WES Gator

A compliant seal free hydraulic PTO

Project Overview

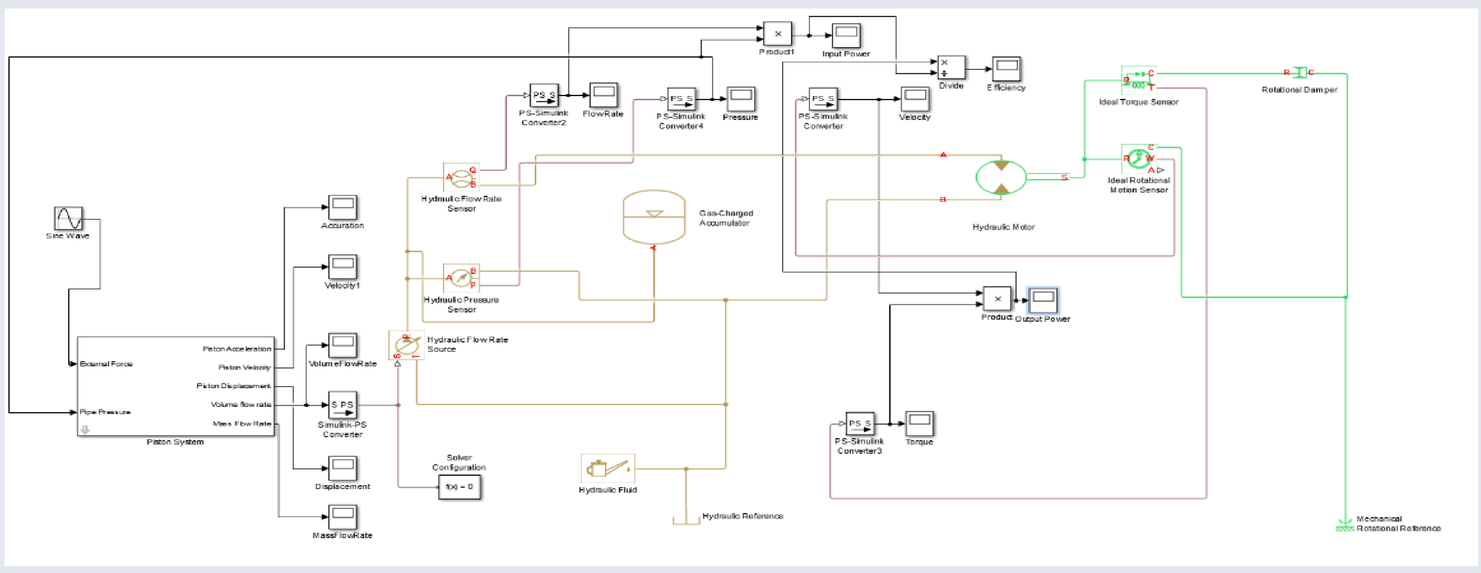
The project is to develop and test a novel innovative hydraulic PTO concept consisting of a flexible compliant polymer spring tube. This polymer spring (or Gator) can be designed with a wide range of non-linear response curves allowing tailoring of the stress strain response. The seawater compatible Gator acts as a pump compressing internal fluid (such as sea-water) and driving a hydraulic PTO system. As it does not require any seals, is designed for 10's of million compression cycles, can be fabricated at reasonable cost at all scales, is seawater compatible, can be implemented in a system with very low maintenance requirements, and offers a potentially appealing LCOE for renewable energy PTO requirements. The project will look at the viability of the thermoplastic spring (Gator) as a PTO system suitable for application in a range of Wave Energy devices. This work will include PTO system analysis, numerical modelling, performance modelling, Gator design, LCOE calculations and bench-top testing.

The Gator

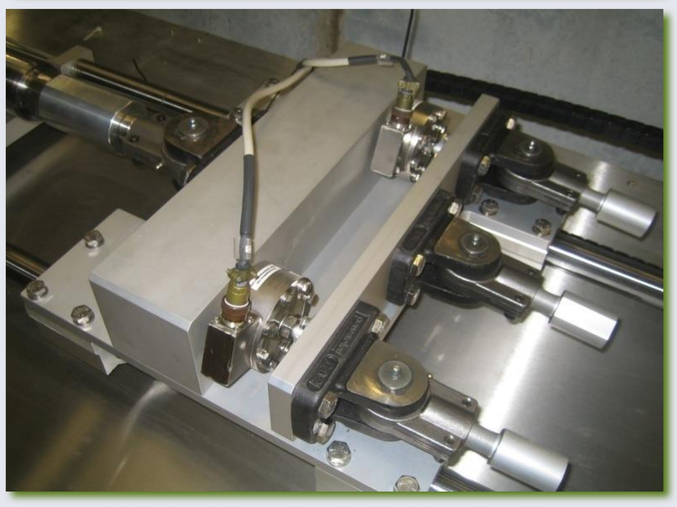
The Gator will compress seawater on both up and down strokes, driving it at pressure through the rest of the system. While the Gator cannot achieve the same pressure as a metallic cylinder, it can be implemented at a larges diameter delivering a much higher flow to compensate. It will also have a much lower cost and higher availability delivering excellent LCOE performance. The project will focus on designing, testing and validating the system around a suitable Gator design.

Simulation and Modelling

The team at the University of Strathclyde have carried out preliminary modelling and real-time simulation of the GATOR system. Prototypes of the spring pump system, turbine and accumulator have been modelled and preliminary simulation results have been obtained using an idealised sinusoidal excitation to represent the wave induced force from the WEC. The hydrodynamic response of the WEC will be included in the future versions of the simulation. The final simulation will allow the precise dynamics of the non-linear spring to be investigated in order to give optimal power capture efficiency.

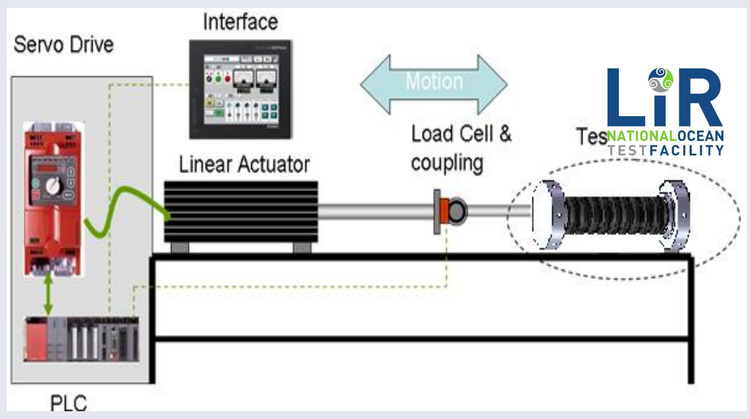


Testing



Lir National Ocean Test Facility Linear Test Rig

Testing of the Gator tubes will be carried out at University College Cork in the Lir National Ocean Test Facility using a Linear Test Rig. This is a ¼ scale linear electromechanical test rig which emulates the linear motion induced by the waves. Using this rig, tubes of varying thickness and spring configurations in the PTO device will be investigated under a various range of wave motions. Parameters to be measured will include loads, motion accelerations, displacement, forces, flow, and pressure, among others. Varying damping levels may be achieved using pressure controlled valves.



WES Gator test set-up

System Engineering

Pelagic Innovation draws on the experience gained from designing, building, installing, operating and maintaining the Aquamarine Power Oyster Wave Energy Converter to offer engineering consultancy services to the wider marine renewables sector.

In the Gator project Pelagic Innovation are providing the 'voice of the customer', outlining the fundamental requirements of WECs and ensuring that the system that is developed is applicable to as wide a range of technologies as possible. Pelagic Innovation are also heavily involved in the overall system concept and the specification of critical items in the wider system. Ultimately, our objectives are to ensure that the Gator PTO has a robust concept 'from waves to wire' and that it is a practical proposition from the engineering perspective.

Gator Design

TfI are responsible for the Gator design work. The Gator can be designed around a wide range of variables, including the inner and outer diameters, the convolute shape, the pitch, the convolute radii, the wall thickness, the material choice, and the height. Changing these parameters changes the stress strain response of the Gator, the burst pressure and the volume pumped. The work will take the outputs from the system design and simulation and modelling tasks and convert those into an actual Gator shape which can deliver the required performance. It will also manufacture a selection of Gators with varying design parameters for testing.

LCOE

Exceedence are responsible for the overall management of the project. Its staff have experience in managing large EU and national R&D projects from both an academic and commercial perspective.

Together with TfI, Exceedence will conduct an LCOE analysis using a novel finance model called ExceedenceFinance. Results will highlight the impact of the GATOR PTO on LCOE by determining a baseline and projections with sensitivity analysis. Furthermore, the market potential of the technology will be assessed in regard to scale, range, potential impact and other viable markets.

Acknowledgements

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