Analysis of two cruise ships performance trends

Introduction

In this analysis, we examine the performance trends of two cruise ships, Vessel 1 and Vessel 2, over a one-year period. The focus is on key performance indicators such as efficiency, propulsion, and power generation, essential for maritime operations. This analysis aims to identify patterns, draw insights, based on comparison of both the Vessel 1 and Vessel.Here There is no background about journey of the vessels so the condition under which the vessels have travelled may differ which will also cause changes in the Analysis.

Note: This is a quick look up for vessel 1 and vessel 2 comparison, detailed analysis is given in the respective jupyter notebooks.

Methodology

The dataset was cleaned and preprocessed to handle missing values and convert time columns to a proper datetime format. Key metrics were selected to analyze efficiency (fuel and power consumption), propulsion (propulsion power and speed).
Power Generation and consumption
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1.Analysis of Monthly Diesel Generator Power Generation from different Diesel generators.

In analyzing the power production of both vessels, it was observed that for both Vessel 1 and Vessel 2, the hierarchy of power generation from the diesel generators followed the order: Diesel Generator 3 > Diesel Generator 1 > Diesel Generator 2 > Diesel Generator 4.

Vessel 1 exhibited higher overall power production compared to Vessel 2. Specifically, Vessel 1 demonstrated a significant increase in power production at the start of the year, followed by a gradual decrease, with a notable spike occurring in the month of November.

In contrast, Vessel 2 showed a steady increase in power production from the beginning of the year, reaching its peak in the eighth month, and subsequently experiencing a sudden drop in the ninth month.

Overall, the data indicates that Vessel 1 consistently produced more power throughout the year compared to Vessel 2, reflecting differences in operational efficiency and usage patterns between the two vessels.

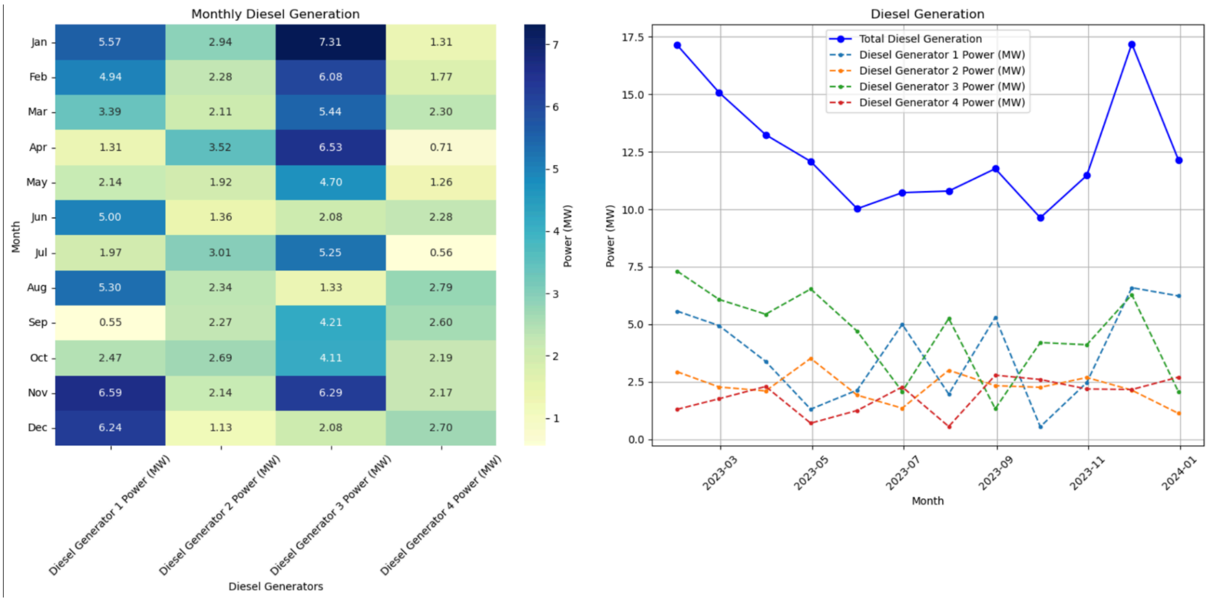


Fig .1 : Vessel 1 Monthly Diesel Generator Power Generation

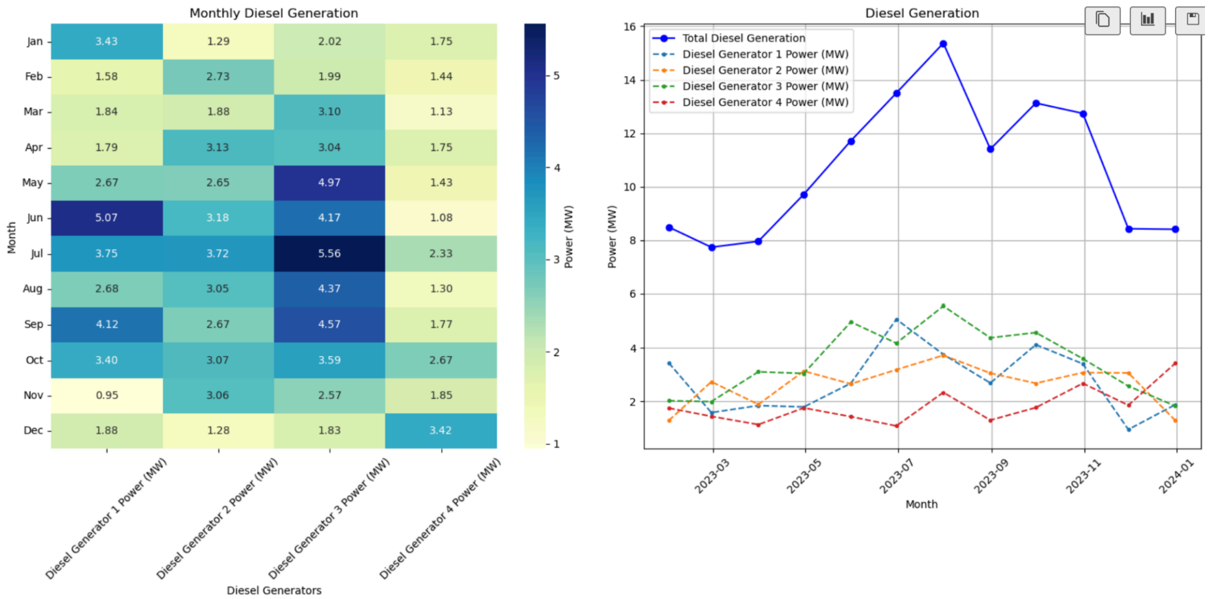


Fig .2 : Vessel 2 Monthly Diesel Generator Power Generation

2.Diesel-Generated Power Consumption

In analyzing the distribution of power consumption between Vessel 1 and Vessel 2, significant differences were observed across several key metrics.

Scrubber Power Consumption:

Scrubber power accounts for 8.15% of the total power consumption in Vessel 1, whereas it constitutes 4.9% in Vessel 2. This suggests a higher emphasis on emissions control through scrubber systems in Vessel 1.
HVAC Chiller Power Consumption:

Vessel 2 consumes more power through HVAC chillers compared to Vessel 1. This indicates greater energy usage for cooling purposes on Vessel 2, possibly due to varying operational conditions or environmental factors.
Power Service Area:

The power service area dominates the power consumption in both vessels. This area supports essential onboard operations, highlighting its critical role in vessel functionality and energy distribution.

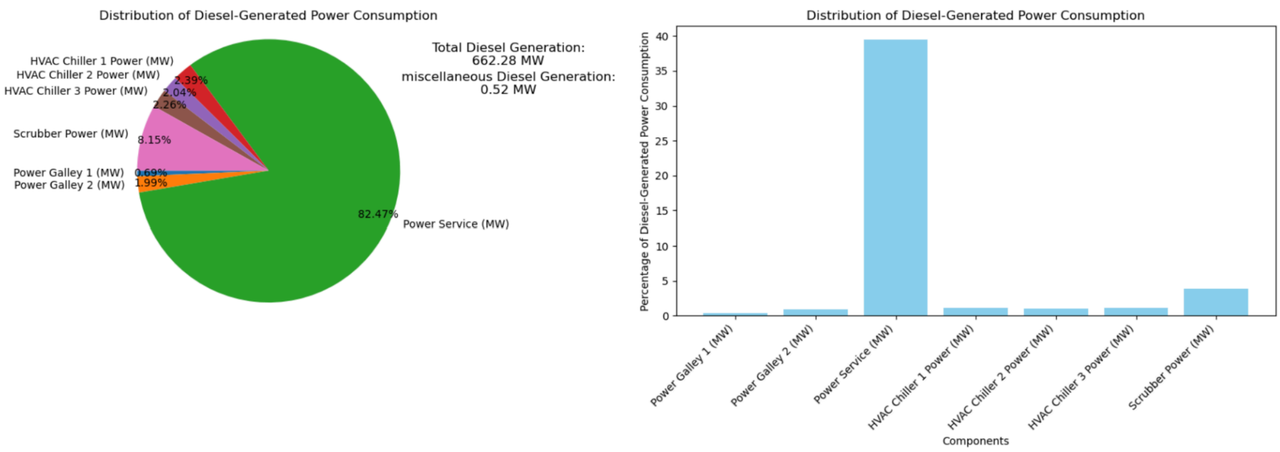


Fig 3. Vessel 1 Diesel-Generated Power Consumption

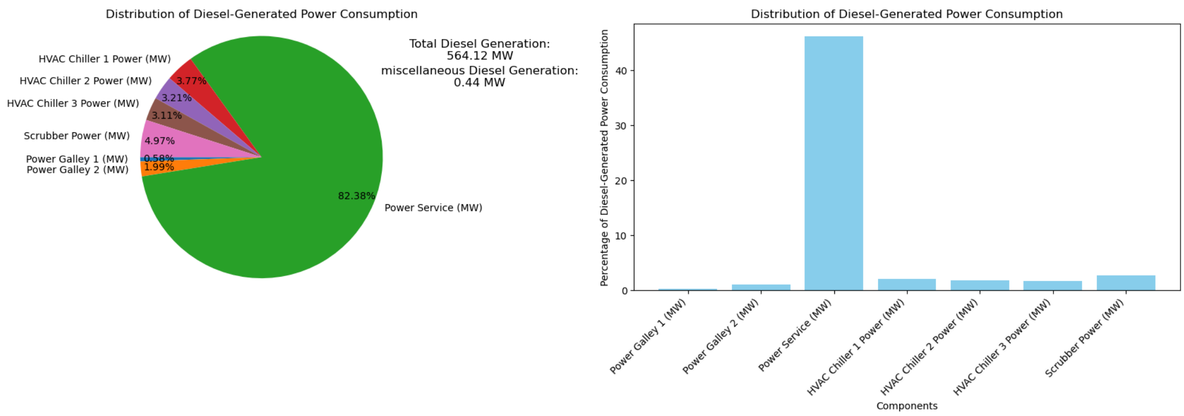


Fig 4. Vessel 2 Diesel-Generated Power Consumption

3.Analysis of Propulsion Power Consumption and Fuel Flow Rate:

Propulsion power represents the cumulative miscellaneous power consumption and exhibits a linear correlation with the total main engine fuel flow rate. While this relationship resembles the graph for diesel power generation in both Vessel 1 and Vessel 2, there are notable differences.

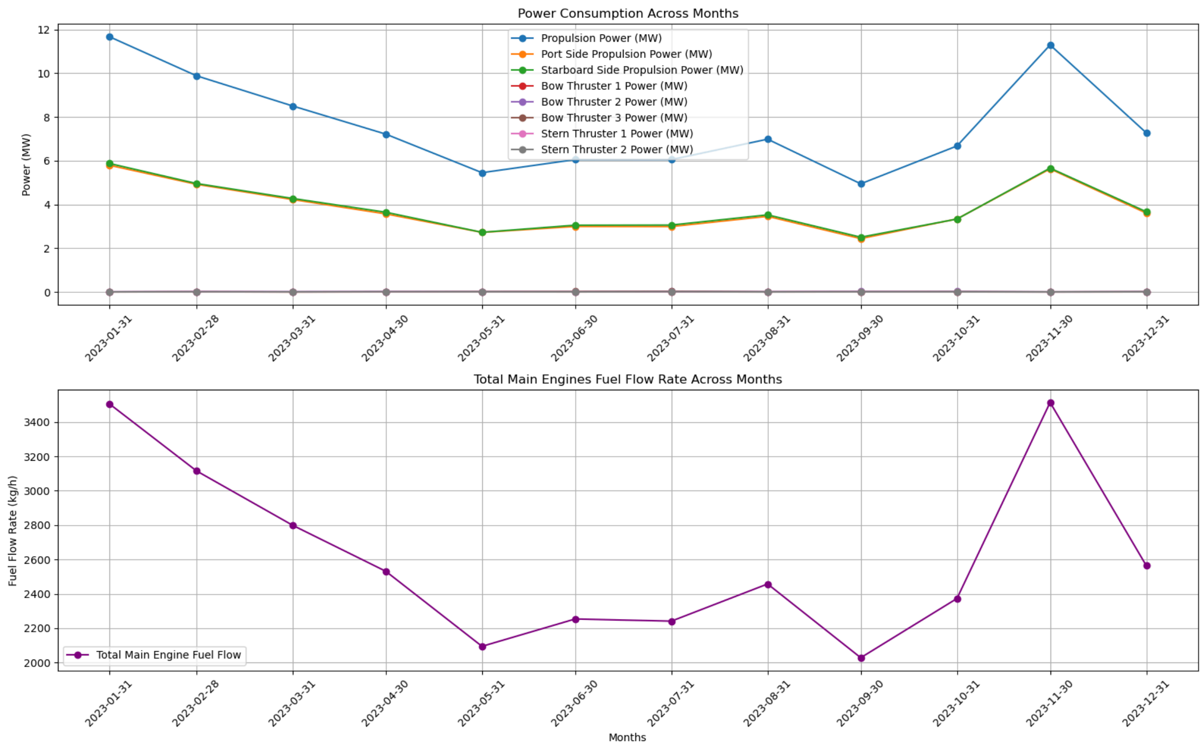


Fig5. Vessel 1 Analysis of Propulsion Power Consumption and Fuel Flow Rate

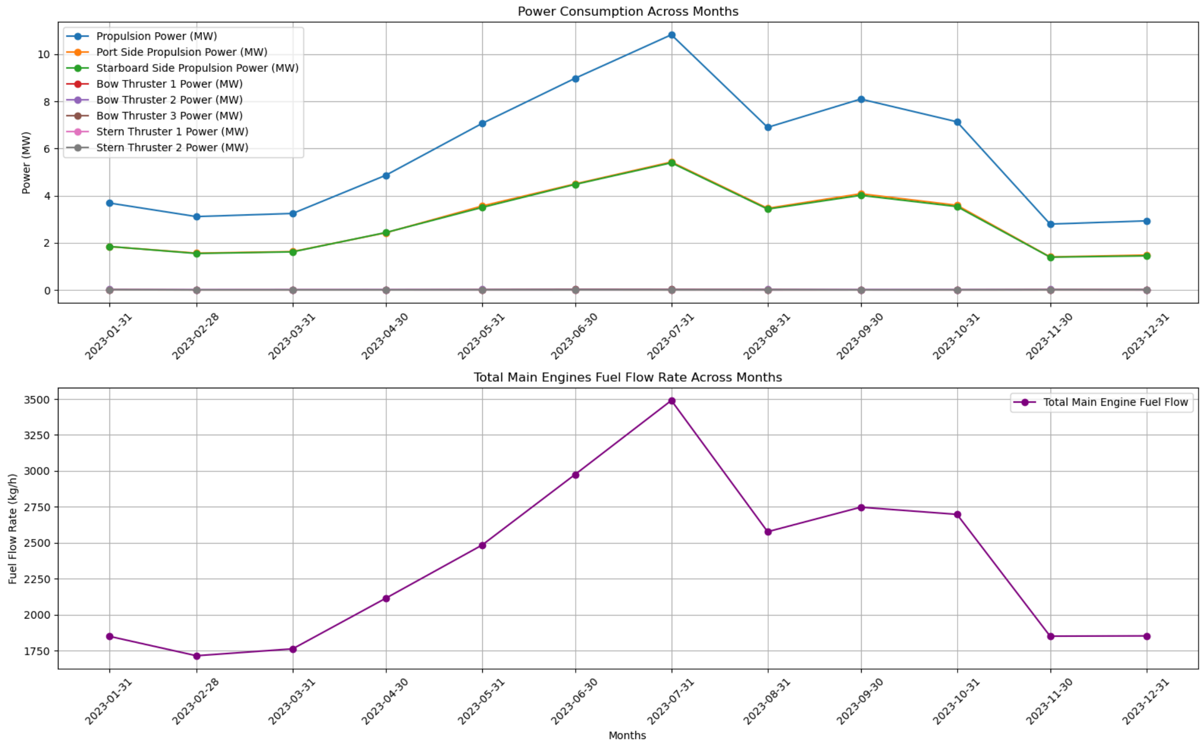


Fig 6. Vessel 2 Analysis of Propulsion Power Consumption and Fuel Flow Rate

4.Efficiency and Fuel Consumption

The monthly specific fuel consumption (SFC) trends for both vessels exhibit inverse patterns. Similarly, the graphs depicting propulsion efficiency also demonstrate contrasting trends between Vessel 1 and Vessel 2. This inverse relationship is expected because specific fuel consumption is a measure of how efficiently a vessel uses fuel to generate power. As propulsion efficiency increases, the vessel uses less fuel to generate the same amount of power, resulting in lower specific fuel consumption. Conversely, when propulsion efficiency decreases, more fuel is required to generate the same power, leading to higher specific fuel consumption. The observed opposite trends in SFC and propulsion efficiency graphs reflect this inherent inverse relationship.

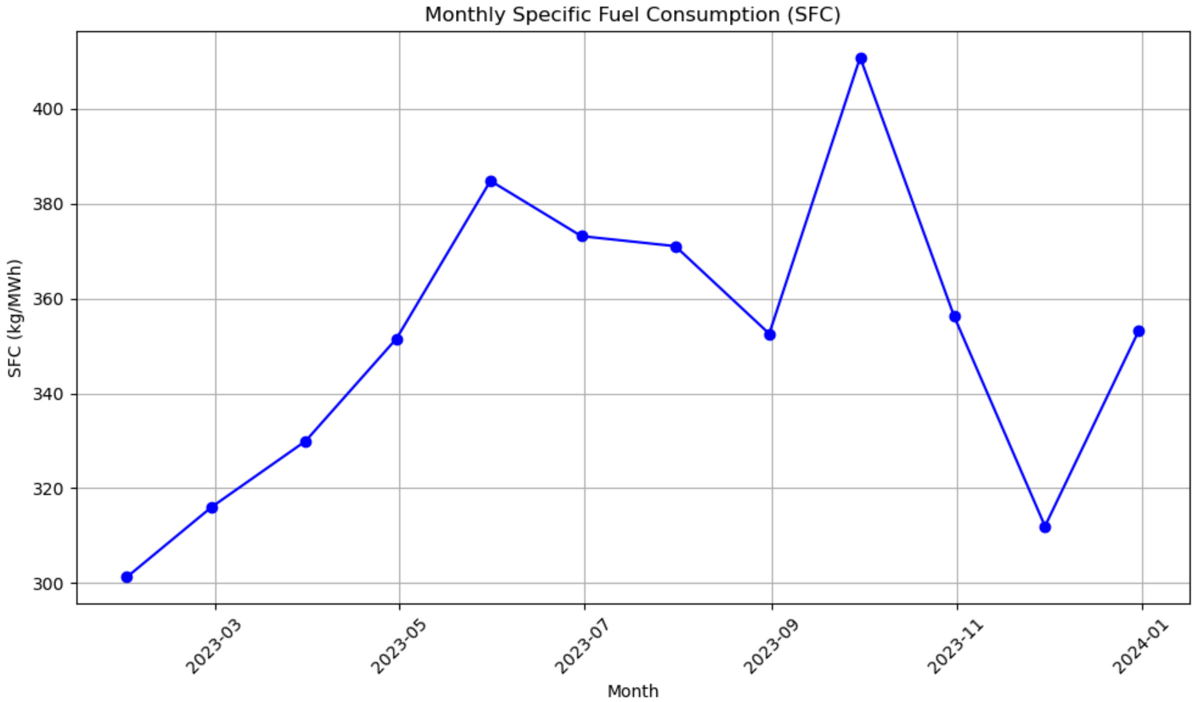


Fig.7 Vessel 1 SFC

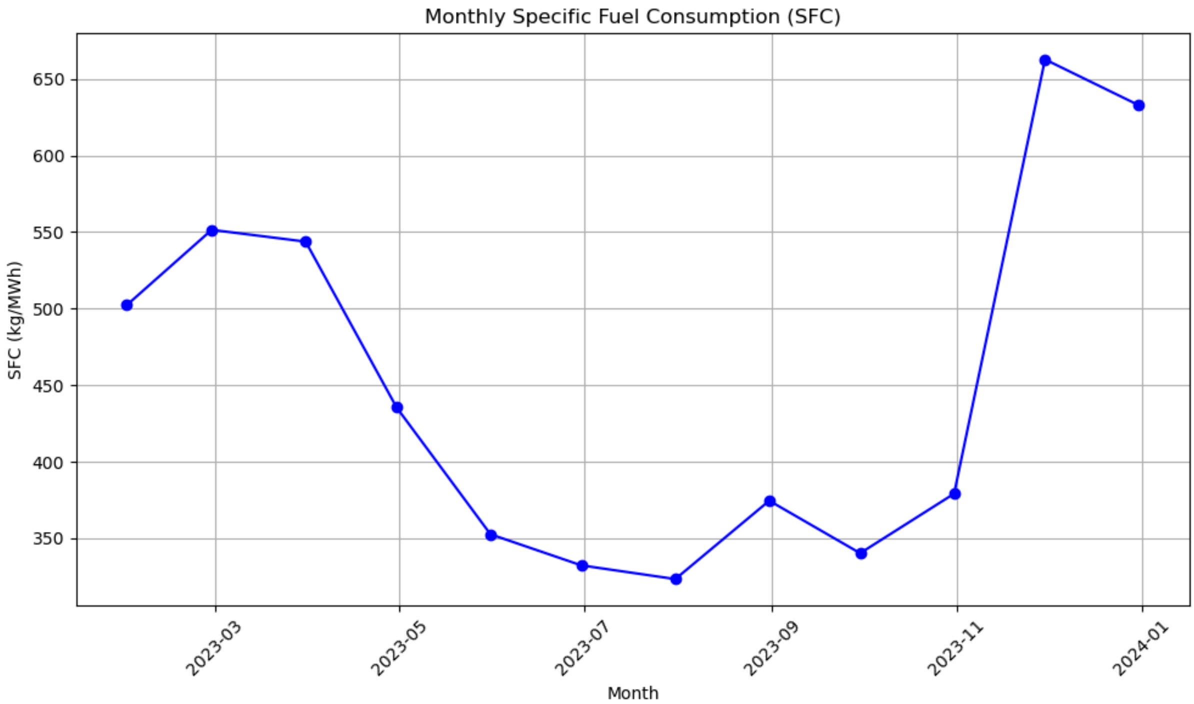


Fig 8. Vessel 2 SFC

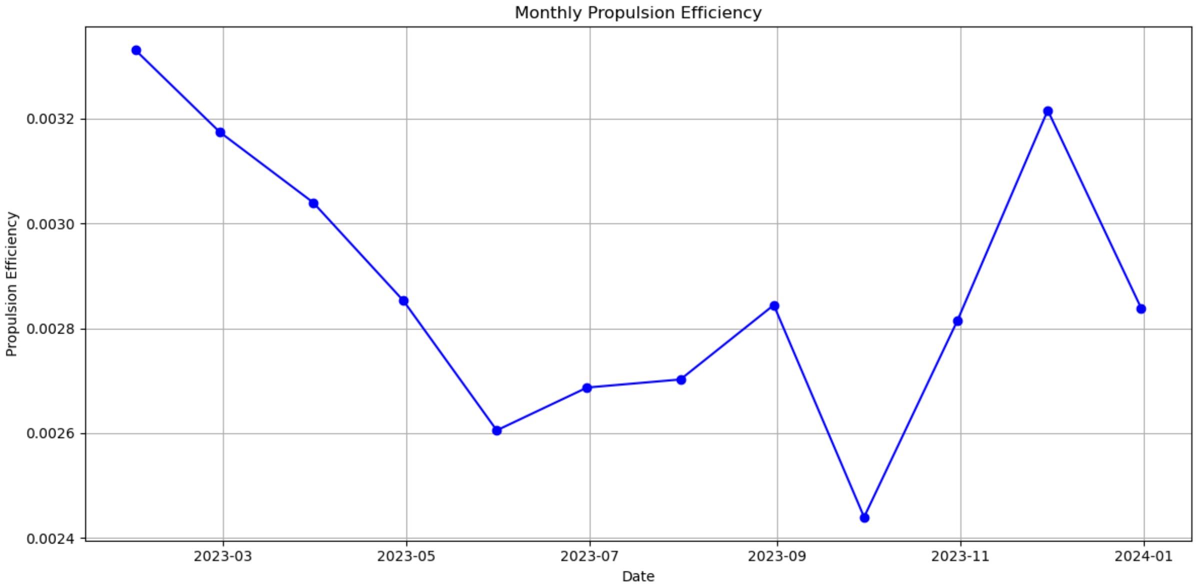


Fig 9. Vessel 1 Propulsion Efficiency

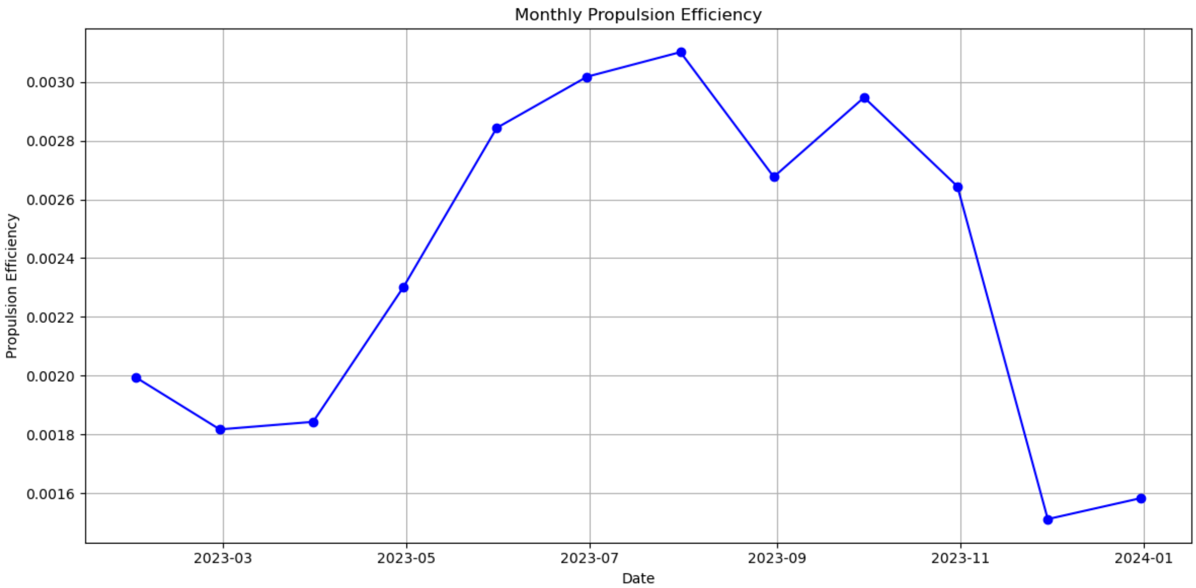


Fig 10.vessel 2 propulsion efficiency

5. Analysis of Speed and Propulsion Power

Interpretation of Slopes

1. Slope Definition:
   - The slope in the context of this regression analysis represents the rate of increase in speed through water for each additional megawatt (MW) of propulsion power.
   - Specifically, a slope of 0.99 means that for every 1 MW increase in propulsion power, Vessel 1's speed through water increases by 0.99 knots. Similarly, a slope of 0.98 means that for every

1 MW increase in propulsion power, Vessel 2's speed through water increases by 0.98 knots.

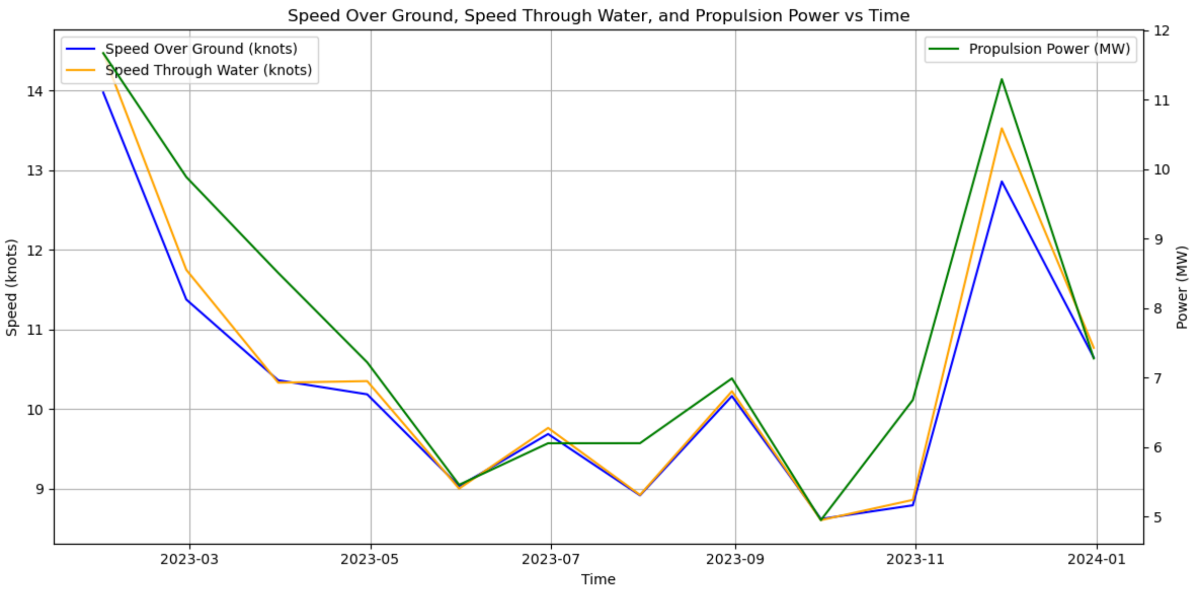
Comparison of Efficiency:
The difference in slopes between the two vessels is very small (0.99 vs. 0.98). This indicates that both vessels have very similar propulsion efficiency, with Vessel 1 being slightly more efficient.
Vessel 1 requires marginally less propulsion power to achieve a comparable increase in speed through water compared to Vessel 2.

Operational Efficiency:
Both vessels are quite similar in terms of how efficiently they convert propulsion power into speed. The slight edge in efficiency for Vessel 1 might not be significant in practical terms, but it does suggest a marginally better performance in its propulsion system or hull design.

Fuel Consumption and Cost:
Since the propulsion power directly relates to fuel consumption, Vessel 1 might consume slightly less fuel to reach the same speed as Vessel 2, potentially leading to cost savings over long voyages.

Performance Benchmarking:
Although Vessel 1 shows a slight advantage, both vessels are performing almost equally well. This small difference might not warrant immediate operational changes but could be a point of consideration for long-term efficiency improvements.

Conclusion
The very similar slopes indicate that both Vessel 1 and Vessel 2 have almost identical propulsion efficiencies. The slight difference suggests that Vessel 1 is marginally more efficient, but this difference is so small that it may not have a significant impact on overall operational performance. Regular monitoring and further analysis could help in maintaining or improving the efficiency of both vessels.



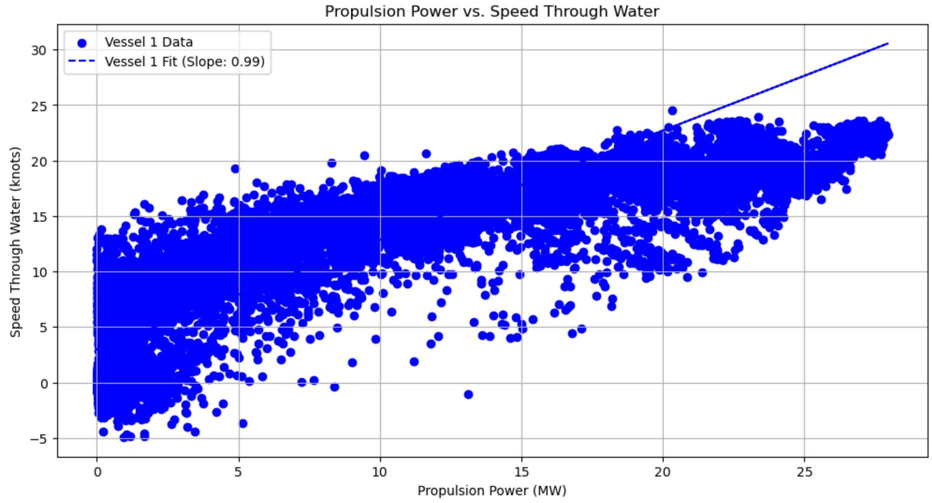
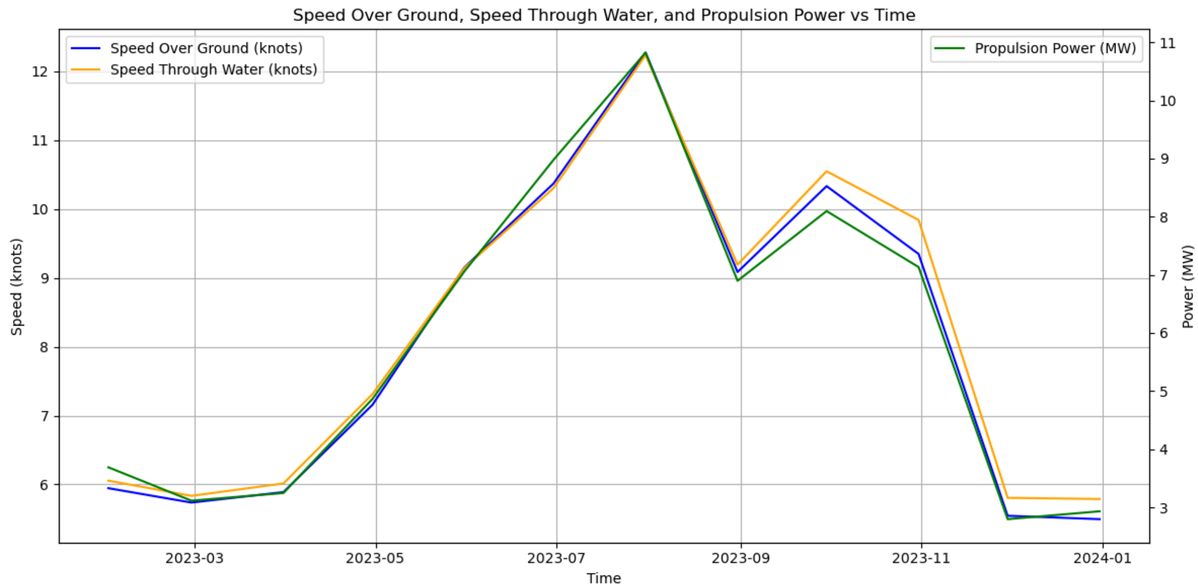


Fig 11. Vessel 1 Propulsion power vs Speed through water



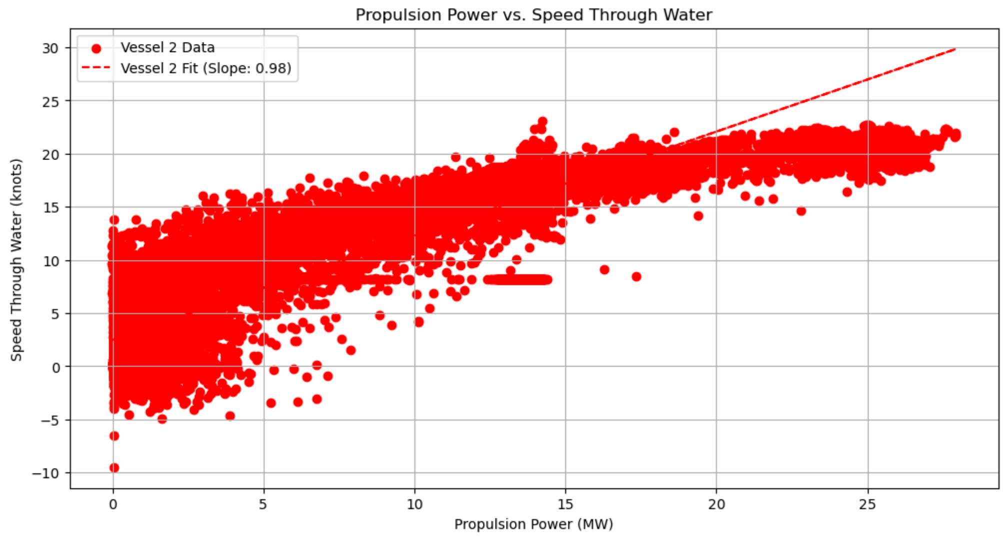


Fig 12. Vessel 2 Propulsion power vs Speed through water

Summary of Vessel 1 and Vessel 2 Analysis

Overview

The analysis of power consumption, fuel flow rates, and operational efficiency for Vessel 1 and Vessel 2 provides critical insights into their performance characteristics. By examining various metrics such as power generation, propulsion power, specific fuel consumption, and efficiency, we can draw meaningful conclusions about the operational capabilities and efficiency of each vessel.

Key Findings

1. **Power Generation:**
    - **Vessel 1:** Exhibited higher overall power production compared to Vessel 2. The power generation followed a distinct pattern with a significant increase at the start of the year, a gradual decrease, and a notable spike in November.
    - **Vessel 2:** Showed a steady increase in power production from the beginning of the year, peaking in the eighth month, followed by a sudden drop in the ninth month. Overall, Vessel 2 produced less power than Vessel 1 throughout the year.
2. **Propulsion Power and Efficiency:**
    - Both vessels showed a strong linear relationship between propulsion power and speed through water, indicating efficient power utilization for propulsion. However, Vessel 1 demonstrated a marginally higher efficiency with a slope of 0.99 compared to 0.98 for Vessel 2.
    - The specific fuel consumption (SFC) and propulsion efficiency graphs for both vessels exhibited opposite trends, highlighting differences in how each vessel manages its power and fuel resources.
3. **Power Consumption Distribution:**
    - **Scrubber Power:** Vessel 1 allocated 8.15% of its power to scrubbers, while Vessel 2 allocated 4.9%. This suggests that Vessel 1 invests more power in emissions control.
    - **HVAC Chillers:** Vessel 2's HVAC chiller power consumption was higher than Vessel 1's, indicating a greater demand for cooling power, potentially due to operational or environmental differences.
    - **Power Service Area:** In both vessels, the majority of power consumption was attributed to the service area, reflecting its significant operational demand.
4. **Operational Insights:**
    - **Vessel 1:** Demonstrated superior overall performance in power generation and propulsion efficiency. The observed power spikes and variations suggest periods of high operational demand or changes in voyage conditions.
    - **Vessel 2:** Despite producing less power overall, Vessel 2 maintained steady operational performance with a notable peak mid-year. The differences in power allocation, particularly in HVAC systems, suggest variations in environmental conditions or operational practices.

Conclusion

Both vessels exhibit efficient power and fuel management, with Vessel 1 showing a slight edge in overall power production and propulsion efficiency. The differences in power consumption patterns, particularly in scrubber and HVAC chiller usage, provide insights into their operational strategies and environmental management practices. Continuous monitoring and optimization can further enhance the performance and efficiency of both vessels, ensuring better fuel economy and operational sustainability.