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On the shoreline wave energy potential and its conversion in Morocco

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Abstract

The efficiency of a wave energy converter (WEC) device for wave energy conversion depends on many factors, among which the incident wave conditions. In this paper, the case of Moroccan Atlantic shoreline wave energy resource will be presented through the exploitation one year of data records in terms of wave height and period variations. It is found that with its 3 000km Atlantic coastline the global potential of offshore wave energy is nearly of 75 000MW which makes the country able to reinforce significantly its renewable energy resources. As a part of this work, the flow behavior inside the chamber of an oscillating water column (OWC) device has been analyzed by means of a numerical flow simulation code. The flow is set to be incompressible, three dimensional (3D), viscous and unsteady. The turbulence has been modeled with the classical (k-ε) turbulent model. Computations have been carried out on the geometry of Pico plant built in Azores. Local flow characteristics have been determined in order to obtain an accurate understanding of the flow behavior inside the chamber.

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Keywords: Wave energy; Moroccan wave energy potential; OWC device; Unsteady flow simulation

1. Introduction

Over the last few years, ocean energies have gained a great importance not only for their high potential, but also for their high energy density, considered as the highest among all renewable energies. This explains the great R&D

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efforts that have been made during the last decades in this matter, aiming to reach industrial exploitation, economic and technical mastering.

Energy consumption is considered to be one of the most relevant ways to allow the progress of a society. It is expected that the global energy demand will rise by about 35% from 2010 to 2040. Moreover, by the year 2040, electricity production will be higher than 40% of the global energy demand [1]. Within this regard, the move toward renewable energies has significantly raised.

Among the ocean energy investigations, significant works are devoted to wave energy. As known, the power level for this energy resource can reach a level of 70 kW/m [2] in areas of high latitudes, greater than 40º from the equator. In the present work, an attempt to assess accurately the potential of the wave energy on the Moroccan Atlantic coastline has been considered, by exploiting monthly data records of wave height and period variations from the Oceanic and Atmospheric Administration (NOAA) WW3 spectral model. It is found that the level of the wave energy at the Atlantic coastline has an average value of 25 kW/m, which is in good agreement with estimations reported in [3]. Therefore, with a 3 000 km coastline, the global potential of this energy resource is nearly 75 000 MW which makes the country able to reinforce significantly its renewable energy strategy.

The OWC device is the widely used type of wave energy converters. An OWC-device consists of a submerged air chamber connected to the atmosphere by means of a circular duct inside which a bidirectional flow turbine is installed Fig. 1. The flow rate of air through the turbine is created by the successive incident sea water waves that compress and depressurize air in the chamber by means of the periodic motion of the oscillating free surface.

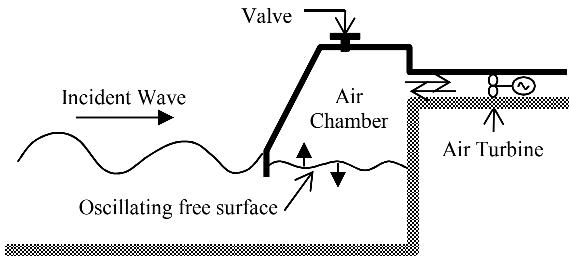

Fig. 1.The oscillating water column device

Performances of the OWC device depend on the flow behavior inside the chamber. So, a 3D numerical simulation of the flow behavior inside an OWC air chamber has been performed using the computational fluid dynamic (CFD) approach. The flow is set to be incompressible, 3D, viscous, and unsteady. The turbulence has been modeled with the classical ($k-\varepsilon$) turbulent model. More details about the adopted numerical model are presented in [2], Computations have been conducted considering the geometry of the Pico' OWC plant built in Azores [4,5,6].

Nomenclature

P_W	wave power (kW/m)
H_S	significant wave height (m)
T_p	peak period (s)
$\eta(t)$	water's free surface elevation (m)
g	gravity acceleration (m/s^2)
ρ	sea water density (kg/m^3)
ω	angular pulsation (rad/s)