Wind-assisted ship propulsion: matching Flettner rotors with diesel engines and controllable pitch propellers

Response to reviewers

We greatly appreciated the comments that have been made to improve the quality of the paper. The paper has been revised accordingly.

Here you find in red colour the response to each comment.

Kind Regards

Massimo & Veronica

Reviewer 1

This paper presents a method for the preliminary sizing of a ship propulsion plant that integrates a diesel engine, a controllable pitch propeller, and Flettner rotors for wind-assisted propulsion. The study aims to evaluate fuel consumption and CO_2 emissions of wind-assisted propeller solutions to achieve decarbonization goals in marine transportation. The innovation comprises the ability to study the performance of the integrated propulsion system in a parametric way to find optimal solutions during ship design, including downsizing the diesel MCR or optimizing the propeller pitch for different wind conditions to reduce fuel consumption. The paper needs some improvements. My detailed comments are as follows:

1. It would be helpful to include a more in-depth discussion on the limitations of the study, especially in terms of the assumptions made in the model and the applicability of the results to different types of vessels and operating conditions.

A new section 2.6 is added to discuss limitations in detail.

2. How do the results of this study compare to previous research on wind-assisted propulsion technologies for ships? The authors should clearly clarify the main innovation of this paper according to the most recent publications on this hot topic of research.

This aspect is addressed in page 3 line 122-126, further, a new section 3.5 has been added.

3. Some literature studies on the application of the Magnus effect in the marine field are missing, as follows:

[1] Abramowicz-Gerigk, T., & Burciu, Z. (2022). Investigations of Hydrodynamic Force Generated on the Rotating Cylinder Implemented as a Bow Rudder on a Large-Scale Ship Model. Sensors, 22(23), 9137.

[2] Lin, J., Guo, C., Zhao, D., Han, Y., & Su, Y. (2022). Hydrodynamic simulation for evaluating Magnus anti-rolling devices with varying angles of attack. Ocean Engineering, 260, 111949.

A new paragraph is added in the literature review.

4. The authors should further elaborate on the sensitivity analysis conducted in the study and provide more details on the impact of varying each parameter on the results.

New figure 2b is added and more details have been reported in the description of the figure.

Tab 4 shows the parametric variation of the Spin Ratio SR

Tab 5 shows the parametric variation of the propeller Pitch/Diameter ratio

5. The paper would benefit from a more detailed explanation of the method used to compute the fuel consumption and CO_2 emissions of the wind-assisted propulsion system, including the sources and accuracy of the input data.

More detailed explanations are provided in section 2.5 fuel consumption.

6. Can you explain more about the methodology used to integrate the Flettner rotors into the engine-propeller matching procedure?

The reference where the method is fully developed has been added [ref 29, Stapersma and Klein Woud].

7. It would be interesting to see a comparison of the results obtained in this study with those of experimental trials or other numerical simulations of Flettner rotor-assisted systems, especially for vessels of similar size and operational characteristics.

A new Section 3.5 has been added.

8. How were the design parameters for the ship, such as the resistance-speed curve and rotor geometry, chosen?

9. It is suggested to provide more detail about the case study and how the results were analyzed.

Section 3.1 case Study has been revised.

10. The conclusion section could be improved by summarizing the main findings of the study more concisely and highlighting their practical implications for the design and operation of ship propulsion systems.

Section 4 Conclusions has been implemented.

Reviewer 2

This paper presents a method for wind-assisted ship propulsion. It is interesting and meaningful. Before accepting for publicaion in JMSE, some issues should be addressed.

1)The author should briefly explain the research tools used and their implementation steps in the examples.

A new figure representing the flow chart of the method and of the developed code is added.

A new section 2.6 is added to discuss limitations in detail.

2)In Figure 4 and 8, how to understand power savings percentage in the polar coordinates in the figure, I suggest the authors explain in detail.

The figure description has been improved.

3)Why does the data of KPI 2 in Figure 7 and the corresponding points in Table 6 not match? Please give explaination in detail.

In figure 7 (n. 8 in the new paper) the wind is 15 knots, however the wind speed 30 knots in the table. Now it is better explained in the text.

4)In the conclusion section, the author should provide a quantitative conclusion based on the previous results.

The conclusion section has been improved.

Reviewer 3

The paper presents a holistic method to evaluate the wind-assisted propulsion system for a vessel. The methods uses parametric models that are simplified that are useful for the early design stage where one needs to find an optimized set of design parameters for the whole vessel system. The method may have limitations as the models proposed here are simplified and may not reveal other emerging properties of the system during the operation. In this regard, it will be important that the authors to state the limits of the methods and models provided in the paper.

The resistance model of a ship provided in the paper does not include added resistance due to waves. As wind at sea accompanies waves, the relevance of include such model will be high for the evaluation. The propeller loading will be different with the additional resistance, and the result may be deviate from the current one.

A new section 2.6 is added to discuss limitations in detail.

The study will be more complete if the authors can include semi-empirical model such as SNNM.

Thanks for the suggestion.

The description of Figure 6 can be improved. Especially the labels for the contour lines are not clearly stated even though it may be guessed as vessel speed and the P/D values.

Unfortunately, such figures are difficult to read, we have improved the description.

However, using the downloadable code, it is not difficult to zoom the area of interest.

The case study goes through steps of selecting the parameters for the rotors, selecting the engine and propeller. It will be interesting to see how all these parameters will affect the result, like a sensitivity analysis.

New figure 2b is added and more details have been reported in the description of the figure.

Tab 4 shows the parametric variation of the Spin Ratio SR

Tab 5 shows the parametric variation of the propeller Pitch/Diameter ratio

It will also help to present the method and steps for the design with a schematic drawing like a flow chart.

A flow chart has been added.