New mechanisms and concepts for exploiting electroactive Polymers for Wave Energy Conversion: PolyWEC EU Project

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Abstract

Wave energy has a great potential as a sustainable source of energy. Studies have demonstrated that significant percentage of world electricity could be produced by Wave Energy Converters (WECs). However electricity generation from waves still lacks of spreading because the combination of harsh environment and form of energy makes the technical development of cost effective WECs particularly difficult. In November 2012, within the European Community FP7, the project PolyWEC (www.polywec.org) has started a collaborative research on a new class of WECs, characterized by the employment of Dielectric Elastomers (DE) transducers. The main goal is to introduce a radical change in the traditional architecture of WECs by using converters characterized by deformable lightweight and low-cost polymeric elements. PolyWEC assumes a multidisciplinary approach that includes competencies on WEC design/tests, fluid dynamics, control/mechatronics and material science.

Objectives

PolyWEC aims at generating new knowledge in different fields of science and with specific scientific objectives developing:

- concepts and methodologies for wave energy harvesting through transducers based on Electroactive Elastomers (EEs) materials;
- fully-coupled electro-hyperelastic-hydrodynamic models for DE based WECs design, numerical simulation and control;
- techno-economical models for assessing the economic potential of DE-based WECs in given wave-climates;
- algorithms for EE-based WECs control;
- optimized DE materials and transducers for wave energy harvesting.

In addition PolyWEC will address the following technological challenges developing:

- innovative small-scale DE-based WECs including experimental tank-testing;
- new types of transducers for wave energy harvesting including experimental tank-testing;
- the definition of guidelines for designing DEs and transducers for energy harvesting applications;
- the definition of guidelines for the design and operation of DE-based WECs in specific wave-climates;
- preliminary economic and environmental assessment of wave-energy farms based on DE units.

Workpackages

WP1. “Concept and modelling”
WP2. “New materials and transducers”
WP3. “Design and control”
WP4. “Wave tank testing”
WP5. “Assessment, Exploitation and Dissemination”
WP6. “Management and coordination”

Approach

In order to tackle with the high risks connected with the novelty of the considered scientific and technological objectives, an incremental approach to systems development is followed within the course of the Project. In particular, two types of WEC concepts, are considered:

- In a early stage of the project first-generation concepts are considered, which are characterized by indirect interaction between DE and fluid. That is, the DE deformations are not directly generated by the fluid pressures but by a mechanical interface. Due to the absence of direct fluid-DE interaction, the modeling and design of first-generation PolyWECs is simplified and consequently the level of uncertainty and risk is reduced.

- More ambitiously, second-generation concepts are characterized by direct interaction between DE membrane and fluid, which occurs over wide contact surfaces. That is, fluid-DE interaction is not mediated by any mechanical means, and DE membrane deformation is directly generated by wave-induced fluid pressures. As a result, second-generation PolyWECs are highly-integrated wave-energy converters that feature the minimal number of mechanical and electrical components beside the DE membrane. This second type of WECs is however much more difficult to model and design.

Example of Poly-OWC

Consortium:

Coordinator:
- PERCRO SEES, TeCIP Institute, Scuola Superiore Sant’Anna, Pisa, IT

Partners:
- Wave Energy Center, Lisbon, PT
- Petru Poni Institute, Iasi, RO
- Edinburgh University, Edinburgh, UK
- Selmar S.r.l., La Spezia, IT

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References