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Multi-Criteria Selection and Improvement of Effective Design for Generating Power from Sea Waves

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Abstract : Sustainable development is the nominal goal of most countries at present. In general, fossil fuels are the development mainstay of most world countries. Regrettably, the fossil fuel consumption rate is very high, and the world is facing the problem of conventional fuels depletion soon. In addition, there are many problems of environmental pollution resulting from the emission of harmful gases and vapors during fuel burning. Thus, clean, renewable energy became the main concern of most countries for filling the gap between available energy resources and their growing needs. There are many renewable energy sources such as wind, solar and wave energy. Energy can be obtained from the motion of sea waves almost all the time. However, power generation from solar or wind energy is highly restricted to sunny periods or the availability of suitable wind speeds. Moreover, energy produced from sea wave motion is one of the cheapest types of clean energy. In addition, renewable energy usage of sea waves guarantees safe environmental conditions. Cheap electricity can be generated from wave energy using different systems such as oscillating bodies' system, pendulum gate system, ocean wave dragon system and oscillating water column device. In this paper, a multi-criteria model has been developed using Analytic Hierarchy Process (AHP) to support the decision of selecting the most effective system for generating power from sea waves. This paper provides a widespread overview of the different design alternatives for sea wave energy converter systems. The considered design alternatives have been evaluated using the developed AHP model. The multi-criteria assessment reveals that the off-shore Oscillating Water Column (OWC) system is the most appropriate system for generating power from sea waves. The OWC system consists of a suitable hollow chamber at the shore which is completely closed except at its base which has an open area for gathering moving sea waves. Sea wave's motion pushes the air up and down passing through a suitable well turbine for generating power. Improving the power generation capability of the OWC system is one of the main objectives of this research. After investigating the effect of some design modifications, it has been concluded that selecting the appropriate settings of some effective design parameters such as the number of layers of Wells turbine fans and the intermediate distance between the fans can result in significant improvements. Moreover, simple dynamic analysis of the Wells turbine is introduced. Furthermore, this paper strives for comparing the theoretical and experimental results of the built experimental prototype.

Keywords : renewable energy, oscillating water column, multi-criteria selection, Wells turbine
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