

Minimizing Potential Damage To Butterworth To Optimize Tank Cleaning Processes At MT. Bro Combo

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Abstract.

Butterworth is one of the main equipment in the tank cleaning process on tankers that plays a role in maintaining tank cleanliness before the next loading. Damage to the Butterworth can cause the tank cleaning process to be suboptimal, thus disrupting the smooth operation of the ship. This study aims to determine efforts to minimize potential damage to the Butterworth and identify obstacles that often occur during the tank cleaning process at MT. Bro Combo. The study used a qualitative method with data collection through observation, interviews, and documentation. The study population included all Butterworth maintenance activities and the tank cleaning process, while the sample was determined purposively, namely officers and crew directly involved in these activities. The research instrument was the researcher with data analysis through data reduction, data presentation, and drawing conclusions. The results showed that efforts to prevent damage were carried out through checking the condition of the equipment, checking the nozzle and connections, proper installation, and routine maintenance after use. Obstacles found included unstable water pressure, nozzle wear, suboptimal Butterworth rotation, and imprecise installation. This study concluded that consistent inspection, regular maintenance, precise installation, and water pressure control are the main factors in minimizing Butterworth damage and optimizing the tank cleaning process.

Keywords: *Butterworth, Maintenance, Ship Operations, Tank Cleaning and Tankers.*

I. INTRODUCTION

Tankers are a form of maritime transportation used to transport various liquid cargoes, such as oil, gas, and chemicals, with designs tailored to the characteristics of the cargo (Sabrina, 2023). These vessels have special storage tanks to maintain the safety and quality of their cargo during shipping and play a vital role in the distribution of liquid commodities through loading and unloading activities at ports (Amrullah, 2020).

One of the cargoes transported by tankers is fuel oil (FO), which serves as the ship's operational fuel. To maintain cargo quality, every operational stage, from tank cleaning and loading to temperature control and discharging, must be carried out according to procedures. Proper cargo management is also crucial for maintaining safety, smooth operations, and revenue for shipping companies (Nur Rohmah et al., nd).

Tank cleaning is a crucial step before a ship receives its next cargo. Suboptimal tank cleaning can leave residue, cause damage or freezing of the cargo, delay the unloading process, and potentially lead to lawsuits from the cargo owner. Furthermore, tanks that do not meet standards require the ship to undergo tank cleaning again before the next loading process.

The success of tank cleaning is greatly influenced by the condition of supporting equipment, such as the Butterworth system, piping network, pumps, and other equipment. All of this equipment must be maintained according to Standard Operating Procedures (SOP) to ensure optimal function. Damage to the Butterworth system can reduce the effectiveness of tank cleaning, thus hampering smooth ship operations.

Based on these conditions, this study focuses on efforts to minimize damage to Butterworth and identify common obstacles encountered during the tank cleaning process at MT. Bro Combo. These issues are important to examine because they relate to the effectiveness of the tank cleaning process and the ship's readiness to receive the next cargo.

This study aims to determine how to minimize Butterworth damage and identify obstacles that occur during the tank cleaning process at MT. Bro Combo. This research is expected to provide benefits in improving Butterworth maintenance to support smooth ship operations. The novelty of this research lies in

the focus of the study on efforts to minimize potential Butterworth damage to optimize the tank cleaning process at MT. Bro Combo.

II. METHODS

This study used qualitative methods to examine efforts to minimize potential damage to Butterworth and optimize the tank cleaning process at MT. Bro Combo. Data were obtained through observation, interviews, and documentation to understand the conditions occurring in the field. The qualitative approach aims to systematically and comprehensively understand the phenomenon (Nursanjaya, 2021). The study was conducted on MT. Bro Combo for 12 months while the researchers underwent sailing practice, with analysis emphasizing understanding the meaning of the phenomenon (Anggito & Setiawan, 2018).

The study population included all Butterworth maintenance activities and tank cleaning processes at MT. Bro Combo. The sample was determined purposively, namely officers and crew members directly involved in both activities so they could provide information in accordance with the research objectives (Anggito & Setiawan, 2018).

The research instrument was the researcher, supported by observation, interviews, and documentation. Primary data was obtained through observations of Butterworth's conditions and interviews with officers and crew, while secondary data was obtained from activity photographs, maintenance records, work reports, manuals, and other supporting documents. Data analysis was conducted through data reduction, data presentation, and drawing conclusions (Abdi, 2021).

The research procedure began with observations during sailing practice, followed by interviews and documentation collection. All data was then reduced, systematically presented, and analyzed to reach conclusions regarding efforts to minimize potential damage to Butterworth and optimize the tank cleaning process at MT. Bro Combo.

III. RESULTS AND DISCUSSION

Data Presentation

1. Observation Results



Fig. 1 Condition of Butterworth

Based on Figure 1, the physical condition of the butterworth on board the ship indicates that several parts of the equipment have deteriorated. This is evident from the presence of dirt adhering to the equipment's surfaces, particularly on the exterior and nozzles. Furthermore, signs of wear were also found on some units' nozzles. Further observation also revealed rust on certain parts of the butterworth, particularly on components frequently exposed to water and in humid environments.



Fig. 2 Butterworth's examination

This condition can be seen in Figure 2, where the ship's crew conducted a direct inspection of the butterworth before the tank cleaning process. This inspection generally included checking the exterior of the equipment, the condition of the nozzle, and ensuring there was no visible physical damage. However, field observations indicated that this inspection had not been carried out comprehensively on every butterworth unit.



Fig. 3 Treatment at Butterworth

Based on observations, after the tank cleaning process was completed, maintenance activities were carried out, including butterworth cleaning. This is evident in the image, where the ship's crew cleaned the equipment using a stream of water to remove any remaining dirt. Furthermore, the exterior of the equipment was manually cleaned to maintain its cleanliness.



Figure 4 Butterworth Performance and Rotation

Based on Figure 4, the device can be seen operating inside the tank, producing water sprays in various directions. The image shows the device emitting water sprays in a specific pattern, indicating movement or rotation during the tank cleaning process. However, observations indicate that the spray direction, in some cases, does not appear to be evenly distributed across the entire tank surface. Furthermore, supporting systems such as pumps and hoses are visible, channeling water into the tank. This indicates that the device's performance is highly dependent on the water flow system used.



Fig. 5 Water Pressure Instability

Based on observations, the water pressure flowing into the Butterworth during the tank cleaning process appears to be unstable. The image shows that the resulting water jets vary in strength, with some areas appearing stronger and others weaker.



Fig. 6 Butterworth installation

Based on Figure 6, the Butterworth was manually installed by the ship's crew prior to the tank cleaning process. Observations indicate that the device was installed in the tank opening and connected to a pipe and hose system for water flow. However, installation accuracy was not always consistent, resulting in differences in the position of the device and the precision of its connection to the pipe during each use. This situation could potentially affect the position and direction of the Butterworth within the tank.

2. Interview Results

Table1 Interview Results Question 1

Question 1: How to minimize butterworth damage during the tank cleaning process?		
Respondents	Interview results	Summary
First Class Officer	Efforts to minimize Butterworth damage include conducting a thorough inspection before use. This includes checking the nozzle's cleanliness to ensure there's no debris that could block the water flow. Furthermore, the condition of the connections and fittings are checked to ensure there are no leaks. Installation involves ensuring the device is properly positioned and securely attached before applying pressurized water. This ensures the device doesn't shift or become compromised during use in the tank.	The first officer explained that damage to the butterworth can be minimized by inspecting the equipment before use, such as checking the cleanliness of the nozzle, the condition of the connections, and ensuring the equipment is installed correctly and securely so that it can work safely and without any problems during the tank cleaning process.
Second Officer	Efforts to minimize Butterworth damage include conducting a thorough inspection before use. This includes checking the nozzle's cleanliness to ensure there's no debris that could block the water flow. Furthermore, the condition of the connections and fittings are checked to ensure there are no leaks. Installation involves ensuring the device is properly positioned and securely attached before applying pressurized water. This ensures the device doesn't shift or become compromised during use in the tank.	The second officer stated that prevention of Butterworth damage is carried out through a thorough check before operation, including checking the cleanliness of the nozzle, the completeness of the equipment, and ensuring proper installation so that the equipment can function optimally without leaks or damage.
Helmsman	Efforts to minimize Butterworth damage in the field include ensuring the equipment is properly installed before use. The helmsman assists with the installation process, ensuring proper positioning and proper tilting of the equipment. Furthermore, the equipment is used according to the officer's instructions to avoid	The helmsman explained that efforts to reduce Butterworth damage include ensuring the equipment is installed in the correct and stable position. Furthermore, equipment operation must follow the officer's instructions to prevent misuse that could cause damage.

Question 1:

How to minimize butterworth damage during the tank cleaning process?

Respondents	Interview results	Summary
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	operational errors that could cause damage.	
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Table 2 Table of Interview Results Question 2**Question 2:**

What are the Butterworth maintenance activities carried out?

Respondents	Respondents	Summary
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First Class Officer	Routine maintenance is performed after the tank cleaning process has finished. This includes cleaning the exterior of the device to remove any remaining dirt or residue using clean water. Furthermore, the physical condition of the device is regularly checked to ensure there are no wear or damage. The nozzle is also inspected to ensure there are no blockages that could interfere with the device's performance. If minor damage is detected, immediate action is usually taken to prevent more serious problems.	The first officer explained that routine maintenance on the Butterworth is performed after use. This includes cleaning the equipment, checking its physical condition, and checking the nozzle for clogging. If minor damage is found, repairs should be made immediately to prevent further damage.
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Second Officer	Butterworth maintenance involves cleaning the tool to remove any remaining dirt after use. Cleaning is done with clean water to remove any residue left on the tool, especially the nozzle. Additionally, simple tests are performed to ensure the tool is still functioning properly, such as ensuring the tool rotates smoothly when water is flowing through it. This activity is performed routinely as part of tool maintenance.	The second officer explained that Butterworth maintenance involves cleaning the equipment with clean water after use and checking its functionality to ensure it remains in good working order. This routine is necessary to maintain optimal performance.
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Helmsman	Maintenance involves cleaning the equipment after use, especially the exterior, which is frequently exposed to dirt. The helmsman also ensures that there is no remaining dirt on the equipment before storing it. This activity is part of the crew's responsibility to maintain the cleanliness and condition of the equipment.	The helmsman explained that butterworth maintenance involves cleaning the equipment of dirt after use and ensuring it is clean before storage. This is to maintain cleanliness and condition so it remains ready for reuse.
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Table 3 Table of Interview Results Question 3**Question 3:**

What are the obstacles often encountered when using butterworth?

Respondents	Interview results	Summary
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Question 3:

What are the obstacles often encountered when using butterworth?

Respondents	Interview results	Summary
First Class Officer	A common problem encountered when using a Butterworth is the device's rotational speed being suboptimal. This results in an uneven water spray across the tank. This can be caused by several factors, such as unstable water pressure, dirt clogging the nozzle, or worn components. Furthermore, improper installation can also affect the spray's direction and reach.	The first officer explained that a common problem with using a Butterworth is that the device's rotation speed isn't optimal, resulting in an uneven water spray. This can be caused by unstable water pressure, a clogged nozzle, worn components, or improper installation.
Second Officer	A common problem is unstable water pressure, which can lead to suboptimal performance. Furthermore, wear and tear on the tool, particularly on the nozzle and internal components, also affects Butterworth performance. In some cases, the tool may not rotate properly, resulting in an uneven water spray.	The second officer explained that the main obstacles to using Butterworth were unstable water pressure and the equipment's wear and tear. As a result, the equipment couldn't rotate optimally, making the tank cleaning process less effective.
Helmsman	A common problem is improper installation of the tool, which can lead to instability during use. Furthermore, the tool may not rotate properly when water is flowing through it, resulting in an uneven spray distribution throughout the tank. This can affect cleaning results.	The helmsman explained that common problems include improper butterworth installation and sluggish rotation of the tool. This results in an uneven water spray and can reduce the quality of the tank cleaning results.

Table 4 Table of Interview Results Question 4**Question 4:**

How does water pressure affect butterworth performance?

Respondents	Interview results	Summary
First Class Officer	Water pressure significantly impacts Butterworth performance. If the water pressure is unstable or too low, the tool won't rotate optimally and the water spray will be weak, resulting in suboptimal cleaning results. Conversely, if the water pressure is sufficient and stable, the tool will rotate effectively and produce an even spray across the entire tank surface. Therefore, water pressure stability is a crucial factor to consider during the tank cleaning process.	The first officer explained that water pressure is crucial to the Butterworth's performance. Sufficient and stable water pressure allows the tool to rotate smoothly and produce an even spray, while low or unstable pressure can reduce the tank's cleaning effectiveness.

Second Officer	Unstable water pressure significantly impacts Butterworth performance. If the water pressure drops, the machine's rotation speed will be lower, resulting in an uneven water spray. This can hinder the tank cleaning process. Therefore, monitoring the water flow system is essential to ensure stable pressure throughout the process.	The second officer explained that unstable water pressure can cause the butterworth to rotate less than optimally and the water spray to be uneven. Therefore, water pressure must be maintained to ensure optimal tank cleaning.
Helmsman	Water pressure significantly impacts the performance of a butterworth. If the water pressure is too low, the tool won't rotate properly, and the spray will be less powerful. Furthermore, if the water pressure is unstable, the spray will be uneven. Therefore, water pressure is essential for optimal performance.	The pilot explained that weak or unstable water pressure can hinder the Butterworth's rotation and reduce the power of the water spray. Consequently, cleaning results are less than optimal, so water pressure must be monitored consistently while using the tool.

3. Documentation Results



Fig. 7 Butterworth Nozzle Cleaning Activity

Based on Figure 7, the ship's crew cleaned the Butterworth nozzle after the tank cleaning process. Cleaning with fresh water removes oil residue, scale, and dirt adhering to the equipment. This routine maintenance activity is performed to maintain the cleanliness of the nozzle, which serves as the main channel for high-pressure water and to prevent deposits that could impair the Butterworth's performance during subsequent use.



Fig. 8 Butterworth Maintenance Activities

Based on Figure 8, the ship's crew performed maintenance on the Butterworth by dismantling several key components for inspection. The inspection included checking the condition of the gears, bearings, nozzles, and other components involved in the tool's rotation mechanism. Furthermore, moving parts were greased to reduce friction and maintain smooth rotation. This maintenance is performed periodically to ensure the Butterworth continues to function optimally during the tank cleaning process.

INTEGRATED MANAGEMENT SYSTEM (IMS) STANDARD FORM 42-BAC
 SHEETS FILE NO. 401.8.001.1 OFFICE FILE NO. N/A
 BUREAU FORM 400000 / 401.8.001.1
 401 Chapter 1 Section 1.1
 401 Chapter 1.1 Section 4.0
 401.8.001.1.1.1.1

BUTTERWORTH DAMAGE REPORT

Name: MT BRO COMBO
 ID: 0239719
 Position: PT. WILKINSON
 Date: 15/12/2024

KETERANGAN
 Pada hari ini, telah terdapat 13 butir kerusakan yang terdapat di atas kapal MT BRO COMBO pada saat pelaksanaan tank cleaning, hasil yang terdapat terdapat di bawah ini: 1. kerusakan pada alat yang digunakan untuk membersihkan tank, 2. kerusakan pada alat yang digunakan untuk membersihkan tank, 3. kerusakan pada alat yang digunakan untuk membersihkan tank, 4. kerusakan pada alat yang digunakan untuk membersihkan tank, 5. kerusakan pada alat yang digunakan untuk membersihkan tank, 6. kerusakan pada alat yang digunakan untuk membersihkan tank, 7. kerusakan pada alat yang digunakan untuk membersihkan tank, 8. kerusakan pada alat yang digunakan untuk membersihkan tank, 9. kerusakan pada alat yang digunakan untuk membersihkan tank, 10. kerusakan pada alat yang digunakan untuk membersihkan tank, 11. kerusakan pada alat yang digunakan untuk membersihkan tank, 12. kerusakan pada alat yang digunakan untuk membersihkan tank, 13. kerusakan pada alat yang digunakan untuk membersihkan tank.

Dengan ini menyatakan bahwa kerusakan alat yang terdapat di atas kapal MT BRO COMBO telah dilaporkan kepada pihak yang berwenang untuk diteliti dan diperbaiki.

Tanggal: 15/12/2024
 Nama: MT BRO COMBO
 ID: 0239719
 Position: PT. WILKINSON
 Date: 15/12/2024

Fig. 9 Butterworth Damage Report

Showing the Butterworth Testing Record document at MT. Bro Combo. The document contains records of the results of Butterworth's periodic tests, including the test date, test location, and the results of equipment condition checks such as nozzles, tool rotation, water pressure, and Butterworth connections.

Data analysis

Table 5 Data Analysis Table

Formulation of the problem	Data source	Analysis Results
How to minimize butterworth damage to support the smooth running of the tank cleaning process?	Interviews and Observations	The crew's efforts to minimize Butterworth damage include several steps, including checking the condition of the equipment before use, particularly the nozzles, connections, and ensuring cleanliness to ensure there is no dirt that could impede water flow. Furthermore, the equipment is installed with attention to positioning and stability to ensure optimal operation within the tank. Observations indicate that these activities have been carried out, but have not been carried out consistently and thoroughly. Inaccuracies in equipment installation and a lack of thorough inspection are still found, potentially disrupting equipment performance during the tank cleaning process.
What are the common problems encountered by Butterworth during the tank cleaning process at MT. Bro Combo?	Interviews and Observations	Common problems encountered in using Butterworth include several technical and operational issues, such as suboptimal rotation of the tool, resulting in uneven water spray across the tank. Furthermore, unstable water pressure is also a major factor affecting tool performance. Worn components, particularly the nozzle, contribute to decreased performance. Observations show irregular water spray and suboptimal tool performance during the cleaning process, indicating that these problems are indeed present in the field and directly impact the effectiveness of the tank cleaning process.

IV. DISCUSSION

The discussion in this study is based on the presentation and analysis of data obtained through observations, interviews, and documentation during the onboard research. The discussion focuses on interpreting the research findings related to efforts to minimize potential damage to the Butterworth and optimize the tank cleaning process, as well as the challenges encountered in its use.

1. How to Minimize Butterworth Damage to Support the Smooth Running of the Tank Cleaning Process.

Based on the results of the data presentation and data analysis, it is known that the ship's crew has made several efforts to minimize the potential damage to the Butterworth before and after use in the tank cleaning process. These efforts include checking the condition of the equipment before use, checking the cleanliness of the nozzle, checking the equipment connections, installing the Butterworth in the correct position, and carrying out maintenance and cleaning after the equipment is finished using. The results of the interviews indicate that the initial inspection was carried out to ensure the Butterworth was in a ready-to-operate condition and did not experience any problems that could affect the tank cleaning process. In addition, the ship's crew also cleaned the nozzle and the outside of the equipment to prevent the accumulation of dirt that could potentially hinder the equipment's performance. This finding is supported by the results of observations that showed the presence of inspection and cleaning activities on the Butterworth before and after use.

However, observations indicate that these efforts have not been implemented consistently. On several occasions, worn nozzles, dirt adhering to the equipment, and inaccuracies in Butterworth installation were found. These conditions indicate that although damage prevention procedures have been implemented, their implementation still needs to be improved to achieve optimal results.

Based on these findings, it is clear that the success of efforts to minimize potential damage to the Butterworth depends not only on the maintenance procedures in place, but also on the ship's crew's consistency in thoroughly inspecting, installing, and maintaining the equipment. The better these efforts are implemented, the less likely damage will be to disrupt the tank cleaning process.

2. Obstacles at Butterworth during Tank Cleaning Process

Based on the data presentation and analysis, several challenges were frequently encountered when using Butterworth during the tank cleaning process. These challenges included unstable water pressure, suboptimal Butterworth rotation, worn nozzles, and improper tool installation. Interviews revealed that water pressure significantly impacted Butterworth performance. When water pressure is unstable, the tool's rotation is less than optimal, preventing the water spray from reaching the entire tank surface evenly. Furthermore, worn nozzles also reduced spray quality and reduced the effectiveness of the cleaning process.

These findings are reinforced by observations that indicate uneven water spray distribution during the tank cleaning process. In some cases, the Butterworth was also observed to not rotate optimally, resulting in less than optimal cleaning coverage. In addition to technical factors, observations also revealed inaccurate installation of the Butterworth, which could potentially affect the device's position within the tank. These findings suggest that the challenges with Butterworth usage stem from a combination of technical and operational factors. Technical factors include unstable water pressure and component wear, while operational factors relate to the accuracy of installation and pre-use inspection. If these issues are not addressed promptly, the effectiveness of the tank cleaning process will decrease and potentially result in suboptimal tank cleaning results.

Overall, the discussion results indicate that efforts to minimize potential damage to Butterworth and address operational constraints are closely linked to the success of the tank cleaning process. The better the condition of Butterworth and the more consistent the inspection, installation, and maintenance, the more effective and optimal the tank cleaning process can be.

V. CONCLUSION

This study shows that efforts to minimize potential damage to the Butterworth on MT. Bro Combo are carried out through checking the condition of the equipment before use, checking the cleanliness of the nozzle, checking the connections, proper installation, and maintenance and cleaning after the tank cleaning process. The research findings also show that the implementation of these efforts is not entirely consistent, so that there are still nozzles that are experiencing wear, dirt adhering to the equipment, imprecise installation, and unstable water pressure. These conditions cause the Butterworth rotation to be less than optimal and the water spray is uneven, thus reducing the effectiveness of the tank cleaning process. The results of the study confirm that the success of the tank cleaning process is greatly influenced by the condition of the Butterworth, the stability of the water pressure, and the consistency of the ship's crew in carrying out inspections, installation, and maintenance of the equipment according to procedures.

This research is still limited to the results of observations, interviews, and documentation conducted on a single vessel, namely MT. Bro Combo, so the findings obtained describe the operational conditions at the research location. Therefore, further research is expected to be conducted on more tankers with different operational characteristics to obtain a broader picture of the factors that influence Butterworth performance. Practically, the results of this study can provide input for ship crews and shipping companies to improve the consistency of inspections, periodic maintenance, the accuracy of Butterworth installation, and monitoring of water pressure stability. The implementation of these efforts is expected to reduce the potential for Butterworth damage, increase the effectiveness of the tank cleaning process, and support the smooth operation of the ship.

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