Marine Current Turbine Prototypes

Phil Clancy, Eric Schiferl, Nathen Winter, Adam Zajac, Shouyu Chen, Morgan Cespedes, Ryan Christiansen
Faculty Advisors: Stephen Wood, Robert Weaver, Dept of OCE, Florida Institute of Technology

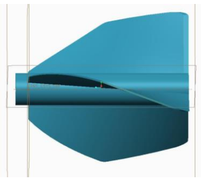
What are marine current turbines?

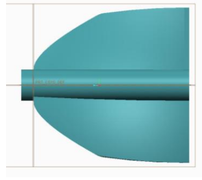
Marine current turbines (MCT) are used to generate green energy from currents and tides. This is done by converting the kinetic energy of rotating blades into electrical energy.

Design Concepts

Screw Propellers:

- 2 and 3 blade propellers
- Blade pitch 10˚, 15°, 20°, 25°, 30°, 35°
- Scale to industry tested blades $\frac{1}{30}^{th}$





Standard Propellers:

- 2, 3 and 4 blade propellers
- Foil and flat blade designs
- Blade pitch 10˚, 15°, 20°, 25°, 30°, 35°
- Scale to industry tested blades $\frac{1}{30}^{th}$

Theory

Much like wind energy, hydroelectricity can be produced from similar turbines. Marine currents flow as kinetic energy, which powers the generator and converts the energy into power. However, due to the density difference, the flux will be much greater by about 800 times of air. The Power coefficient, Cp, represents the maximum power that can be extracted from a single unit. The Cp can be experimentally determined using the tip speed ratio, TSR, which requires obtaining the rpm of the blade being tested.

Cp is calculated by the equation:

Cp = P / [(½)ρA(v_o)^3]
where:
P is power
ρ is density of the fluid
A is the cross sectional area
v_o is the fluid stream velocity

TSR is calculated by the equation:

TSR = ω * R / v_o
where:
ω is the angular velocity of the blades
R is the radius of the blades
v_o is the fluid stream velocity

Experimentation

The testing environment mimicked the low end of the speed of the Gulf Stream at 1.64 m/s. A PVC rig was created to house a motor and then waterproofed. Testing each propeller on the motor, the voltage and rpm was found using an Arduino code. From there, the power was calculated using simple circuit theory, and angular speed from the rpm, to find the power coefficient and tip speed ratio.

Overview

Through testing the various MCT prototype blade designs the team was able to determine the performance of each design and several improvements for future designs.

Improvements:

- Larger prototypes and testing environment
- Manufacturing prototypes out of lightweight metals
- Experimenting with rough and smooth surface blades

The testing showed the standard propellers to perform significantly better than the screw propellers however it is recommended further experimentation be done.