

Decarbonising tugboats in Southampton harbour

Silvia Calvo Benthem (33169063) – supervised by Prof. Alan J Murphy



Introduction

The maritime transport industry, responsible for 2.9% of global greenhouse gas emissions, is under increasing pressure to reduce its carbon footprint [1].

Tugboats are a key part of the maritime cargo transport; they help berth and unberth bigger ship that require assistance during each manoeuvre. Tugboat gas emissions contribute to overall gas emissions of the shipping and cruises companies.

Complying to the IMO rules of reducing in carbon intensity of international shipping by at least 40 per cent by 2030 and to reach net zero by or around 2050 [2].

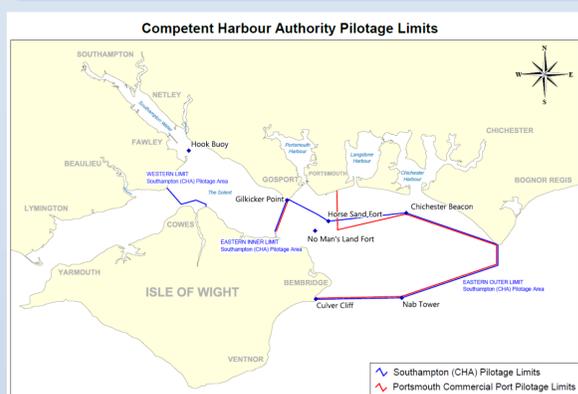
This project focuses on reducing fuel consumption in Svitzer-owned tugboats operating in the Solent, particularly in Southampton Docks and Fawley Refinery.

Aims and objectives

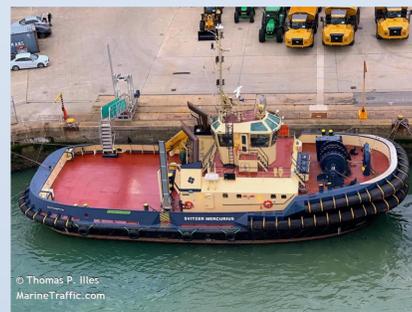
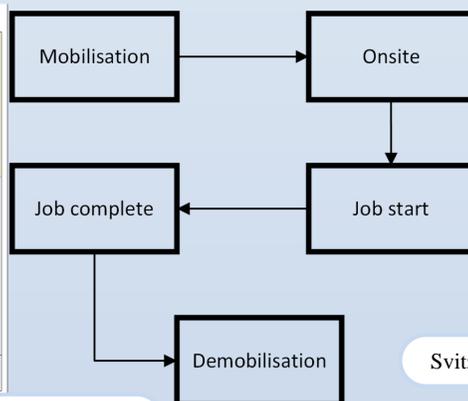
The overall aim of this project was to understand the operational characteristics of two different fleets in the same region and how to improve their fuel consumption.

1. Identify and assess the current state of operations in the vessels.
2. Identify and organise the supply energy and shoreside support as well as the technoeconomic of each ship.
3. Develop new operational strategies to reduce fuel consumption and emissions.
4. Develop a cost analysis with these strategies.

SVITZER



Map of operation of the 2 fleets and operation phases



Svitzer Mercurius most powerful and highest BP of the fleet



Apex Fawley refinery tugboat with highest BP

Results

- Fuel Consumption Correlation: The model showed a strong correlation between the number of jobs performed and their fuel consumption.
- Bollard Pull Impact: The bollard pull, was identified as a major factor affecting fuel consumption.
- Model Validation: The model's predictions were closely aligned with the fuel consumption data from Svitzer's record data for 2023. This confirms the model's accuracy in estimating energy usage based on vessel activities.
- Operational Phases: The analysis highlighted that high-power phases, such as towing and trawling, were the primary contributors to fuel consumption.

Methodology

The methodology involved researching the current state of decarbonization in the maritime industry, including regulations, technologies, and Svitzer's initiatives. Used AIS and VTS data to understand vessel activity, supplemented by Svitzer provided data.

A model will be developed to estimate energy usage based on fuel consumption. This model will account for various operational modes, including transiting, trawling, and escorting. Stakeholder engagement will involve meetings with key Svitzer personnel and field visits to understand tugboat operations.

$$Power \propto V_S^3 \quad CoT = \frac{SFOC \times P}{V \times \rho_{fuel} \times 0.852}$$

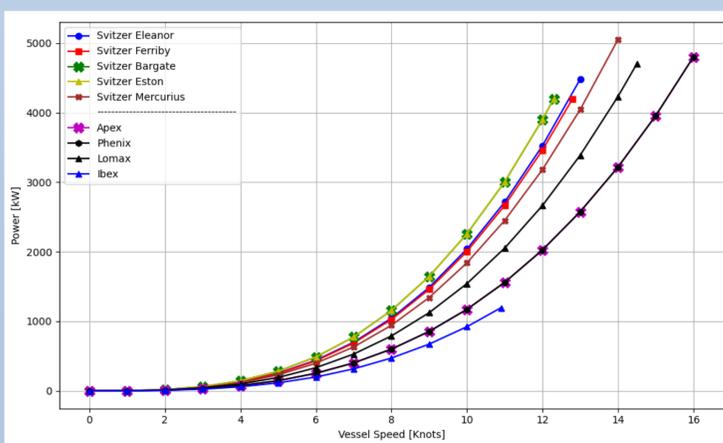


Figure 1: power comparison for all the vessels in the Southampton harbour.

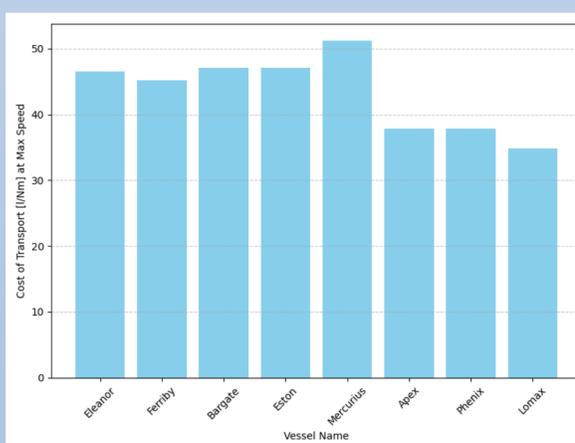


Figure 2: cost of transport for all the vessels

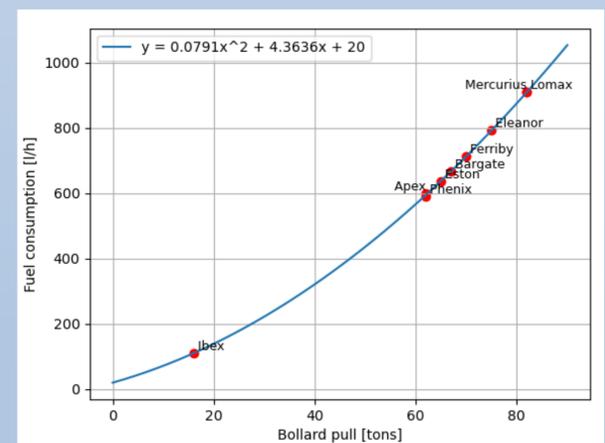


Figure 3: fuel consumption compared to bollard pull

Conclusions

A basic model was created for fuel estimation during transit, highlighting areas for improvement like including auxiliary systems and variable engine speeds into the calculations.

The case study on one tugboat showed promise for a bollard pull-based consumption model but requires more vessel-specific data and broader job types to be truly accurate.

Stakeholder collaboration, field visits, and crew expertise proved valuable.

Further work and impact

- Investigating the use of alternative fuels such as hydrogen and methanol.
- Further refinement of the model to include detailed towing and trawling fuel consumption data. To add scenarios such as changes in operational strategies and the introduction of alternative fuels, to assess their impact on fuel consumption and emissions.
- Explore Svitzer's 'Project monitor' system and implement it into the model
- Seawork 2024 selection for commercial ideas.

References

- [1] INTERNATIONAL MARITIME ORGANIZATION, "Fourth IMO GHG Study," International Maritime Organization, London, 2020.
- [2] IMO, "Revised GHG reduction strategy for global shipping adopted," 2023.