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Analysis of Damage to the Fresh Water Maker (Reverse Osmosis) in the Fresh Water Production Process on the MT. SENGETI Ship

***Muh Raflih Idris[1], Alberto[2], Rahmat Hidayat[3],**
[1] Diploma IV Program, Politeknik Pelayaran Makassar, Makassar, Indonesia
[2] Department of Technical, Politeknik Ilmu Pelayaran, Makassar, Indonesia

*** Corresponding Author:**
Muh Raflih Idris
Diploma IV Program, Politeknik Ilmu Pelayaran Makassar, Makassar, Indonesia
Jl. Tentara Pelajar No. 173 Makassar, 90172, Indonesia
Email: mhmmdraflhy12@gmail.com

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ABSTRACT

This study aims to analyze the causes of damage to the reverse osmosis freshwater maker system in the freshwater production process on the MT. Sengeti vessel. The research method used was descriptive qualitative, with direct observation, interviews, and documentation studies of maintenance and damage reports. The results showed that the most common damage occurred in the high-pressure pump valve adapter due to high pressure, excessive vibration, and material fatigue, as well as cavitation and lack of routine maintenance. Repair efforts included component replacement, adjustment of working pressure, and improvement of crew operational understanding to optimize RO system performance.
Keywords: *Reverse Osmosis, High Pressure Pump, Cavitation.*

ABSTRAK

Penelitian ini bertujuan untuk menganalisis penyebab kerusakan pada sistem fresh water maker reverse osmosis dalam proses produksi air tawar di kapal MT. Sengeti. Metode penelitian yang digunakan adalah deskriptif kualitatif dengan observasi langsung, wawancara, dan studi dokumentasi laporan perawatan serta kerusakan. Hasil penelitian menunjukkan bahwa kerusakan dominan terjadi pada adaptor katup pompa tekanan tinggi akibat tekanan tinggi, getaran berlebih, dan kelelahan material, serta dipengaruhi oleh kavitasi dan kurangnya perawatan rutin. Upaya perbaikan meliputi penggantian komponen, penyesuaian tekanan kerja, dan peningkatan pemahaman operasional kru agar kinerja sistem RO lebih optimal.
Kata kunci: *Reverse Osmosis,Pompa Tekanan Tinggi,Kavitasi.*

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1. INTRODUCTION

Fresh water is a primary requirement on board ships for various operational and daily crew needs. Because ships operate in vast oceans with very limited freshwater availability, seawater treatment technology is a crucial alternative for producing fresh water. One widely used technology is the reverse osmosis (RO) freshwater production system.

The RO system works by separating salt and other dissolved substances from sea air through a semipermeable membrane that allows only pure water molecules to pass through. This process requires high pressure to force air molecules through the membrane, while retaining dissolved substances. Despite its high efficiency, this system is susceptible to damage if not properly maintained and operated. The high-pressure pump and membrane are the components most frequently affected, disrupting freshwater production performance.

Observations on the MT. Sengeti revealed frequent problems with vital components such as the high-pressure pump, which causedDelays in freshwater production and increased salinity of the processed air. This demonstrates the importance of a thorough analysis of the causative factors and the implementation of optimal maintenance procedures to ensure the RO system operates effectively and efficiently. By understanding the mechanisms and emerging issues, repairs and maintenance can be carried out appropriately to support smooth vessel operations.

2. METHOD

This study uses a qualitative descriptive approach to analyze damage to the reverse osmosis freshwater maker system during the freshwater production process on the MT. Sengeti. The primary objective of the study was to describe in detail the damage that occurred to the high-pressure pump components and the reverse osmosis system, and to identify the causal factors and impact of these damages on freshwater production performance. Data were obtained through direct observation, interviews with the ship's crew, a study of maintenance data documentation, and a review of relevant literature.

Data collection was conducted through direct field observation during sea practice assignments, informal interviews with the captain and engine operators, and the collection of damage reports and maintenance records. This approach enabled the authors to obtain a comprehensive picture of the actual field conditions and the technical factors affecting the reverse osmosis system.

The collected data included qualitative data on damage conditions and maintenance processes, as well as quantitative data on technical parameters such as pressure, salinity, and freshwater production levels. Data analysis was conducted by comparing field findings with relevant theories to develop effective improvement recommendations. The research schedule was systematically designed, starting with reference collection, data collection, and report preparation, all the way through to the final stage. This method ensures that research can continue and the results can be used as a guideline for improving the reverse osmosis system on the MT. Sengeti.

3. RESULTS AND DISCUSSION

3.1 Research Overview

This research was conducted on the MT. Sengeti tanker, a vessel owned by PT PERT AMINA INTERNATIONAL SHIPPING, headquartered at No. Kav 32-34 Gatot Sub Roto, South Jakarta. This vessel has been in operation since 1982 and is still active, operating several routes in the Balikpapan area. The research, which analyzed damage to the freshwater production system (reverse osmosis) in the freshwater production process on the MT. Sengeti, was conducted from 2023 to 2024. The author conducted this research during his maritime practice as a mechanical cadet, directly involved in the operation of the ship's engines. The research period included direct observation of the reverse osmosis system in operation, data collection through interviews with competent crew members, and study of maintenance documentation and operating procedures for the system on board. The main objective of this research was to identify the components responsible for disruptions in the RO system and provide recommendations to improve the system's performance and reliability.

a. Data Objek yang Diteliti

Tabel 1. Spesifikasi Ship Particular

Parameter	**Spesifikasi**
Ship's Name	MT. Sengeti / P. 3007
IMO NUMBER	8103420
Flag/Call Sign	Indonesia / YDXX
Owner	PT. PERTAMINA INTERNATIONAL SHIPPING
Operator	PERTAMINA INTERNATIONAL SHIPPING
GRT / NRT	21.747 / 7.582
Builder	*Onomichi Dockyard Co.Ltd, Sanbacho Onomichi City – Hiroshima – Japan*
L.O.A	180.00 meters
L.B.P	171.00 meters
Beam	30.00 meters
Depth	15.00 meters
Main Engine	HI - SULZER 6RLB 66 (ERP2)
Auxiliuary Engine	4-*Cycle Diesel* 6PSHTd - 26 H

Tabel 2. Speifikasi Reverse Osmosis

Merk	**SLCE WATERMAKER**
Type	*REVERSE OSMOSIS SD22-408*
Kapasitas Produksi	1.200 *L/h*
HP Pump	Cats Pump
Discharge Pressure	7-70 *Bar*
Bore	32 *mm*
Stroke	38.5 *mm*
Maximum Temperature	71° *C*
Voltage Supply	23 – 380/400 *three phase*
Power	9 kW
Filter Wash Outlet Pressure	0.5 – 3 *Bar*
Filter Water Flow (Debit)	1250 *Max*
Sand Filter	2.5 – 3 *Bar Pressure*

Tabel 3. Spesifikasi High Pressure Pump

Fabricant	*Cat Pumps*
Type	2531 – 710120 SLCE
Maximum rotation speed	1025 *t/min*
Applied rotation speed	710 *t/min*
Maximum flow	95 *l/min*
Operation flow	3900 *l/h*

Discharge pressure	7 – 70 *bar*
Bore	32 *mm*
Stroke	38.5 *mm*
Shaft diameter	30 *mm*
Maximum temperature	71° *C*
Dimensional characteristics	485x382x198 mm 37.1 kg
Oil (pump lubritation)	MOBIL DTE 10 EXCEL 100 / equal
Oil capacity	2.5 liter

3.2. Research Data Analysis

Based on direct observations and measurements during sea practice on the MT. Sengeti, several key factors have been identified related to damage and disruptions to the reverse osmosis freshwater production system. One of the most frequent and significant damages is damage to the high-pressure pump components, particularly the adapter valve, which causes the pump to frequently trip unexpectedly.

This damage occurs due to a combination of several technical factors, such as cavitation, continuous mechanical vibration, material fatigue, and the ingress of solid particles from unclean sea air. Furthermore, corrosion due to the aggressive seawater environment accelerates the deterioration of pump components. These factors lead to decreased pump performance and disrupted freshwater production. In addition to pump damage, performance degradation can also be triggered by operational issues such as lack of regular maintenance on the sand filter, which leads to the accumulation of dirt and algae. This condition impedes the flow of seawater into the filtration system, accelerating the buildup of dirt on the membrane and other filters.

Observations of operating conditions indicate that the high-pressure pump outlet pressure, which should consistently maintain between 55-60 bar, frequently

experiences damage, negatively impacting air filtration results. Additionally, abnormal symptoms such as rough pump noise and low inlet pressure are often found, which could indicate potential system damage or contamination. All of this data and findings are explained to provide appropriate troubleshooting recommendations, along with preventive and corrective maintenance steps.

Tabel 3. 2 *High Pressure Pump* keadaan normal

Kondisi	Parameter / Gejala	Penjelasan
Normal	Operating pressure according to specifications	The high-pressure pump outlet pressure meets the maximum limit (70 bar or 1,015 psi). The system operates optimally without excess pressure.
	Steady water flow	Feed, concentrate, and permeate flows are stable as designed, with no significant decline.
	Normal pump sound	The pump operates without any abnormal noise, no vibrations or harsh sounds.
	NO LEAKS	Connections and valve seals are tight, no water leaks.
	Preasure *inlet* positif	The pump inlet pressure is a minimum of 0.5 bar (7.3 psi) and a maximum of 5 bar (72.5 psi) to prevent damage and cavitation.
	Active pressure protection	The low and high pressure switches function to turn off the pump when the pressure is outside the safe limit.

Sumber. *Manual Book SLCE SD22-408* MT. Sengeti

4. CONCLUSION

Based on analysis and observations during the practical implementation on the MT. Sengeti, reverse osmosis system damage primarily occurred in the high-pressure pump component, specifically the adapter valve, which broke due to high pressure, excessive vibration, and material fatigue. Additionally, other problems such as cavitation, corrosion, and lack of routine maintenance also contributed to the decline in system performance and suboptimal freshwater production.

Corrective actions, including replacing damaged adapter valves, thorough pump and filter maintenance, and regular flushing, must be implemented immediately to prevent further damage and maintain stable reverse osmosis system operation. Consistent monitoring of water pressure and salinity is crucial to ensure the quality of the water produced remains up to standard. To reduce the risk of recurrent damage, it is crucial to conduct planned periodic maintenance, replace components when necessary, and provide technical training for ship operators to detect and resolve system problems early. This will ensure the reverse osmosis system functions optimally and ensures a sufficient supply of freshwater throughout the voyage. This conclusion is expected to serve as a guide for ship managers in maintaining the reliability of the freshwater maker system so that ship operations can run smoothly without disruptions due to water supply disruptions.

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