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Gravitational Water Vortex Power Plant: Experimental-Parametric Design of a Hydraulic Structure Capable of Inducing the Artificial Formation of a Gravitational Water Vortex Appropriate for Hydroelectric Generation

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Abstract : Approximately 80% of the energy consumed worldwide is generated from fossil sources, which are responsible for the emission of a large volume of greenhouse gases. For this reason, the global trend, at present, is the widespread use of energy produced from renewable sources. This seeks safety and diversification of energy supply, based on social cohesion, economic feasibility and environmental protection. In this scenario, small hydropower systems (P ≤ 10MW) stand out due to their high efficiency, economic competitiveness and low environmental impact. Small hydropower systems, along with wind and solar energy, are expected to represent a significant percentage of the world's energy matrix in the near term. Among the various technologies present in the state of the art, relating to small hydropower systems, is the Gravitational Water Vortex Power Plant, a recent technology that excels because of its versatility of operation, since it can operate with jumps in the range of 0.70 m-2.00 m and flow rates from 1 m3/s to 20 m3/s. Its operating system is based on the utilization of the energy of rotation contained within a large water vortex artificially induced. This paper presents the study and experimental design of an optimal hydraulic structure with the capacity to induce the artificial formation of a gravitational water vortex trough a system of easy application and high efficiency, able to operate in conditions of very low head and minimum flow. The proposed structure consists of a channel, with variable base, vortex inductor, tangential flow generator, coupled to a circular tank with a conical transition bottom hole. In the laboratory test, the angular velocity of the water vortex was related to the geometric characteristics of the inductor channel, as well as the influence of the conical transition bottom hole on the physical characteristics of the water vortex. The results show angular velocity values of greater magnitude as a function of depth, in addition the presence of the conical transition in the bottom hole of the circular tank improves the water vortex formation conditions while increasing the angular velocity values. Thus, the proposed system is a sustainable solution for the energy supply of rural areas near to watercourses.

Keywords : experimental model, gravitational water vortex power plant, renewable energy, small hydropower
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