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Research Paper

Optimization of Cargo Pump Treatment by Hydrochloric Acid (HCl) Loading at MT. Cipta Anyer

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Abstract

The research is motivated by the occurrence of mechanical seal leakage in cargo pumps, which hampers the efficiency of the loading and unloading process. A mechanical seal is a mechanical component used in various industrial applications, such as pumps, to prevent leakage from the rotating shaft and stationary wall.

The research method used in this thesis is qualitative descriptive, employing the SWOT (Strengths, Weaknesses, Opportunities, and Threats) approach to facilitate data analysis. The data collection methods utilized by the author include observation, interviews, and documentary studies to strengthen the data analysis. The objectives of this research are to identify the causes of damage to the mechanical seal, the handling of mechanical seal damage, and the efforts/methods to prevent mechanical seal damage on MT. Cipta Anyer.

The conclusion revolves around the causes of mechanical seal damage, the methods to handle such damage and preventive measures. The causes of damage include surface wear connected to the pump shaft, direct contact of hydrochloric acid (HCl) with the cargo pump, and incorrect installation of spare parts for the mechanical seal. Solutions to address the damage involve identifying the specific issues, replacing them with genuine and compliant spare parts, and ensuring proper and procedure-compliant installation. To prevent damage, it is advisable to utilize modern equipment, maintain supervision by engineers, and select experienced crew members.

Keywords *optimization, cargo pump, mechanical seal HCl*

INTRODUCTION

Indonesia has long been renowned as a maritime country due to its vast waters. Therefore, a comprehensive and capable maritime transportation infrastructure is crucial for the distribution of goods and public transportation to various regions in Indonesia. One of the means of developing maritime transportation is through the use of sea vessels, and one example is the tanker ship.

A tanker ship is a type of transportation that carries cargo in liquid form. This vessel comes in various types depending on the material to be transported, such as oil tankers, gas tankers, and chemical tankers. Tanker ships are equipped with modern technology and are available in various capacities and sizes. Approximately 30% of the total commercial ships worldwide are tanker ships, ranging from small self-propelled barges to very large crude carriers.

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Tanker ships initially were utilized by oil companies to distribute liquid cargo in small capacities. Transporting oil by tanker ships can be considered advantageous as larger quantities of liquid can be transported at a lower cost, leading to an increased demand for tanker ships. Due to advancements in maritime science and technology, tanker ships require quality seafarers to operate cargo handling equipment and machinery on board.

To support smooth sailing, maintenance of auxiliary equipment is necessary, as it serves as the cargo handling tool used on tanker ships. The common issue encountered on board is the presence of deviations in the operation and maintenance of cargo pumps, which can result in damage or suboptimal performance of the cargo pumps.

A cargo pump is a type of pump primarily used to transfer liquid cargo (such as oil and chemicals) from the ship's tanks to port tanks or other ship tanks. One crucial component of the cargo pump is the mechanical seal, which contains the fluid, restricts hydraulic oil, and handles the load to ensure optimal performance.

An example of a product transported in a tanker ship is hydrochloric acid (HCl), which falls under the category of chemical products. Hydrochloric acid is an aqueous solution of hydrogen chloride gas. It is a strong acid and finds extensive use in various industries. Proper safety precautions must be taken when handling hydrochloric acid, as it is a highly corrosive liquid that can react with other materials such as iron, steel, and aluminum.

On MT. Cipta Anyer, during each journey from the unloading port at PT. AKR Surabaya to the loading port at PT. ASC Banten, the engineers, and the engine crew perform maintenance on the cargo pump to ensure that the mechanical seals are in good condition and ready for use. This ensures optimal pump performance during the loading and unloading process. Recognizing the importance of engineers possessing proficient operational and maintenance skills for the mechanical seals of the pumps, the researcher conducted a study titled: "Optimizing the Maintenance of Cargo Pump by Hydrochloric Acid (HCl) Cargo on MT. Cipta Anyer."

Based on the aforementioned background, the following research questions can be formulated:
1. What are the causes of mechanical seal pump damage?
2. How can mechanical seal pump damage be addressed?
3. What are the efforts/methods to prevent mechanical seal pump damage?

LITERATURE REVIEW

Theory description

Optimization is the process or effort to achieve better results or performance from an existing system or process by maximizing the efficient and effective utilization of available resources. The goal of optimization is to improve the quality, quantity, speed, accuracy, and efficiency of the enhanced system or process, thereby providing greater benefits and reducing associated costs or risks.

Maintenance is a series of actions or efforts to preserve or improve the condition and performance of equipment, machinery, or systems to ensure they function well and safely. Maintenance includes inspection, maintenance, repair, and replacement of damaged or worn-out components.

A pump is a device or machine used to transfer liquids or gases from one place to another by utilizing pressure or force differentials. Pumps can take various forms, such as water pumps, fuel

pumps, vacuum pumps, or chemical pumps, depending on the type of fluid or gas being transferred and their intended function.

According to Tirta (2019), optimizing pump maintenance is crucial to ensure smooth equipment operation and prevent pump damage. In this research, an analysis and evaluation of pump conditions in the chemical industry were conducted, resulting in recommendations to improve efficiency and extend the lifespan of pumps through proper maintenance. According to Banaszek and Urbanski (2020), on tanker ships, cargo pumps are vital components used to transfer liquid cargo from tanks to docks or vice versa. In this study, an analysis of cargo pump performance and maintenance on tanker ships was conducted to enhance efficiency and minimize equipment damage.

On the MT. Cipta Anyer ship, the cargo pump used is a centrifugal pump with a capacity of 280 m^3/h, consisting of 2 sets, with a pressure of 6 kg/cm^2 each, and an RPM of 1800, driven by a diesel engine. Under normal conditions, the typical capacity used is 220 m^3/h, with a pressure of 5 kg/cm^2 and an RPM of 1600. During the researcher's sea practice, the pump's capacity started to decrease to around 150-200 m^3/h, with a pressure of 5 kg/cm^2 and an RPM of 1600.

A cargo pump is a type of pump used on tanker ships or cargo vessels to transfer cargo or goods from the ship's tanks to the dock or vice versa. Cargo pumps are usually equipped with pressure gauges, valves, and integrated piping systems within the ship's tank system.

Optimizing the maintenance of cargo pumps is expected to improve the effectiveness and efficiency of cargo pump operation, extend the pump's lifespan, and reduce maintenance and repair costs for the cargo pump. This will have a positive impact on the smooth transportation process of hydrochloric acid cargo on the MT. Cipta Anyer ship, as well as improve the safety and health of the ship's crew.

According to Melysa (2021), in centrifugal pumps, external energy is transferred to the pump shaft to rotate the impeller in the fluid. The fluid within the impeller is then compressed by the rotating impeller's blade momentum. A centrifugal pump is a pump that utilizes an impeller as an energy source. An impeller is mounted on one end of the shaft, and a coupling is installed on the other end to transmit power from the driving force. The shape applied to the impeller allows the fluid flow to create a flow perpendicular to the pump's axis. Centrifugal pumps have mechanical seals that are used to prevent fluid leakage.

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Research Framework

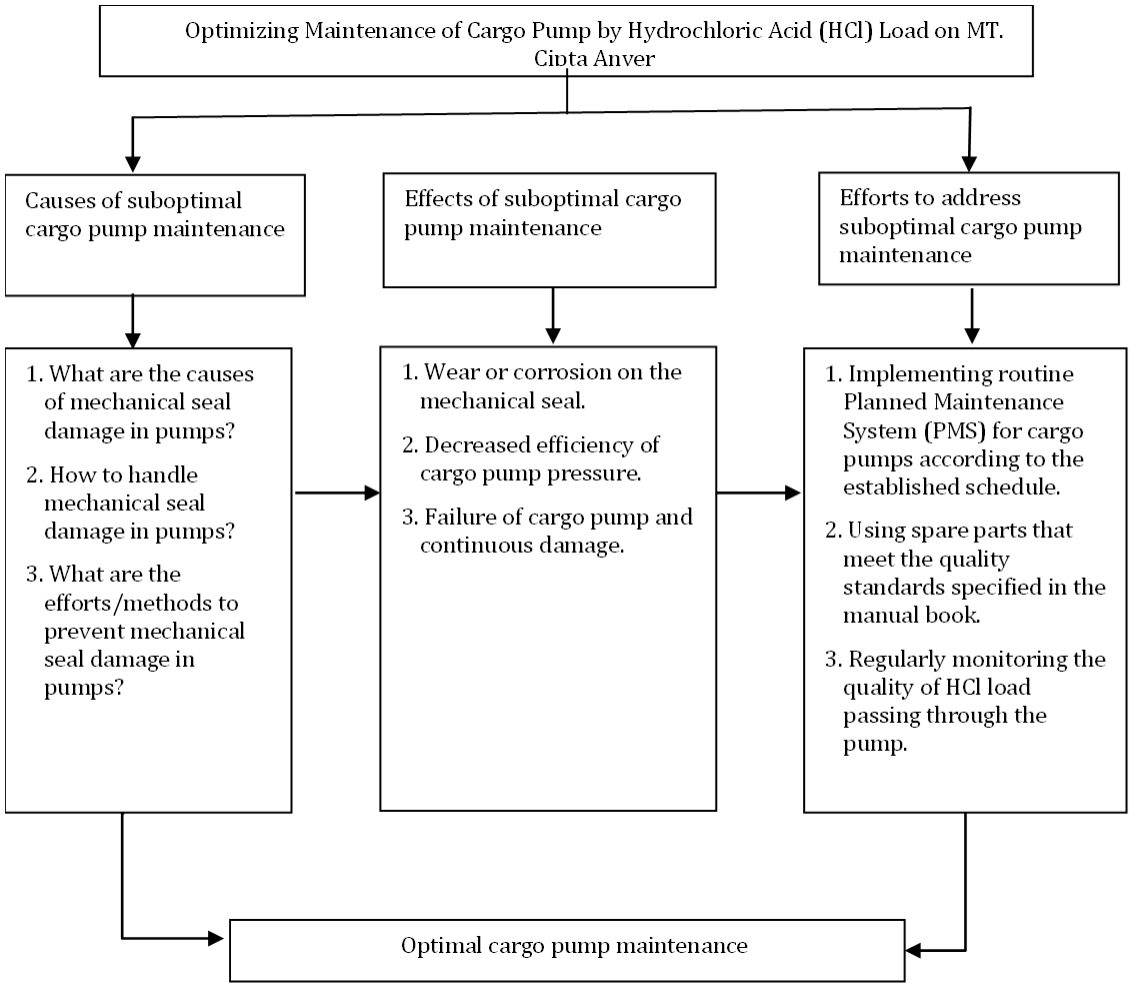

Figure 1. Research framework

METHODOLOGY

The research method used in this study is a qualitative descriptive method.

Time and Place of Research

The research was conducted from August 2021 to August 2022 on MT. Cipta Anyer, operated by PT. Cipta Samudera Shipping Line and chartered by PT. Asahimas Chemical (ASC).

Sample Data Sources

The sample data sources for this research are primary and secondary data. Primary data is obtained through direct observation of the research object, while secondary data is obtained from maintenance reports, instruction manuals, industry publications, government websites, or reports.

Data Collection Techniques

The methods used to collect data in this study are observation, interviews, documentation study, and literature review. Observation is conducted through direct observation of the transportation and handling processes of hydrochloric acid, as well as the maintenance of cargo pumps on MT. Cipta Anyer. Interviews are conducted with the Chief Engineer, Second Engineer, and Third Engineer regarding the research object. A literature review is conducted by referring to journals, books, articles, and other relevant sources related to the research object. Measurements are

performed using suitable tools such as flow meters and pressure gauges. Documentation is obtained from ship archives, letters, and drawings.

Research Instruments
In qualitative research, the data collector is the researcher. Non-human tools (such as questionnaires, interview guides, instructions, observations, etc.) can also be used to support the research work, but their function is limited.

Qualitative Data Analysis Technique
The data analysis technique used in this thesis is SWOT analysis. SWOT analysis is a technique used to identify the strengths, weaknesses, opportunities, and threats of an organization or project.

Validation of Data
For data validation in qualitative research, triangulation is used. Triangulation involves obtaining the truth of certain information by using various data sources such as documents, archives, interview results, and observations.

FINDINGS AND DISCUSSION
Overview of Research Context
a. Cargo pump overview

Figure 2. *Cargo pump*
Source: Research data processed, 2022

MT. Cipta Anyer is a vessel equipped with HANSHIN BT-200-2 cargo pumps. These cargo pumps consist of two centrifugal pumps that can rotate at a speed of up to 1600 rpm. The cargo pumps on MT. Cipta Anyer is used for transferring highly corrosive 33% HCl cargo. Therefore, these pumps are made of special materials such as Hastelloy X (Inconel HX, Nicrofer 4722 Co, and Pyromet 680). Hastelloy X is a variety of nickel-chromium-zinc-molybdenum alloys, known for its exceptional combination of oxidation resistance, ease of fabrication, and high-temperature strength.

b. Overview of mechanical seals

According to Nor et al. (2022), a mechanical seal is a component used to prevent fluid leakage in pumps, compressors, or other rotating equipment in the industrial field. It consists of several parts, including a seal face (wear-resistant surface), elastomer, and spring, working together to form a barrier between the fluid and the atmosphere.

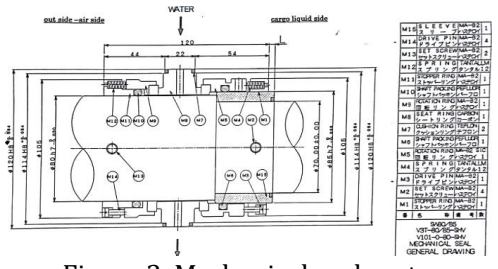

Figure 3. Mechanical seal parts

Source: *Manualbook* MT. Cipta Anyer, 2022

Data Description

The researchers conducted the study on MT. Cipta Anyer with a crew list consisting of 17 crew members, including the Captain. The deck department comprises the Master, Chief Officer, 2nd Officer, 3rd Officer, Boatswain, 3 Able Seamen (A/B), 1 Deck Cadet, and Chief Cook. The engine department includes the Chief Engineer, 2nd Engineer, 3rd Engineer, Foreman, 2 Oilers, and 1 Engine Cadet. The crew list and ship's particulars are attached in the appendix.

However, the use of cargo pumps in transporting hydrochloric acid also poses a high risk of pump damage and wear. Therefore, this study aims to optimize the maintenance of cargo pumps to prolong their lifespan and reduce repair and replacement costs. This situation can disrupt cargo loading and unloading operations and have an impact on the vessel's operational activities. Additionally, the availability of fresh water for pump cooling is often delayed. Furthermore, the fresh water tanks on MT. Cipta Anyer can only hold 90 tons of fresh water, while the average daily requirement is 6 tons. This amount is limited if relying solely on shore supply and can have serious implications if the fresh water supply runs out while the vessel is at sea.

Findings

The following is a description of the factors causing damage to the mechanical seal:

a. HCl Cargo
   The main factor causing damage to the mechanical seal is the cargo itself, which is hydrochloric acid (HCl) with a concentration of 33%. Direct contact with hydrochloric acid (HCl) can lead to mechanical seal damage. The damage is caused by corrosion on the materials used, which lack high resistance to corrosive substances, resulting in a highly corrosive chemical reaction. HCl reacts with metals, including the materials used in the mechanical seal such as stainless steel, aluminum, and brass.
b. Spare *part*
   The use of spare parts in pumps also affects the factors causing damage to the mechanical seal. When different geometry is used for the spare parts compared to the original pump components, there will be unbalanced friction between the components, potentially damaging the pump. The spare parts used by this vessel are made of different types of materials compared to other chemical tankers due to the corrosive nature of Type 1 chemical cargo.
c. Excessive Power Consumption
   If the spare parts used have lower quality than required, the pump will work harder and potentially damage the pump components. Additionally, the corrosive nature of the cargo prevents the pump's spare parts from performing well, leading to faster pump deterioration or leakage. During the research conducted during sea practice, the pump's capacity decreased to around 150-200 m^3/h, with a pressure of 5 kg/cm^2 and an RPM of 1600, compared to the initial pressure of 6 kg/cm^2 and RPM of 1800. The decrease in capacity is also influenced by the pump's age, as prolonged exposure to HCl reduces the quality and durability of the pump's materials.

Below is a table presenting the research results obtained through the distribution of questionnaires using the SWOT method:

Table 4.1. Research Finding

Factor	Category	Research result	Weight	Ratings	Results
Internal	*Strength*	The working principle is simple (S1)	3.3	3	9.9
		Use of modern tools (S2)	3.4	4	13.6
		Strict supervision by engineers (S3)	3	1	3
		Planned Maintenance System (S4)	3	2	6
	Total				32.5
	Weakness	Fresh water pump cooler (W1)	3	-2	-6
		Lack of spare parts in store (W2)	3	-3	-9
		High work risk (W3)	3	-4	-12
		Product quality (W4)	3.2	-1	-3.2
	Total				-30.2
Eksternal	*Opportunity*	Experienced crew selection (O1)	3.7	4	14.8
		Use of the right materials (O2)	3.5	3	10.5
		Reducing environmental impact (O3)	4	1	4
		more effective and efficient. (O4)	4	2	8
	Total				37.3
	Threat	Availability of spare parts is minimal (T1)	2.9	-1	-2.9
		Easy to leak (T2)	3.2	-4	-12.8
		Environmental impact due to cargo (T3)	3.2	-3	-9.6
		Lack of human resources (T4)	3.2	-2	-6.4
	Total				-31.7

After determining the weights and scores for the internal and external factor indicators, the calculation of the coordinate axis (X, Y) is performed, where the X-axis is equal to the total score of S + W = 32.5 + (-30.2) = 2.3, and the Y-axis is equal to the total score of O + T = 37.3 + (-31.7) = 5.6. Therefore, the coordinate point of the SWOT matrix is (X=2.3, Y=5.6).

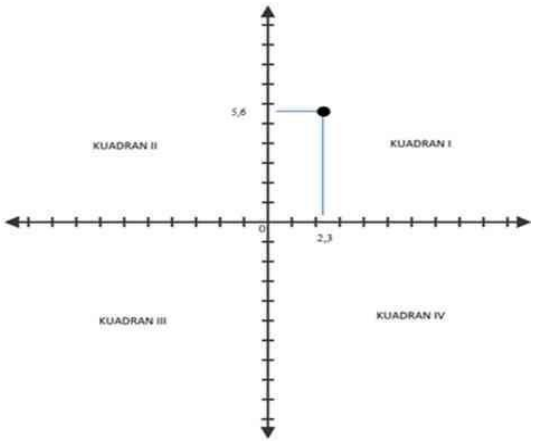

Figure 4. The Cartesian Diagram
Source: Research data processed, 2023

Discussion of Research Findings

a. What are the causes of damage to the pump's mechanical seal?
   1) 33% HCl Load
   2) Surface wear
   3) Incorrect installation
b. How to handle damage to the pump's mechanical seal?
   1) Fault identification
   2) Spare parts replacement
   3) Correct installation
c. How to prevent damage to the pump's mechanical seal?
   Here are the strategies that have been formulated:
   1) Combine simple working principles with the use of modern tools to increase effectiveness and efficiency.
   2) Undergo strict supervision by the engineer with a planned maintenance system to ensure consistency in performance and proper use of materials.
   3) Choose an experienced crew to reduce damage that can impact the environment by optimizing work strategies and procedures that are more effective and efficient.

CONCLUSION AND FURTHER RESEARCH

Conclusion

Based on the research on Cargo Pump Treatment Optimization with Hydrochloric Acid (HCl) Load at MT. Cipta Anyer, the researchers obtained several conclusions based on efforts to optimize cargo pump maintenance, as follows:

a. Damage to the pump's mechanical seal occurs due to the following factors:
   Direct contact of hydrochloric acid (HCl 33%) with the cargo pump, surface wear, and incorrect installation of spare parts.
b. Damage to the pump's mechanical seal can be handled by:
   Identifying the damage by paying attention to signs of leaks, checking the temperature, pH of the cooling water, and the physical condition of the cargo pump. Replacing original spare parts that comply with the provisions, and proper installation according to procedures.
c. The following are efforts/how to prevent damage to the pump's mechanical seal:
   Combining simple working principles with the use of modern tools to increase effectiveness and efficiency, implementing strict supervision by the engineer with a planned maintenance system to ensure consistency in performance and proper use of materials, and choosing experienced crew members to reduce damage that can impact the environment by optimizing work strategies and procedures that are more effective and efficient.

Suggestion

As a researcher in the study of cargo pump maintenance, here are several suggestions for optimizing the maintenance of cargo pumps with hydrochloric acid (HCl) load at MT. Cipta Anyer:

a. All engine crew members on the ship should pay more attention to the possibility of damage to the mechanical seal to prevent any impact on the performance of the cargo pump.
b. It is expected that the engineer always strives to learn the proper handling techniques for the mechanical seal directly related to HCl to ensure more effective maintenance.
c. The crew should perform scheduled planned maintenance systems periodically on the components of the cargo pump that are susceptible to damage.

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