ABSTRACT

The present paper reports a numerical study concerning the modeling and geometric optimization of a two body heave oscillating point absorber wave energy converter (WEC) using the force reacting principle. The device work principle is based on a surface body (or floater) force-reacting against a submerged body, as the excitation force of both, the floater and the submerged body, are in phase opposition. The relative motion between the two bodies generates electrical power through a linear power take off system (PTO). From the hydrodynamic point of view, the main purpose of the concept is to emphasize the radiation capabilities of the body placed under the free surface, as it has both excitation force components (diffraction and Froude Krylov) in phase. Therefore, the excitation force (and thus the hydrodynamic damping coefficient) is higher in the case of a submerged volume variation heave oscillating body (like the AWS wave energy converter) when compared to a floating buoy with the same area, and depth, of the active surface (surface responsible for the device radiation capabilities). The paper investigates the possibility of taking advantage of this effect on the device geometry optimization.

The methodology is described in this paper as far as hydrodynamics and computation are concerned. First a geometrical optimization is carried out, aiming at finding a shape adapted to predefined wave climate conditions. Then, an absorbed power improvement method based on the regulation of the PTO is detailed.

Most of the observations derive from frequency domain however a time domain simulator had been created too, in order to double check the results.

KEY WORDS: Wave energy, point absorber, radiation, diffraction, Froude Krylov, spring, damping.

NOMENCLATURE

- \( m \) = device mass
- \( P \) = absorbed power
- \( S \) = surface of flotation
- \( \rho \) = water density
- \( \omega \) = angular frequency
- \( \lambda \) = wave length
- \( \gamma \) = adiabatic index
- \( \xi \) = heave complex amplitude
- \( u \) = heave complex velocity

Subscripts

- \( \text{abs} \) = absorbed
- \( \text{exc} \) = excitation
- \( \text{diff} \) = diffraction
- \( \text{FK} \) = Froude Krylov
- \( \text{max} \) = maximum
- \( \text{pto} \) = power take off
- \( p \) = pressure
- \( t \) = total

Superscripts

- \( - \) = mean value
- \( ^\wedge \) = complex amplitude
- \( A \) = refers to body A
- \( B \) = body B
- \( 0 \) = equilibrium conditions

INTRODUCTION

The behaviour of oscillating bodies in the sea is well known and frequently used in wave energy conversion. Falnes [1] gives a great overview of the different issues for point absorber devices in which the characteristic dimension is small compared to the wavelength of the incident wave.

The present study is focused on a particular WEC point absorbed device which uses the relative motion between two bodies to produce power. A boundary element method numerical code, based on classic linear water wave theory and potential flow, is applied to compute the excitation forces and the hydrodynamic coefficients. Then the