Exploring the Effect of Vortex Generators on Boundary Layer Separation and Laminar Flow in a Venturi and Determining the Potential Improvement on Efficiency of Vertical Axis Wind Turbines (VAWTs)

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Purpose: To determine if vortex generators improve efficiency of 3D printed vertical axis wind turbines housed in a venturi. Vortex generators were positioned at the entrance of a venturi to create microvortices, potentially increasing laminar flow and delaying boundary layer separation, as air flowed through the venturi. Shape of the vortex generators mimic a shark's dorsal fin (Biomimicry), and it is posited that air will flow more smoothly through the venturi due to microvortices being produced. Hypothesis: Incorporating vortex generators into a venturi, that houses vertical axis wind turbines (VAWTs) and varying the angle of the diverter doors, will significantly improve laminar flow and delay boundary layer separation, thereby improving low speed turbine efficiency. Control - Diverter Door with Airfoil Surface Independent Variables - Triangle Shaped Vortex Generators added to Airfoil Surfaces Shark Shaped Vortex Generators added to Airfoil Surfaces Dependent Variable - Total Energy Output (mJ) Three designs (Airfoil, Triangle, and Shark) were tested at diverter door angles 5.4° to 18.0° at 1.8° increments. 10 trials at each angle, for each wind speed (1.0, 2.0 and 3.0 m/s), were collected. (240 trials/design - Total 720 trials) Results: A one-way ANOVA showed adding Triangle and Shark Vortex Generators to Airfoils produced significant ($p<.01$) improvements in Total Energy Output (mJ) at all wind speeds vs. Airfoils alone. Shark Vortex Generators produced significantly ($p<.01$) more Total Energy Output (mJ) than Triangle Vortex Generators at wind speeds of 1.0 and 2.0 m/s. However, the improvement was nonsignificant at 3.0 m/s between Shark vs. Triangle.

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