Ship Conversion: Addition of Flettner Rotors on a T-AKE

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Study Selection

The maritime industry faces increased pressure to reduce emissions and reliance on fossil fuels. In 2011, the International Maritime Organization (IMO) adopted a strategy to reduce the greenhouse gas emissions from ships. It was the first international body to mandate energy efficiency measures. The initial goal was to make the ships built in 2025 30% more efficient than those built in 2014. The new goal of the IMO is more stringent, aiming to reduce total emissions by 40% by 2030 and 50% by 2050 compared to emissions in 2008. In 2016, the Paris Climate Accords sought to limit the global temperature rise to 2 °C above pre-industrial levels and pursue limiting the rise to 1.5 °C. These accords accounted for climate change mitigation, adaptation, and financing to ascertain this goal. The 2021 United Nations Climate Change Conference (COP26) laid the foundation for a global push to global net-zero carbon emissions. With the IMO at the forefront of the trend to reduce emissions, ship builders are looking at new and old technologies to reduce emissions while still meeting global demands.

The military may face similar pressure as the economy changes and technology advances. Unlike military ships classed by the Naval Sea Systems Command (NAVSEA), military supply ships are classed by the American Bureau of Shipping (ABS). As a result, these ships are subject to ABS regulations, which are influenced by the regulations of the IMO. Since improvements in diesel technology alone are not expected to meet these standards, this conversion project investigates an alternate method to achieve this goal.

Technology Selection: Flettner Rotors and their Operation

Power sources with zero emissions include solar, fuel cells, and wind. Before steam engines, wind power was the preferred power source on the high seas and allowed access to all ports. Furthermore, after taking a deeper look into the improvements in wind propulsion methods, one of the more promising methods is Flettner Rotors. Flettner Rotors are spinning, vertical columns that employ the Magnus Effect to induce a horizontal “lift” force for propulsion. A picture of the Flettner rotors installed on a vessel and a diagram explaining the Magnus Effect are shown below.

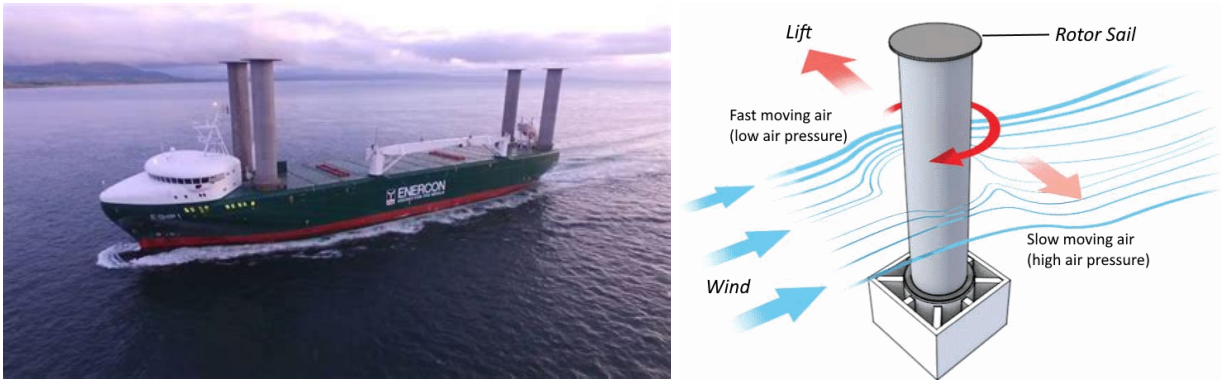

Figure 1: Flettner Rotor Installed on a Vessel (Left) and Description of Magnus Effect (Right)

Previous studies of Flettner rotors on bulk carriers revealed significant cost savings due to reduced fuel use, along with commensurate reductions in NOx (nitrogen oxides) and CO_2 (carbon dioxide) emissions.

Ship selection: T-AKE: purpose and image

Since these regulations would impact ships operated by vessels classed by ABS sooner than military ships, this conversion project conducted a feasibility study on adding Flettner rotors to a T-AKE dry cargo ship. The figure below shows the original T-AKE on the left and the modified T-AKE with Flettner Rotors on the right.

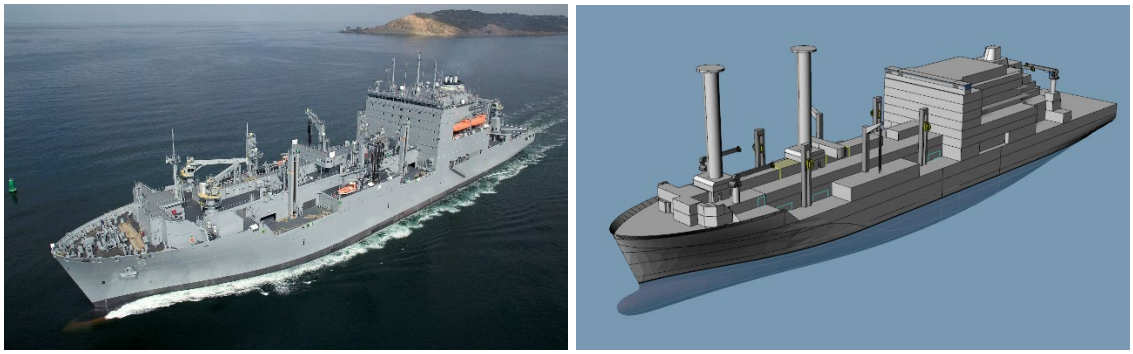

Figure 2: Current T-AKE (Left) and Modified (Right)

The T-AKE is not the ideal ship for this project. It has essential topside equipment that interferes with placing the maximum number of rotors onboard. More and larger rotors are desired for best results with the Flettner Rotor. The idea behind selecting arguably the most limiting candidate for this project was to demonstrate feasibility even in this limiting scenario.

Design Philosophy and Assumptions

All calculations will be based on standard T-AKE hullform at design length, beam, and displacement for this study. Only minor changes will be made to the machinery onboard to accommodate the implementation of Flettner Rotors. The focus of this study was on (1) the change in overall fuel consumption and seakeeping, and (2) the feasibility of installation on the vessel while meeting current ABS radar and visibility standards.

Feasibility, Performance, and Cost-Savings

The focus of our study was on the effect of Flettner Rotors. Thus, the project team opted not to create costly, custom rotors but instead used rotors already commercially available for comparison. Norsepower is a Finnish company that specializes in the installation, operation, and maintenance of Flettner Rotors. They have five standard Rotor sizes ranging from 18 to 35m tall with a lifespan of 25 years. The cost and saving potential was evaluated from both the emission and financial point of view. Reduction of fuel emissions was expected, so the selling point would focus on the financial benefit from adding these rotors.

Conclusion

Analysis of these rotors along with installation guidance from the manufacturer found the installation of two 28m tall Flettner rotors on a T-AKE is a viable option that produces an estimated $5.6 million in savings over the Rotor's lifecycle, 3.2% reduction in emissions, and a monetary payback period of 4.9 years. The project team found that current regulations stood in the way of better performance for these Rotors. For example, placing two 35 m tall Flettner Rotors onboard would save $9.46 million. However, this is not possible with current ABS visibility restrictions. Changing the current regulation to adding visibility assistance from live video would allow more significant emission reduction for this technology.