Energy Converter Sub-Assembly

A turbine to feature in an oscillating water column (OWC) wave energy harvester

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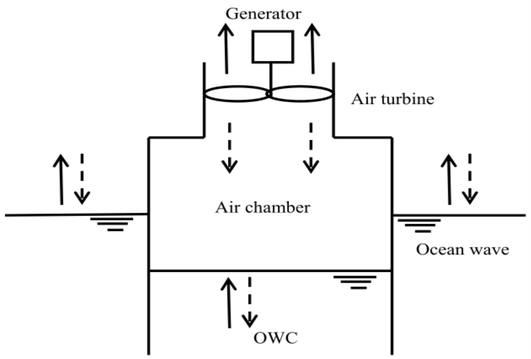
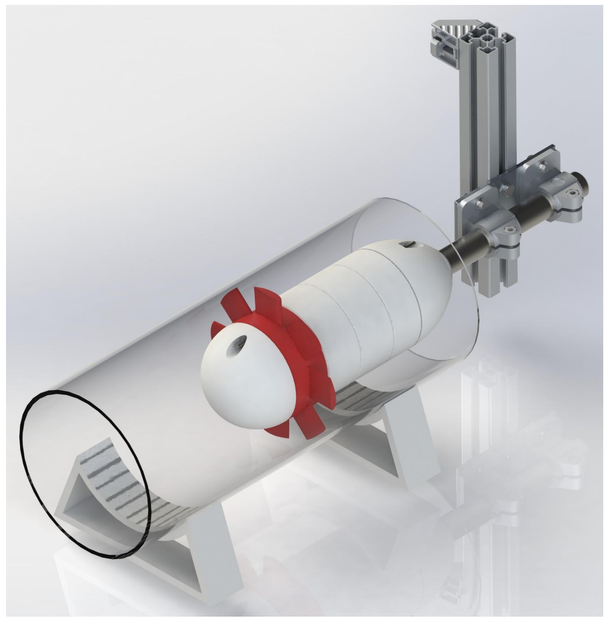
Project constraints

- Capable of self-starting without a motor
- 200 mm outer diameter, 120 mm inner diameter
- Fixed reduction in area of air chamber



OWC energy harvester schematic



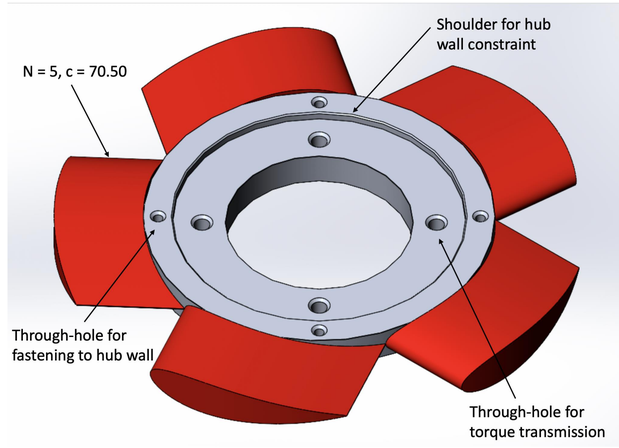
1st iteration turbine testing rig for wind-tunnel

Key points

- Ocean waves are an attractive source of renewable energy
- Modular design throughout for ease of assembly and testing
- Utilised standard parts to reduce cost and lead times
- Trends shown by experimental results agree with theoretical results
- Design for a 2nd iteration has been produced following analysis of wind-tunnel test results
- Total project expenditure: £1264.78
- Turbine estimated to produce a power of 92 W at full scale

2nd iteration design

- Chord length of 70.5mm with 5 blades
- Maximised solidity with optimum Reynolds number
- Would be tested in a full assembly wave tank test with other two sub-assemblies of energy harvester
- Estimated cost of aluminium CNC milling: £475



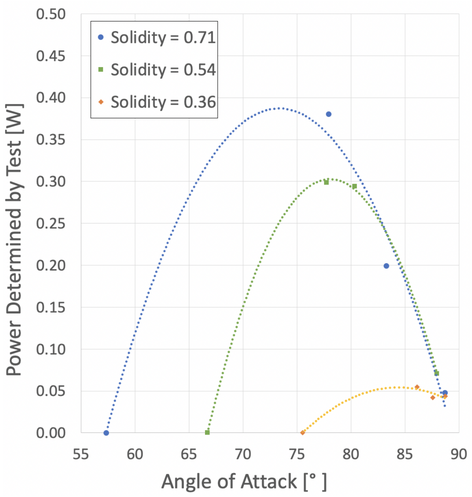
2nd iteration CAD model

Wind-tunnel tests for varying solidity and torque

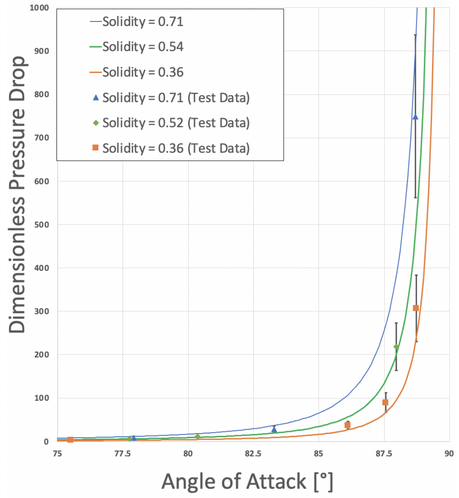
- Empirically determined power was approximately a factor 7 smaller than model predictions
- A parabolic curve was formed for power as predicted by model
- Dimensionless pressure drop determined by

$$\Delta P^* = \frac{\Delta P}{\rho U^2}$$

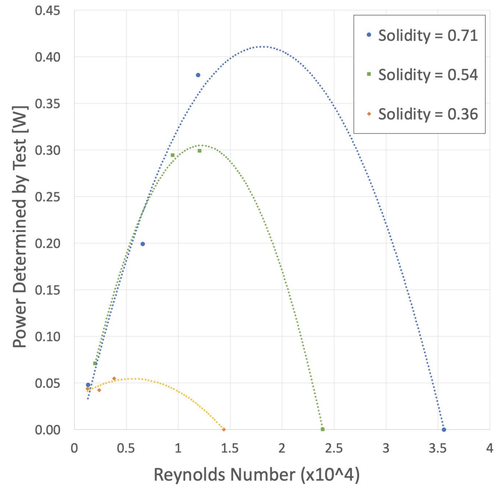
- **Conclusion**: as the solidity increases, so does the power and pressure drop across the turbine



Empirical values for power against angle of attack with fitted regression lines



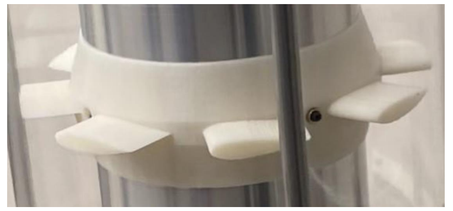
Both empirical and modelled dimensionless pressure drop and angle of attack values



Empirical values for power against Reynolds number with fitted regression lines

Assembly test

- Verified that the integration of all three sub-assemblies into one harvester assembly was possible
- Confirmed through inspection that a slide-on design changes the hub-to-tip ratio, which would invalidate the model – this informed on 2nd iteration design decisions



Assembly prototype