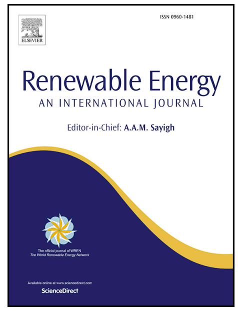
Accepted Manuscript



A conceptual model of the hydrodynamics of an oscillating wave surge converter

Alan Henry, Matt Folley, Trevor Whittaker

PII: S0960-1481(17)31051-0

DOI: 10.1016/j.renene.2017.10.090

Reference: RENE 9378

To appear in: *Renewable Energy*

Received Date: 24 February 2016

Revised Date: 14 July 2017

Accepted Date: 26 October 2017

A Conceptual Model of the Hydrodynamics of an Oscillating Wave Surge Converter

Alan Henry[1], Matt Folley[2*], Trevor Whittaker[2#]

[1]*Rockall Solutions*
Dublin, Ireland
alan.henry@rockallsolutions.com
+353 (0) 857185697

[2]*Queen's University Belfast*
Belfast, Northern Ireland
+44 (0) 28 9097 4751
*m.folley@qub.ac.uk
#t.whittaker@qub.ac.uk

Abstract — This paper investigates the hydrodynamics of a seabed-mounted, bottom-hinged, flap-type wave energy converter in shallow water. A conceptual model of the hydrodynamics of the device has been formulated and shows that, as the motion of the flap is highly constrained, the magnitude of the wave force on the flap is the key determinant of power capture.

The results from a physical modelling program have been used in conjunction with numerical data from WAMIT to validate the conceptual model. The work finds that designing the device to increase the wave force is more profitable than designing it to be tuned to the incident wave climate. As wave force is the primary driver of device performance it is shown that the flap should fill the water column and pierce the water surface to reduce decoupling due to wave overtopping.

It is concluded that, in order to maximize capture factor at a typical North Atlantic site, the flap should be approximately 20 to 30m wide, with large diameter rounded side edges, having its pivot close to the seabed and its top edge piercing the water surface.

Keywords — Oscillating Wave Surge Converter, Nearshore, Surge, Pitch, Point Absorber, Non-resonant

Introduction

In the 1970s it was shown [Budal & Falnes 1975, Evan 1976, Newman 1976] that a wave energy converter (WEC) could act as a point absorber. That is to say that it is possible for a small body to absorb a large amount of power from the incident waves. In fact it was shown that the theoretical maximum power which could be absorbed was limited only by the wavelength and the mode of the body's oscillation irrespective of the dimensions of the body. This is shown in Equation 1, (reproduced from [Evans 1976] Equation 7.3), where P_{max} is the maximum power capture, P_i is the incident wave power per unit crest length, λ is the wavelength and ε is 1 for a heaving device and 2 for a surging device.

$$P_{max} = \varepsilon \frac{\lambda}{2\pi} P_i \tag{1}$$

It is worth noting here that this paper uses the term "point absorber" in the original sense of [Evans 1976] to mean a body small relative to the wavelength, which is a more general definition to the more recent use of "point absorber" to refer to only heaving devices.

This formulation led to the adage that 'small is beautiful' which has commonly been used as a design axiom throughout the development of wave power. Heaving buoys have long been the point absorber of choice, perhaps because they are common fixtures in the offshore environment, or because they are axis-symmetric and capable of absorbing power from waves incident from any direction. However, Equation 1 shows that the maximum power capture of a body moving in surge is twice that of a heaving body. It is somewhat surprising then that little attention has been paid to surging WECs until recent years. This may be attributed to the misconception that they are limited to a maximum power capture of 50% due to a two-dimensional formulation of the hydrodynamics which sees 25% of the energy reflected and another 25% transmitted in the wave direction due to the motion of the absorber [Falnes 1997]. However, it is important to note that the surging WECs discussed here are considered small with respect to a wavelength, or point absorbers rather than terminators, and that their hydrodynamics are indeed three-dimensional.