Coordinated Action
on
Ocean Energy (CA-OE)

WS1: Modelling of Ocean Energy Systems
–Summary of workshop–

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1 Introduction

In October 2004, the Coordinated Action on Ocean Energy (CA-OE) was launched, co-financed by the European Commision, under the Renewable Energy Technologies priority within the 6th Framework programme, contract number 502701, chaired by Kim Nielsen, Rambøll, Denmark. The project involves 41 partners.

The main objective of the CA-OE project is to promote and disseminate the knowledge on the Ocean Energy Technologies presently being prototype tested or developed at a more fundamental level. Nielsen (2005) gives a more comprehensive list of objectives, but here we will focus on the dissemination of knowledge.

To disseminate the knowledge and promote the technologies, the CA-OE has organized dedicated interactive workshops in six monthly intervals over 3 years, as a vehicle to exchange, present and analyse information important for Ocean Energy Development.

The present paper summerises the outcome of a two day workshop (WS1) held at Aalborg University, Denmark, April 5th to 6th 2005 under the title: Modelling of Ocean Energy Systems.

2 Structure and idea of the workshop, WS1

The main idea of the WS1 was to use the first full day for presentations and discussions within the group of partners. In this way confidentiality was possible. The second full day was scheduled as an open workshop day with access for the developers and researchers from outside the group of partners, allowing dissemination of knowledge to developers from outside the group.

Partners in the project were offered the opportunity to give a rather short presentations, either the first day or the second day.

In total 18 presentation were given during the workshop. Developers of the Ocean Energy devices were asked to speak about their experience from using physical or numerical modeling of their device. Partners working within the area of developing physical or numerical model were offered to speak about their models. Partners dealing with the development of common standards

were giving status of their work. All sessions were closed with an open broad discussion in order to spot common problems.

Proceedings from the workshop are available on www.wave-energy.net and http://CA-OE.ramboll.dk. The first mentioned webpage is for public access whereas the last mentioned webpage is a restricted page for members of the coordinated network.

The restricted webpage contain as mentioned the presentations from the WS1. Furthermore it also contain a short description from the developers showing how they have used modelling to develop their device. Finally, the webpage contain some papers from the universities participating in the work package about modelling of ocean energy systems.

The present paper summerises all the presentations and discussions during the WS1. Further some notice is given the papers placed on the web.

3 The history of using Modeling in Ocean Energy development

Modelling of ocean energy systems has a long history. Systems have been modeled since the start of the wave energy development. The modelling has been based on:

- Hydraulic laboratories
- Numerical models
- (Electrical laboratories)
- Open sea / Lake tests in scale 1:10 to 1:4

It is a clear statement from most developers that they have used some kind of modelling of their device during the development phase. Actually, most developers have used all types of modelling.

Ocean Power Delivery states: Numerical and experimental modelling has been the core of the Pelamis development program since its inception.

Most devices have a history which can be schematised into the following phases:

- Tests in a hydraulic laboratory to demonstrate performance
- Numerical modelling of system in order to optimize structure
- Tests in a hydraulic laboratory to verify numerical calculations
- Tests in open sea. Still scale tests
- More calculations for further optimisation

Many different topics have been modeled. Hydrodynamic forces on structure, movements of the device, mooring systems, fouling, corrosion, stresses in the structure, power take off, influence on grid, etc. Most effort have been put into modelling of hydraulic performance.

4 What is available today?

For device developers it is valuable to know which types of modelling that are available today. What are the experinces with the modelling?

4.1 Physical Modelling

Within the area of physical modelling two major types of test facilities are available:

- Hydraulic Laboratories
- Real Sea Test Locations.

At the Hydraulic Laboratories testing of the Ocean Energy devices will normally be tested in a length scale 1:50 to 1:20. Main purpose of the testing is normally to quantify the conversion of Ocean Energy (Waves/Current) to Mechanical Energy. Further, the overall performance (Movements/Force etc) is often considered.

Around the world approx. 100 such hydraulics laboratories exist at governmental test institutions, private institutions and universities. Most of these laboratories have a strong background in either offshore structure, ships or coastal engineering.

In general, the inventors like to use hydralics laboratories because in these

laboratories their device becomes very visual. Also a physical model has some value in convincing others about the value of the device.

Real test sites have been set-up for Ocean Energy. Orkney Test Site, Blyth, Nissum Bredning

Some electrical test laboratories exists. Most of these electrical laboratories are connected to universities.

4.2 Numerical Modelling

An enormous amount of numerical models being able to predict specific items like movements, overtopping, pressures etc on specific devices exist. The problem is that all these models are not generalised. The will only work for the specific device which it was developed for.

During the workshop models within hydrodynamic loading and structural response were presented. BEM, FEM, depth integrated models (Mild slope, Boussinesq), time domain, frequency domain, VOF, CFD etc were buzzwords presented.

Generalised numerical models like commersial or 'home made' CFD models exists, but in general they are very difficult to use, and they require so much CPU time, that they are difficult to operate.

It was clear that more development is needed within numerical modelling.

5 Who are the drivers? Ocean Energy developers or Numerical Model developers?

The time required to develop even a simple numerical model is generally so long that most developers can not wait. Therefore the tendency is that the development within numerical modelling is not driven by the existing device developers. The situation is more like the following. A scientist develops a numerical model. He presents the model. The device developer hear about the model. The scientist changes his model to be able to work on the device.

6 The need for Numerical Model (Short term)

6.1 Short term needs

There has been a tendency to model the hydraulics of the devices much more detailed than other topics like corrosion, power take off, biological, environmental, weather prediction, life time analysis etc. Therefore the short term needs for develoment within numerical models are mainly in these areas.

6.2 Long term term needs

In the long term, a numerical model integrating wave forces and power take off system is wanted. Such a model should be based on an advanced CFD model.

Furthermore models predicting life time of different parts of the devices are missing.

7 References

Nielsen, Kim (2005): Coordination Action on Ocean Energy, CA-OE. IEA-OES Newsletter, February 2005. http://www.iea-oceans.org.

Ocean Power Delivery Ltd, Edinburgh, Scotland (2005): The role of numerical and experimental modelling in the development of the Pelamis WEC. Proceedings of the WS1.