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Full-scale Data Assessment in OWC Pico Plant

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The 400-kW Pico OWC plant built in 1995–1999 is a bottom-mounted shoreline structure, equipped with a horizontal-axis, Wells turbine-generator set. Main refurbishment actions through 2004–2006 included the complete replacement of the degraded electrical equipment and restorations of the existing mechanical components. Full-scale monitoring included the analysis of instantaneous values of the water free-surface elevation inside the chamber, the air pressure in the chamber and turbine duct, the rotational speed of the turbine and the electrical power output. This paper describes the plant monitoring during the full-scale demonstration from September 2005 to October 2006 and discusses the data and results obtained so far.

INTRODUCTION

History and Site

The Oscillating Water Column (OWC) European Pilot Plant on Pico Island in the Azores has been practically nonoperational since its commissioning in 1999, mainly due to salt- and sweet-water infiltrations and subsequent degradation of equipment and problems in some of the mechanical components delivered by the suppliers. The original project was cofunded by the EC, the Portuguese government, EDA (Azores utility) and EDP (mainland utility), and it involved several Portuguese companies under the scientific coordination of Instituto Superior Técnico (Falcão, 2000). With the creation of the Wave Energy Centre (WEC) in 2003, the conditions were established for presentation of a proposal to a national funding scheme (PRIME/DEMTEC), having in view the recovery and test of the plant. The Portuguese institutions EDP, EDA, EFACEC, Consulmar, Irmãos Cavaco, IST and INETI participated and cofunded the project under WEC's coordination. During September–November 2005 and June–October 2006, tests were performed, approaching an accumulated production of 1 MWh delivered to the local grid.

Preliminary analysis of results indicates that the equipment works as expected, and that energy is produced even with less energetic sea conditions. A major part of the difficulties and delays encountered in the realisation of this pilot plant since the first activities are due to the geographical remoteness of the Azores, as opposed to the mainland as base for all project partners.

The site had mainly been chosen due to the high energy levels on Pico's north coast, which in addition offers several so-called shoreline gully rocky formations, providing a natural energy concentrating character. Cachorro, where the plant was built, offered a particularly well-developed gully and at the same time suitable water depths in front of the plant and good access from local roads, as well as an EDA substation nearby.

One of the initial project ideas was to demonstrate the viability of producing electricity for a small grid, mainly because this type of plants can be particularly interesting for remote locations, like islands.

Plant Description

The operation principle of the Pico OWC is shown in Fig. 1. The OWC inside the chamber (2) is excited by the incident waves (1), ideally with periods close to the chamber's resonance period. The OWC forces air alternately (3) to and from the atmosphere, via a Wells turbine with symmetrical blades and rotational speed in the 800–1450 rpm range (7). On each side of the rotor there is a guide vane stator carrying fixed steel vanes, in order to increase the turbine's aerodynamic performance. Symmetrical blades with fixed pitch for bidirectional flow are the distinct characteristic of a classical Wells turbine. To avoid overpressure and stall conditions, a relief valve (4) can be opened from 0% to 100%, according to the incident sea state. Redundancy in the closure mechanism of the air duct provides safety for the turbo-generation group: A slow-acting guillotine-type isolation valve (5) is shut whenever the plant is nonoperational over a longer period, while the fast-acting variable-pitch-blade valve (6) can be efficiently operated during test periods.

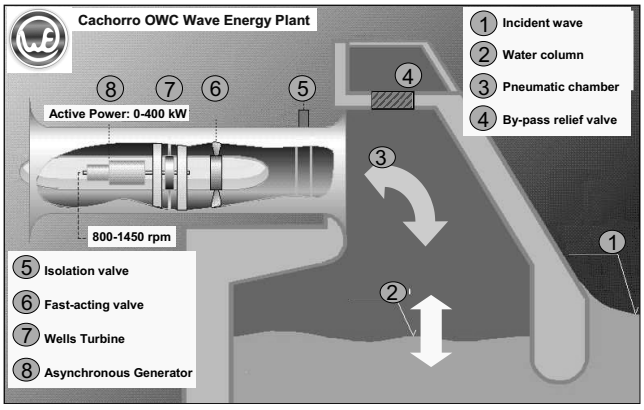

Fig. 1 Essential components of Pico OWC

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