

Design & Analysis of WEC / Swivel Joint Technology

Jacob Hawkins, College of Engineering
Dr. Michael Smith, College of Engineering

Introduction

- Wave Energy Converters (WECs) are developing technologies
- WECs convert tidal energy into usable work
- Desalination WECs can be used for disaster situations in local communities

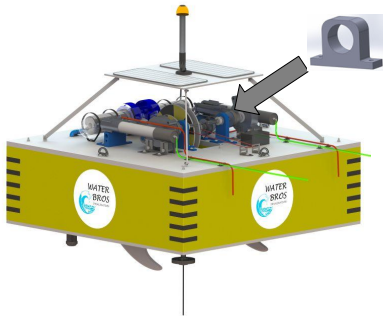


Figure 1: Water Bros Desalination Reverse Osmosis WEC

- Cables (fluid and electrical lines) get tangled due to WECs rotating
- Multiple anchors limit WEC movement and provide environmental challenges
- Swivel joint can provide relief and free rotation for cables

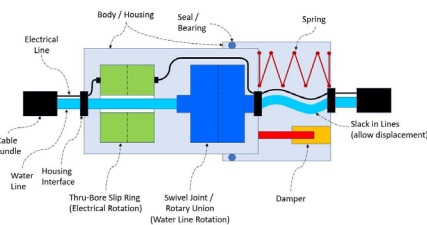


Figure 2: Swivel Joint Concept Design Schematic

Objectives

- Improve Water Bros RO WEC design
- CAD analysis on WEC parts
- Create, modify, and analyze swivel joint CAD documents
- Develop instrumentation for swivel joint data collection
- Hands on manufacturing and work on RO pumps from previous deployment
- Develop skills for design software for future use (design courses and industry)

Water Bros WEC

- Researched HERO WEC
- Designed gear train for linear to rotary motion
- Analyzed several parts included on the WEC

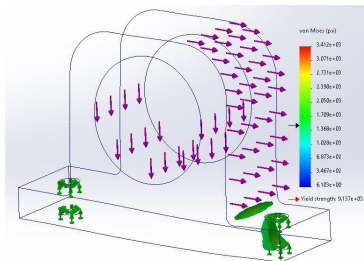


Figure 3: Shaft Bearing Housing FEA (Stress Plot w/ Iso Clipping >1500 psi)

- Shaft bearing housing made of delrin was sufficient for application
- Stresses are well below yield strength

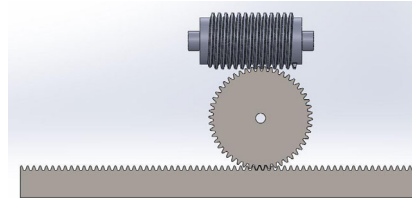


Figure 4: Gear Train Design Project for WEC Device

- Use of rack and pinion gear with a worm gear
- Gear ratio to relate 3 meters of movement to 10 inches of movement

Swivel Joint Design

- Researched swivel joint design
- Developed instrumentation list for concept and functional prototype
- Evaluated model using Solidworks FEA

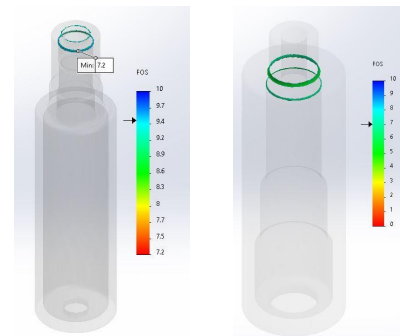


Figure 5: Swivel Joint (Left) Outer and (Right) Inner Shell FEA (Factor of Safety Plot w/ Iso Clipping Left <9.5 and Right <7)

- Both shells analyzed with cable loads of 4893 N
- Material analyzed is 6061 T-6 aluminum
- Minimum FOS was 7.2 and 5.1 for outer shell and inner shell
- Model is sufficient for the anticipated loads

Conclusions

- WEC and swivel joint technologies provide solutions to complex problems
- Designs still need improving and testing
- Further development will move marine energy technologies forward
- Marine energy is a newer technology that provides reliability for the future

References and Acknowledgments

Smith, Michael & Lowcher, Caroline & Patterson, Taylor. *Design Description Document*. 2025. Coastal Studies Institute.

Jenne, Scott. *HERO WEC V1: Design and Experimental Data Collection Efforts*. December 2024. NREL.

This study was supported by the UNC Charlotte Office of Undergraduate Research (OUR)

Water Bros Desalination, LLC provided input data

CSI Team Members: Caroline Lowcher, Ph.D.; Patterson "Trip" Taylor