ID5- MAGALLANES PROJECT: TESTING THE MARINE TIDAL CURRENT PLATFORM IN THE "RÍA OF VIGO"

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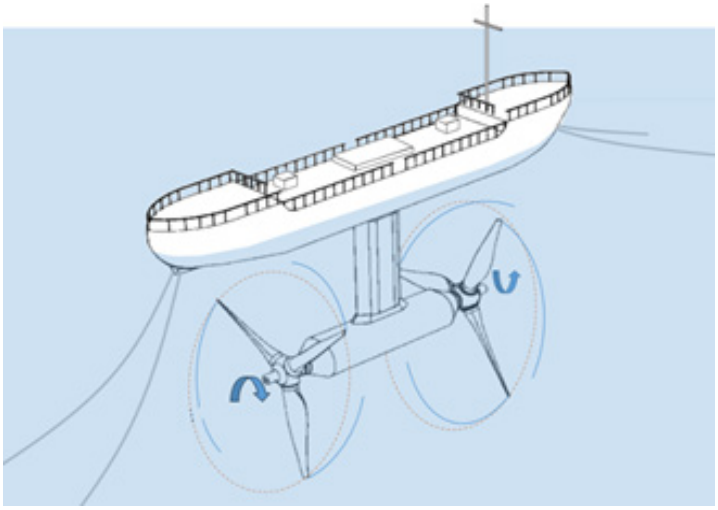
Abstract
In this study, the behavior of a platform for tidal energy is analyzed. The turbine of this platform is formed by two counter-rotating rotors aligned with the tidal current, such that one rotor is always under the wake of the upstream rotor.
The platform has been tested by towing it with a tugboat to emulate tidal currents. The results of these tests are analyzed in this paper in order to estimate the generation capabilities of the platform.

Keywords
Marine current turbine, tidal energy, counter-rotating rotors, towing test.

INTRODUCTION

The floating system called ATIR, developed by Magallanes Renovables, is based on a platform that incorporates a submerged part where rotors are installed [1] [2]. The ATIR platform has a horizontal axis tidal current turbine, which appears to be the most mature technology in tidal energy systems [3][4]. The main element of the platform is the turbine, which is formed by two counter-rotating rotors aligned with the tidal current (from bow to stern or backwards), as shown in Fig. 1. The blades have pitch variation capability that allows to them to change their rotation direction, such that it can harvest energy from the two tide directions without moving the platform.

The main focus of this study is on modeling the turbine formed by two counter-rotating rotors by using data collected during tests that took place at the Ria de Vigo (Spain). To emulate tidal currents, the platform was towed by means of a tugboat.



FLOATING TIDAL ENERGY PLATFORM

The tidal energy platform, developed by Magallanes Renovables (Spain) and called ATIR, consists of a floating platform joined to a marine current turbine (MCT) with a double rotor. During the tests, it was not possible to establish a connection to the power network. Therefore, the network was emulated by means of an autotransformer (400 kVA; 690 V/400 V), a diesel generator (350 kW), and a bank of dump load resistors (600 kW).

TEST RESULTS

In this work, the results of the tests in which the tidal current was emulated by towing the platform with a tugboat are analyzed. The tests were conducted in the Ria of Vigo (Northwest of Spain) where the seabed is at a depth of approximately 40 m, and was thus not expected to interfere with the platform behavior.

The performance of the rotor in terms of the maximum torque, maximum power, or minimum thrust is more easily analyzed in terms of the power, torque, and thrust coefficients. Therefore, these coefficients were used to analyze the rotor behavior.

The measurement data from the tests were used to obtain values for these coefficients. However, most of the measurements were conducted in the power converter and in the high-speed shaft. As a consequence, to estimate the rotor behavior, it is necessary to consider the performance in terms of the losses in the generators, gearboxes, and AC/AC converters [5]. From the power values in rotor and generator and the measurements in marine current, the power coefficient in the rotor (cp) and the generator (cpg) can be obtained using the following equation:

$$c_p = \frac{c_{pg}}{\eta_{gb}\eta_g}$$

where P is power in the rotor, Pg is the power in the generator, ηgb is the gearbox performance, and ηg is the generator performance.

The power coefficient values obtained using the measurements are shown in Fig. 2. It should be noted that the tests were conducted at a power lower than the 50% of platform rated power, and accordingly, the rotor speed was also lower 50% of the rated speed. In this situation, the performance values of the generator and gearbox are approximately equal to 70% and 90%, respectively. The estimated maximum value for the power coefficient at the generator side was approximately 0.5.

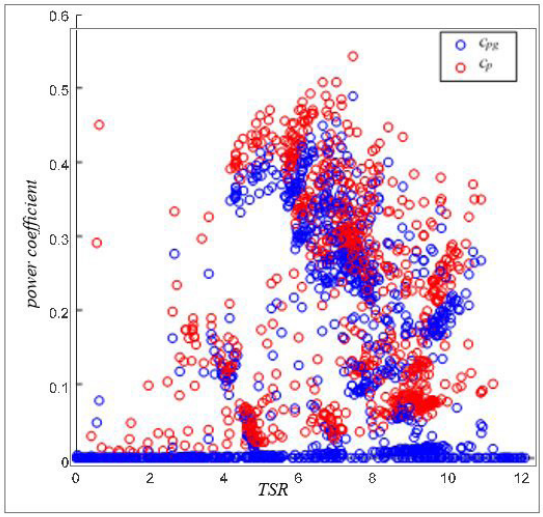


Fig. 2. Power coefficient at rotor side (c_p) and at generator side (c_{pg})

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