

SEAT RING VALVES FAILURE: THE CAUSES AND IMPACTS ON THE CARGO OIL PUMP PERFORMANCE ON MT. KIRANA NAWA

Daifullah Aprilianda*, Janny Adriani Djari, Ria Hermina Sari

Maritime Science Polytechnic Semarang, Semarang

*Corresponding author: daiananda5@gmail.com

Abstract

Cargo discharging is one of the important activities in ship operations. MT. Kirana Nawa experienced a delay during cargo discharging in Batangas, Philippines, on 5 October 2023. Normally, the discharging process would only take one day, but at that time, it took two days to complete. This delay was caused by damaged seat ring valves. This study aimed to identify the factors causing the seat ring valve failure, their impact on the performance of the cargo oil pump, and the role of the ship's crew in maintaining the seat ring valve to ensure that the cargo oil pump can operate optimally during the discharging process. The research used a qualitative method, in which triangulation techniques were used to obtain the data. The collected data were then analyzed using the Fishbone diagram. The study revealed the main factor causing seat ring valve failure on MT. Kirana Nawa was the over-running hours of the seat ring valves due to the lack of usage records. It then impacted the cargo oil pump performance, which became not optimal, leaving residual cargo in the ship's tank and causing delays in the discharging process. Thus, the ship's crew needs to ensure that cargo oil pump performance is optimal by keeping updated records of the seat ring valve's usage and familiarizing the crew with the correct valve operation according to the manual.

Keywords: Discharging process, Cargo oil pump, Seat ring valve

INTRODUCTION

A tanker is one of the most important means of transportation in the maritime industry designed to transport liquid cargo in bulk, such as petroleum cargo. Oil tanker ships are ships that are focused on transporting cargo in the form of bulk oil from loading ports or production ports to unloading/processing ports (Melati Darmastuti, 2019). Along with the advancement of science and technology, tankers also experience developments and updates, especially in loading and unloading equipment on ships. Technological advances in tankers are certainly very helpful in speeding up the loading and unloading process. Loading and unloading is an effort to move cargo from ship to port or vice versa (Samuel Budi Defrianto, 2023). Loading and unloading is the transfer of cargo from and to the ship to be stockpiled into or directly transported to the owner of the goods through the port dock by using loading and unloading equipment, either located at the dock or on the ship (Dwi Sri Wahyu Ningrum, 2021), loading and unloading is the transfer of cargo from and to the ship to be stockpiled into or directly transported to the owner of the goods through the port dock by using loading and unloading equipment, either located at the dock or on the ship. On a tanker, unloading can be defined as a process of moving liquid cargo from the ship's tank to the land tank. Loading activities can be defined as a process of moving liquid cargo from the land tank into the ship's tank. Technological advances in loading and unloading equipment on ships must also be supported by sufficient human resources to operate the equipment on the ship correctly and according to the procedures contained in the manual book.

In carrying out the operation of increasingly sophisticated and advanced equipment, this is a challenge that must be better mastered by the ship's crew. A cargo oil pump is one of the equipment that plays an important role in implementing the loading and unloading process on a tanker. A cargo pump is a type of pump that is principally used to transfer liquid cargo (oil and chemical products) from tanks on one ship to another ship or tank on land (Sumarno P.S., 2018). A pump is a device that moves a liquid from one place to another by flowing the liquid (Mela Rizki Angraini, 2021). The type of pump used on MT. Kirana Nawa is a type of centrifugal pump. Centrifugal pumps or centrifugal pumps are pumps that have the main element in the form of a driving motor with an impeller that rotates at high speed (Gatot Ranggatama, 2020). If there is damage to the cargo oil pump, the tanker cannot carry out the loading and unloading process. Therefore, the performance of the cargo oil pump is very important for the ship's loading and unloading process. Performance is the result of a process that is measured over a certain period based on predetermined provisions, standards, or agreements (Nabila, 2023). Performance can also be interpreted as a record of the results produced for certain job functions or activities over a certain period (Dudung Hadiwijaya, 2021). From this explanation, it can be concluded that performance represents the results achieved through work indicators in the work system. In this case, sophisticated loading and unloading equipment also cannot guarantee the timeliness of loading and unloading, so the ability of the ship's crew to operate loading and unloading equipment must be developed under applicable procedures in the use of current technology to create time efficiency in the loading and unloading process and the safety of the operating crew.

The research was conducted on board MT. Kirana Nawa on 3 January 2023 to 5 January 2024. MT Kirana Nawa is classified as a new ship because it was built in 2019. However, deck and engine maintenance are always carried out so that the condition of the engine and deck is always in prime condition. MT. Kirana Nawa carries out the loading and unloading of black oil cargo from the port under the voyage order from the charter party. During the implementation of the research, it was found several times that the Chief Officer experienced difficulties during the unloading process. This is because the black oil cargo cannot be maximally sucked by the cargo oil pump. This happened when the ship was unloading cargo in Batangas, Philippines, on 5 October 2023. At that time, the ship unloaded MFO (Marine Fuel Oil) cargo for 2 days. In normal conditions, the unloading process of cargo with the same type and total cargo takes only 1 day. However, when unloading cargo, there is still 35,519 mt of MFO remaining in the ship's tank that the cargo oil pump cannot suck. As a result, the ship received a protest from the Loading Master and a penalty in the form of a Note of Protest.

Valve is a valve that functions to manage, provide flow, or control the flow of liquid by opening and closing, shrinking or enlarging the flow. Valve is a mechanical instrument that manages fluid flow or pressure (Risky Arman, 2019). Valve has many types including globe valve, butterfly valve, ball valve and others. Various types of valves with different characteristics and operations, including: pinch valve, needle valve, globe valve, ball valve, diaphragm valve, butterfly valve, plug valve, check valve, and others (Abdul Malik, 2021). On the ship MT. Kirana Nawa uses a type of butterfly valve in its use. Butterfly valve is a type of multifunctional valve that can be used in various pipe systems including industry, ship construction, platforms, housing and so on (Rizky Arman, 2019). "A butterfly valve is a shut-off valve with a relatively basic configuration." (R.Manikandan, 2021). From this explanation, it can be interpreted that the butterfly valve is a valve that has a simple and multifunctional way of working, making it suitable for use in various conditions in the piping system.

The valve seat ring is a surface inside the valve that is in direct contact with the disk, which is a component that seals and allows flow through the valve. The seat ring also has the following

explanation “seat ring is a part of the valve body assembly that provides a seating surface for the closure member and can provide part of the flow control orifice.” (Emerson, 2023). “Seat ring is a surface inside the body of a valve that comes into contact with the disc, which is a moveable component that restricts and allows flow through the valve.” (S. Sathishkumar, 2017). From the above explanation, it can be interpreted that the seat ring is part of the valve that provides a seat for the valve disk and can be part of the flow control hole. Seat ring valves must meet functional criteria, such as flow, mechanical and thermal functions (Christian Boeling and Eberhard Abele, 2018). The valve seat ring has a function to close the gap between the valve disk and the valve body, thus causing the valve to become impermeable. However, if there is damage to the valve seat ring, this causes the valve to become impermeable due to a leak in the valve seat ring. With the impermeability of the valve, this can result in the cargo oil pump not being able to work optimally because the cargo oil pump sucks air and of course this hampers the unloading process.

Based on the background that the researchers have described, the purpose of this study is to determine the factors that cause damage to the seat ring valve on MT. Kirana Nawa, define the impact caused by a damaged seat ring valve on the performance of the cargo oil pump on MT. Kirana Nawa and knowing the role of the ship's crew in maintaining the seat ring valve so that the cargo oil pump can work optimally during the unloading process.

LITERATURE REVIEW

1. Seat Ring Valve

Emerson (2023) states “seat ring is a part of the valve body assembly that provides a seating surface for the closure member and can provide part of the flow control orifice.” From the explanation above, it can be interpreted that the seat ring is a part of the valve that provides a seat for the valve disk and can be part of the flow control orifice. According to S. Sathishkumar (2017), “Seat ring is a surface inside the body of a valve that comes into contact with the disc, which is a moveable component that restricts and allows flow through the valve.” It can be interpreted that the valve seat ring is a surface inside the valve that is in direct contact with the disk, which is a component that closes and allows flow through the valve. Christian Boeling and Eberhard Abele (2018) explain that the seat ring valve must meet functional criteria like flow, mechanical, and thermal functions. The meaning of mechanical is that the seat ring must have the ability to withstand mechanical loads when in direct contact with the valve in operation. Meanwhile, thermal indicates that the valve seat ring must withstand heat. The flow function on the valve seat ring is to drain a flow. From the explanation above, it can be concluded that the function of the valve seat ring is to withstand a flow pressure with a certain temperature.

2. Valve

According to Mandanaka in Risky Arman (2019), a valve is a mechanical instrument that manages fluid flow or pressure. A valve functions to manage, provide flow, or control the flow of liquid by opening and closing, reducing or increasing the flow. In this study, a valve can be defined as a device installed in a piping system that has the function to control, regulate, and directing the flow of liquid by fully or partially opening and closing the valve to get the desired pressure, the valve can also be likened to a faucet. Abdul Malik (2021) mentions various types of valves with different characteristics and operations, including pinch valves, needle valves, globe valves, ball valves, diaphragm valves, butterfly valves, plug valves, and check valves. The valves often used on tankers

are butterfly valves, check valves, non-return valves, gate valves, globe valves, plug valves, and gate valves. In this study, researchers will only discuss butterfly valves. R.Manikandan (2021) states, "A butterfly valve is a shut-off valve with a relatively basic configuration." It can be interpreted that a butterfly valve is a shut-off valve with a relatively basic configuration. According to Rizky Arman (2019), a butterfly valve is a type of multifunctional valve that can be used in various pipe systems, including industry, ship construction, platforms, housing, etc. From this explanation, it can be interpreted that the butterfly valve is a valve that has a simple and multifunctional way of working, making it suitable for use in various conditions in the piping system.

3. Cargo Oil Pump

According to Sumarno P.S. (2018), a cargo pump is principally used to transfer liquid cargo (oil and chemical products) from one ship to another ship or tank on land. From this description, the cargo oil pump can be interpreted as a device that functions to move or pump liquid cargo from the ship's tank to the tank of another ship or port. In this study, researchers will explain centrifugal pumps because this pump is used on MT. Kirana Nawa. According to Gatot Ranggatama (2020), centrifugal pumps have a main element: a driving motor with an impeller that rotates at high speed. Centrifugal pumps are widely used in industry because they have more advantages than other pumps.

4. Unloading Process

According to F.D.C. Sudjarmiko in Dwi Sri Wahyu Ningrum (2021), loading and unloading is the transfer of cargo from and above the ship to be stockpiled into or directly transported to the owner of the goods through the port dock by using complementary loading and unloading equipment, either on the dock or on the ship. According to Samuel Budi Defrianto (2023: 69), loading and unloading is moving goods or cargo from conveyances (ships) to land or vice versa. On tankers, unloading can be defined as a process of transferring liquid cargo from ship tanks to land tanks, and for loading can be interpreted as moving cargo from land tanks to ship tanks.

RESEARCH METHOD

Research methods are scientific ways to collect data for specific purposes and uses (Sugiyono, 2019). In this study, researchers applied qualitative research methods with a descriptive approach. Qualitative research methods produce descriptive data in the form of written or spoken words from people and observed behavior (Bogdan and Taylor in Marinu Waruwu, 2023). The descriptive research approach is conducted to determine the existence of independent variables, either only one or more variables (variables that stand alone), without comparing these variables and without looking for relationships with other variables (Sugiyono, 2020). This research was conducted on the MT. Kirana Nawa for 12 months, from 3 January 2023 to 5 January 2024.

The data sources in this study consist of primary data and secondary data. Primary data is a data source that provides data directly to data collectors (Sugiyono, 2018). Primary data is collected directly from the first source, in this case, the crew and the research location, namely the MT. Kirana Nawa. Researchers used the results of observations about seat ring valve damage on MT. Kirana Nawa and the results of interviews with the ship's crew, namely the Master, Chief Officer, Pumpman, and Bosun, regarding the causes of seat ring valve damage that affect the performance of the cargo oil pump as primary data in this study. Meanwhile, secondary data can be defined as data sources that do not provide data directly to data collectors (researchers), for example, through other people

or documents (Sugiyono, 2018: 456). In this study, the secondary data was obtained through photographs of the damage to the seat ring valve and related ship documents, namely reports on seat ring valve replacement and seat ring valve maintenance documents.

All data were collected through observation, interview, and documentation study. Researchers made observations by observing the loading and unloading process where the seat ring valve was damaged. Then, the researcher interviewed several crew members on the ship: the master, Chief Officer, Pumpman, and Bosun. Documentation studies were carried out by analyzing photos of seat ring valve replacement, ship documents, and seat ring valve replacement reports. All the results were noted and recorded by the researchers.

Researchers adopted a qualitative data analysis from Miles and Huberman, in which the collected data were reduced and presented before concluding (Sugiyono, 2017). Data reduction is done by summarizing the data obtained to focus on the data under study, namely the cause of seat ring valve damage, which affects the performance of the cargo oil pump. The data in this study are presented in the form of narratives, tables, and images that explain the problems regarding seat ring valve damage that affect the performance of the cargo oil pump. This study also used a fishbone diagram to analyze the causes of seat ring valve damage that affect the performance of the cargo oil pump on MT Kirana Nawa. The fishbone diagram or cause and effect diagram is one of the tools used to identify or show a causal relationship to find the root cause of a problem (Yoston Harada Sinurat, 2022). It is called a fishbone diagram because its shape is similar to a fishbone where the head snout is facing to the right (Agniya Thahira, 2023).

RESULTS AND DISCUSSION

1. Factors affecting seat ring valve damage at MT. Kirana Nawa

According to the fishbone diagram that the researchers have made, several factors were found to be the cause of seat ring valve damage, namely:

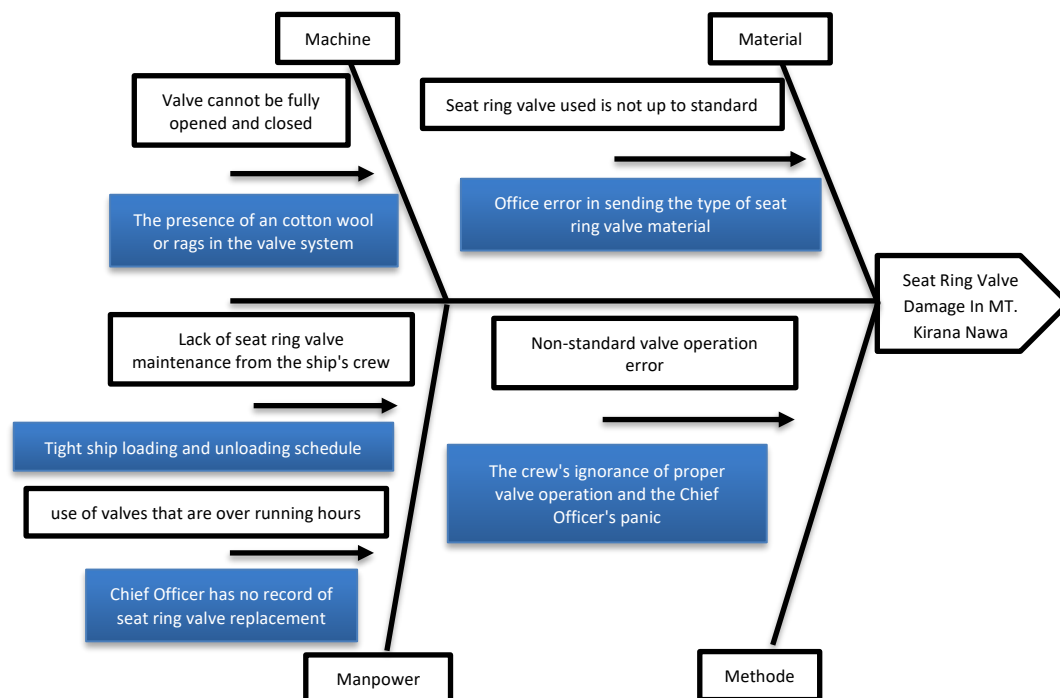


Figure 1. Fishbone diagram

a. Incorrect valve operation

When conducting research, researchers found valve operation methods that needed to follow the SOP of valve operation. Researchers found that the AB on duty and the Ordinary Seaman on duty did not understand the valve operation correctly. When operating the valve, the valve opening and closing were done quickly. This incident occurred when unloading activities were almost complete on voyage 43 in Batangas, Philippines. At that time, the Marine Fuel Oil (MFO) unloading process was almost complete. There was only one more tank left, but at that time, the cargo oil pump could not suck the cargo from the tank. The incident made the Chief Officer panic and told the deck duty AB to close and open the valve repeatedly and quickly so that the cargo oil pump could suck the cargo. However, despite doing this, the cargo still could not be sucked by the cargo oil pump. Thus, the incorrect valve operation became one factor contributing to the damage of the seat ring valve.

b. Non-standard valve seat ring.

Using a seat ring valve that is not up to standard has damaged the seat ring valve. This is because the company was incorrectly sending the type of seat ring valve material requested by the ship. MT. Kirana Nawa uses a Viton-type seat ring valve, but the seat ring valve sent by the company does not have any brand. Meanwhile, on 9 October 2023, there was damage to the seat ring valve on valve C51, which resulted in the seat ring valve having to be replaced with a new one. The Viton-type seat ring valve ran out in this incident, so the Chief Officer was forced to use an unbranded seat ring valve. After the installation, the Chief Officer ordered Pumpman to carry out testing on the same day. When the pumpman tested the valve by opening and closing it, a problem occurred: the valve could not be fully opened and closed. Finally, the valve was disassembled again and rechecked. It turned out that caused the valve not to be able to open and close fully because the valve seat ring was torn again, preventing the disk from opening and closing. Consequently, the Chief Officer could not do anything, so he could only wait for the company to resend the Viton-type valve seat ring. The seat ring valve on valve C51 was again replaced on 27 November 2023 with a Viton-type seat ring valve.

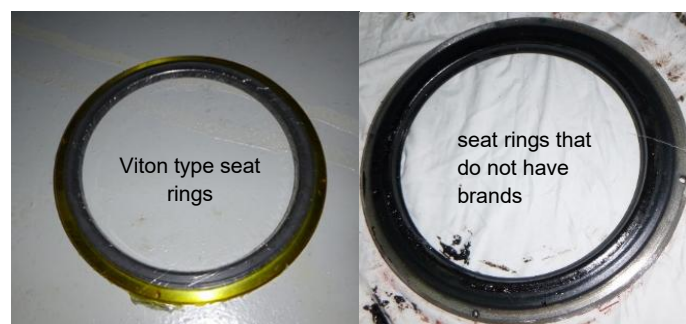


Figure 2. Viton-type seat rings and seat rings that do not have brands

- c. The presence of cotton wool or rags in the valve system.



Figure 2. The presence of cotton wool on the valve

One of the factors that cause damage to the valve seat ring is the presence of cotton wool or rags in the valve system. This incident occurred when the Pumpman repaired the valve seat ring on valve S8 in the stripping suction pipe section on 30 November 2023. When the valve was disassembled for cleaning, there was cotton wool or rags in the valve system, which prevented the valve from being fully closed because cotton wool blocked the valve disk. This led to the damage to the seat ring valve.

- d. There was no record of seat ring valve replacement on board.

Another factor that affects the damage to the seat ring valve on the MT. Kirana Nawa is over running hour. This occurred because the ship had no seat ring valve replacement records. Based on the observations, the researchers noticed that the seat ring valve replacement was carried out when the seat ring valve was damaged. Usually, every component on the ship must have a standard running hour. The valve maintenance manual on MT. Kirana Nawa stated that the running hour of the seat ring valve is 3000 times, where the valve opening and closing are counted as one-time usage. So, if the use of the seat ring valve exceeds the running hour, the seat ring valve must be replaced with a new one. However, the researchers had yet to find a record of replacing the seat ring valve, so it is unknown how long it had been used. There should be a record of seat ring valve replacement to monitor the seat ring valve running hours more efficiently and know when it needs to be replaced. A good condition of the seat ring valve will maintain the performance of the cargo oil pump so that the loading and unloading process can be optimized.

- e. Lack of valve maintenance

The lack of valve maintenance from the ship's crew is also one of the causes of seat ring valve damage. This is due to the ship's busy loading and unloading schedule. The Chief Officer as the head of work on the deck, also believes that the loading and unloading schedule of the MT. Kirana Nawa is too busy. Based on observations, MT. Kirana Nawa carried out a total of 50 voyages in one year. Every month, MT. Kirana Nawa carries out 4 to 5 voyages where the distance between the unloading and loading ports is only 20 hours. Therefore, the crew of the MT. Kirana Nawa rarely carries out maintenance due to the busy loading and unloading schedule, which resulted in a lack of maintenance and caused damage to the seat ring valve.

2. Impact of damaged seat ring valve on cargo oil pump performance at MT. Kirana Nawa

a. Cargo Oil Pump Performance was not Optimal.

Cargo oil pump works by sucking the cargo in the ship tank through the suction pipe and channeled to the exhaust pipe to the land tank. Between the suction pipe and the exhaust pipe, many supporting components control the cargo oil pump. Supporting components between the suction and exhaust pipes include bellmouth, stainer, valve, and manifold. The bellmouth on this component serves to help suck the cargo at the bottom of the tank. The valve controls the charge that will be moved through the suction and exhaust pipes. After that, the cargo flows to the manifold, where the manifold connects the land tank and the tank on the ship. There is a valve seat ring on the valve that functions as a valve disk holder so that the valve becomes impermeable. If the seat ring valve is damaged, this dramatically impacts the performance of the cargo oil pump.

The seat ring valve significantly impacted the performance of the cargo oil pump on MT. Kirana Nawa. The type of cargo oil pump on MT. Kirana Nawa is a centrifugal type where this type of cargo oil pump has a weakness, such as if there is air entering the cargo oil pump system, the cargo oil pump cannot suck the cargo from the tank. Therefore, the seat ring valve greatly affected the performance of the cargo oil pump. The effect of the seat ring valve on the cargo oil pump is that if the seat ring valve is torn, it can cause the valve to become impermeable and can make air enter the cargo oil pump. The impact caused by the entry of air into the cargo oil pump is that the cargo oil pump cannot suck the cargo from the tank.

b. The presence of remaining cargo in the tank.

The impact of seat ring valve damage found by researchers during observation is the presence of remaining cargo in the tank. It was caused by the air entering the cargo oil pump system making the cargo oil pump unable to suck cargo. The entry of air in the cargo oil pump system can result in the remaining cargo in the tank that the cargo oil pump cannot suck. Consequently, this causes the cargo transferred ashore to be less than the cargo in the ship's tank before unloading. Due to this issue, the ship received a Notice of Protest from the shore because the amount of cargo sent to the shore tank was less than the amount of cargo in the ship's tank at the loading time, according to the Bill of Lading.

c. Delay in unloading process time

Based on the results of the documentation study, the impact of seat ring valve damage is the longer unloading time. This is due to the failure to optimize the performance of the cargo oil pump. This event was proven when the ship unloaded Marine Fuel Oil (MFO) at CPI BATANGAS TERMINAL #5A, Philippines, which usually took 1 day to unload to 2 days to carry out the unloading time. It then resulted in the ship getting a Letter of Protest from the terminal.

3. The role of the ship's crew to keep the seat ring valve in good condition so that the performance of the cargo oil pump can be maximized.

The role of the ship's crew is vital so that the seat ring valve can remain in good condition and durable. Things that the ship's crew can do are:

a. Operate the valve according to the manual book

A manual book is a book that contains instructions on how to use and how to maintain an item or product. All items on board must have a manual book. Researchers found that the crew operated the valve not by the manual book or standard. This resulted in the valve seat ring becoming damaged and hampering the performance of the cargo oil pump. The crew should be advised to read the

manual book before operating the valve to avoid damage to the seat ring valve. In this case, each product has different specifications and usage methods.

The crew's role in keeping the seat ring valve in good condition is to operate the valve following the manual. Based on the results of the interview with the Chief Officer, this strengthens the evidence that operating the valve in accordance with the manual book can keep the seat ring valve in good condition.

b. Perform valve maintenance according to PMS



Figure 3. Valve maintenance

Plan Maintenance Schedule (PMS) is a schedule the company has made and planned to carry out equipment maintenance on board. Therefore, the PMS contains equipment that needs maintenance and when to carry out maintenance. However, when conducting research, researchers noticed a problem, namely the busy loading and unloading schedule of the ship, which resulted in the crew being unable to perform maintenance. An example of PMS on board MT. Kirana Nawa, regarding valve checking and maintenance is checking valves carried out every week before loading and unloading activities. However, the valve maintenance is carried out every month. Therefore, the Chief Officer should be able to utilize the time available to maintain equipment on board effectively so that it takes little time and gets good results.

One of the roles of the crew in keeping the seat ring valve in good condition is to conduct a Plan Maintenance Schedule (PMS). This is important because it can improve the performance of the cargo oil pump due to the good condition of the seat ring valve. The results of interviews with the Master further strengthen the evidence that implementing the Plan Maintenance Schedule (PMS) can keep the seat ring valve in good condition.

c. Familiarization of the ship's crew on proper valve operation

Familiarization is making people familiar or familiar with something fluently. Familiarization is very important at the beginning of the crew boarding the ship. However, there was no familiarization of valve operation on the MT. Kirana Nawa. It made the crew not understand the correct valve operation. Officers usually exemplify familiarization on board to make the crew understand the use of an item or equipment. The Chief Officer should give the familiarization of how to operate the correct valve according to the manual. It aimed to help the crew understand how to operate the valve correctly.

Thus, one of the crew's roles in maintaining the seat ring valve in good condition is to familiarize themselves with how to operate it correctly. This is important because correct valve operation makes the seat ring valve more durable and not easily damaged, and it is essential that the crew understands how to operate a tool, including the valve.

CONCLUSION

Based on the results and discussion, it can be concluded that the main factor affecting the damage to the seat ring valve on MT. Kirana Nawa, is an absence of seat ring valve replacement records on the ship, resulting in the seat ring valve becoming overused. The impact of a damaged seat ring valve on the performance of the cargo oil pump on MT. Kirana Nawa is the decreased performance of the cargo oil pump, causing the remaining cargo in the ship's tank and the delay in unloading time. As a result, the ship received a penalty in the form of a Notice of Protest and a Letter of Protest. The role of the ship's crew is to keep the seat ring valve in good condition so that the cargo oil pump's performance can be maximized by familiarizing the ship's crew with the correct valve operation following the manual book. Familiarization on board the vessel is usually exemplified by the officers, who aim to make the crew understand how to operate the valve correctly by the manual book.

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