# Innovative Climate Change Emissions Reduction: The Cargo Ship Flettner Rotor Centrifugal Vortex Exhaust Scrubber

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Our global cargo ship fleet emits 4% of climate change emissions and particulate pollutants, leading to roughly 7.6 million childhood asthma cases, and 150,000 premature deaths annually. A novel centrifugal vortex scrubber integrated into a Flettner rotor creates a hybrid wind and fossil fuel powered vessel that cleans exhaust while generating auxiliary wind propulsion. 3D CAD modeling, computational fluid dynamics analysis, and prototyping were used for design iterations and testing. Flettner rotor performance was measured in a water test tank and wind tunnel and was not diminished by the integrated scrubber. Two-Sample t-Tests were used to statistically compare means at each operating point. For all operating points $p < alpha (0.05)$. The exhaust scrubber was simplified, replacing high-maintenance moving parts with a cyclonic separation-based design that fits well into the cylindrical Flettner rotor geometry. The scrubber removed 42% of particulate matter. The Kutta–Joukowski force generated was significant, even under mild wind conditions. This Flettner Vortex Scrubber shows promise as an economically attractive design to limit emissions from heavy fuel oil engines in marine applications, as well as provide an auxiliary propulsion source to reduce heavy fuel oil consumption, both climate change causes. Combining Flettner rotors with an exhaust scrubber makes the investment more attractive by allowing a Neopanamax ship to transport an additional 53 TEU containers, thus increasing the rate of adoption of this important climate change and public health risk-mitigation technology. If conservative estimates of Flettner rotor performance scale to the global cargo shipping fleet, it could mean a climate change impact equivalent to taking five million cars off the road.

**Awards Won:**

Fourth Award of $500

United States Environmental Protection Agency: Alternate trip winner