Full-scale Data Assessment in OWC Pico Plant

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ABSTRACT

After being idle for a period of several years after its first commissioning in 1999, the European OWC pilot plant on the island of Pico in the Azores has been reactivated by 2005 and initial tests have been performed since then. The refurbishment, co-ordinated by the Wave Energy Centre in Portugal, started in 2004, and was supported by National funding under a new Portuguese funding scheme for scientific pilot projects (PRIME/DEMTEC). The activities included the complete replacement of the degraded electrical equipment and refurbishments of the existing mechanical components. This paper describes the Pico plant monitoring during the full-scale demonstration from September 2005 to October 2006 and discusses the data and results obtained so far.

KEY WORDS: OWC; Oscillating Water Column; Real-scale Experience; Monitoring; Wave energy.

INTRODUCTION

History and Site

The Oscillating Water Column (OWC) European Pilot Plant on Pico Island (Azores) has been practically non-operational 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 co-funded by EC, the Portuguese government, EDA (Azores utility) and EDP (mainland utility) and involved several Portuguese companies under scientific coordination of Instituto Superior Técnico (see Falcão, 2000). With the creation of the Wave Energy Centre (WEC) in 2003, the conditions for presentation of a proposal to a national funding scheme (PRIME/DEMTEC) were established, having in view the recovery and test of the plant. The Portuguese institutions EDP, EDA, EFACFC, Consultal, Irmãos Cavaco, IST and INETI, participated and co-funded the project under co-ordination of WEC. During Sept – Nov 2005 and Jun - Oct 2006 tests have been 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 that have been 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 the Pico North coast, which in addition offers several "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 depicted in Fig. 1. The oscillation water column inside the chamber (2) is excited by the incident waves (1), ideally with periods close to the resonance period of the chamber. The oscillating water column forces air alternately (3) to and from the atmosphere, via a Wells turbine with symmetric blades and rotational speed in the range 800-1450 rpm (7). On each side of the rotor, a guide vane stator carrying fixed steel vanes is installed, in order to increase the aerodynamic performance of the turbine. The distinct characteristics of a “classical” Wells turbine is the symmetrical blades with fixed pitch for bi-directional flow. To avoid over-pressure and stall conditions, a relief valve (4) exists which can be opened from 0% to 100%, according to the incident sea-state. The safety of the turbo-generation group is provided by redundancy in the closure mechanism of the air duct: a slow-acting guillotine-type isolation valve (5) is shut whenever the plant is non-operational over a longer period, whereas the fast-acting variable-pitch-blade manoeuvre valve (6) can be efficiently operated during test periods.

The generator that transforms the rotational force into electrical power (8) is of the asynchronous wound rotor induction type and is rated 400 kW. Via a converter and two transformers located in the containers 100m above the plant, the electricity is fed into the local grid.