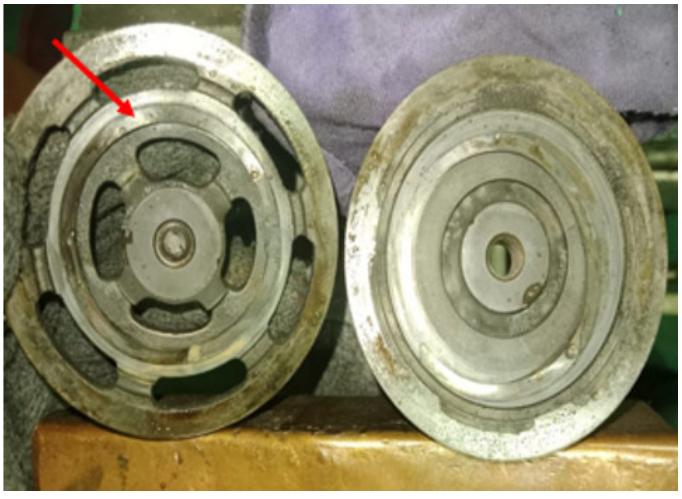
3.6. The impact of a broken spring delivery valve low pressure takes longer to fill the air bottle.

The impact of a broken spring delivery valve low pressure is that the low pressure delivery valve cannot open optimally, because of this the pressure on the low pressure delivery valve is too low which causes it to take a long time to fill the air bottle so that the temperature of the high pressure delivery valve is too high, which results in reduced performance main air compressor.

3.7. An effort to overcome the cause of the decline in the performance of the main air compressor regarding the length of time it takes to fill the air bottle is to replace the spring delivery valve low pressure.

Based on the description of the causes that have been explained, the effort that can be made to overcome the broken spring valve delivery low pressure is to replace the low pressure delivery valve spring. After making the change, observe the main air compressor when it is turned on and make sure the pressure on the pressure gauge is in accordance with the instruction manual book. So that this incident does not happen again in the future, it is necessary to replace the spring valve delivery low pressure when its service life approaches 1500 working hours, so that the low pressure valve can work optimally.

Figure 5: Change the spring valve delivery low pressure.



Source: Personal Documents.

To overcome the problems described, routine maintenance must be carried out to ensure that the main air compressor is working properly and does not experience problems in operation. The following is the main air compressor maintenance schedule:

Table 1: Maintenance main air compressor schedule.

Component	Activity	Time Distance
Low pressure valve	-Suction air duct cleaning	Every 400 hours of work/operation
	-Change the plate valve suction low pressure	Every 4000 hours of work/operation
	-Change the spring valve suction low pressure	Every 3000 hours of work/operation
	-Change the plate valve delivery low pressure	Every 3000 hours of work/operation
	-Change the spring valve delivery low pressure	Every 1500 hours of work/operation
High pressure valve	-Change the plate valve suction high pressure	Every 3000 hours of work/operation
	-Change the spring valve suction high pressure	Every 4000 hours of work/operation
	-Change the plate valve delivery high pressure	Every 2000 hours of work/operation
	-Change the spring valve delivery high pressure	Every 1500 hours of work/operation
Piston	-Replacing the ring piston	Every 5000 hours of work/operation
Gasket	-Gasket maintenance	Make changes when you see cracks or physical damage to your clothes
General	- Oil level check	Before operation
	- Change the lubricating oil	Every 30 hours of work/operation
	-Relief valve inspection	Once every year

Source: Manual book.

Conclusions.

Based on the results and discussion that have been presented, researchers can conclude that the factors that cause the decline in the performance of the main air compressor are the length of time it takes to fill air bottles in MT. Giat Armada 01 was that the spring valve delivery low pressure broke. Then the impact of the broken spring valve delivery low pressure is that the low pressure delivery valve cannot open optimally so that the pressure on the low pressure delivery valve is too low, causing the air bottle to be filled for too long, causing the high pressure delivery valve temperature to be too high, so it is difficult to overcome the decline in performance. The air compressor's

main control for the length of time it takes to fill the air bottle is by replacing the broken spring valve delivery low pressure.

Thus, regarding this problem, the crew and parties involved in MT. Giat Armada 01 should respon can carry out and improve periodic maintenance in accordance with the instruction manual book, carry out routine and regular checks on the main air compressor to minimize the decline in the performance of the main air compressor which can hamper the production of compressed air and slow down the ship's movement process, and can replace spring valve delivery low pressure when its service life approaches 1500 working hours, and also clean the valve set every 500 working hours to ensure the valve is still in good and normal condition.

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