Energy 113 (2016) 597–614

Contents lists available at ScienceDirect

Energy

journal homepage: www.elsevier.com/locate/energy

Analytical and experimental investigation of hydrodynamic performance and chamber optimization of oscillating water column system

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A R T I C L E I N F O

Article history:
Received 2 April 2015
Received in revised form
16 January 2016
Accepted 22 June 2016

Keywords:
Renewable energy
Oscillating water column
Wave energy
Experiment
Numerical

A B S T R A C T

Among the numerous types of renewable energy technologies, wave energy technologies have been considered by many experts as one of the most promising for Taiwan. However, the amount of energy presently provided by wave energy technologies constitutes a minor percentage of Taiwan's total energy production. This paper presents experimental results using a laboratory water chamber, wherein the fundamental parameters of an oscillating water column (OWC) system's geometrical design are individually investigated and optimized for maximum amplification factor of wave energy to mechanically useful energy. The effects of back plate angle, fence plate and open wide parameters of chamber in a view of wave energy catching capability are analyzed. Three experimental models are evaluated to include a discussion of the back plate, fence plate, and open wide. The OWC's operation qualitatively differs from that predicted by linear theory, identify to critical flow characteristic; front wall down-wash in the water column. The surveys were then expanded to offer general arrangement or a planning material for the geometry optimization of the chamber that could potentially achieve the largest amplification factor of an oscillating water column (OWC) system. The amplification factor of the change in back angle of the OWC is significant.

1. Introduction

Energy consumption has always served basic human needs such as heat, light, and sound. However, the manner in which energy has been provided over time has changed. Over the last three centuries, industrialized economies have changed from an almost total dependence on biomass-based fuels (such as wood) to fossil fuels such as coal, natural gas, and oil [1]. Moreover, up to the Second World War, energy consumption increased with the constant development of society, consumption has dramatically increased since then [4]. To reduce methane leakage rates as well, but carbon capture and storage more than better [6–9].

The emergence of renewable energy technologies has recently spurred great efforts among researchers, policy makers, and industry leaders to evaluate the economic viability of this new energy source. Interest in renewable energy technologies is particularly acute in Taiwan for several reasons. First, Taiwan's foreign-energy dependence level is presently concerning, wherein 98% of its energy sources are derived from imports [2]. Moreover, the nuclear accident in Japan, due to its close proximity to Taiwan, has positively shifted Taiwanese public perspectives toward renewable energy technologies.

Renewable energies have become increasingly important in the energy sector of producing. This is partially because they are categorized as clean energy and are resistant to petrifaction fuel-based energy production, and partially because of their plump and enduring availability. Because of the improvements to powers in renewable energy, the obtaining of additional information and exploitation have occurred in the last ten years for the converting of wave energy in electric power. In many countries, goals and standards have been set to increase the use of renewable energy. The world energy demand is expected to increase in the next decade, and energy depletion in China will increase. The knowledge that

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http://dx.doi.org/10.1016/j.energy.2016.06.117
0360-5442/

traditional means of energy fabrication contribute to the severity of issues surrounding the Germany body of persons governing a State has led to the demand for environmental means of generating electricity [3]. The energy department compelled through a renovation procedure, which sees an orifice opposite renewable energy. A wave energy property is increasing in renewable energy industries. Although the manufacturing methods are novel and the costs rival those of more mature technologies such as solar energy, the support from governments and the industry has been steadily increasing. An important characteristic of wave energy is that it has the highest density among renewable energies.

The conversion of ocean energy has been of interest for many years, and discussions regarding this have been occurring not long before developments that concern global warming, heat production, and other future energy problems. Marine energy, which includes ocean thermal energy (OTE), tidal energy, wave energy, salinity gradient power and marine current energy and so on, is considered a starting point of alternative and renewable clean energy for a maritime nation. The study of diffraction and the transmission of energy in rays of surface waves on every side of a complex hole has been the focus of a new interest which began not too long ago that might be attributed to an increase in the devotion of time and thought to obtaining knowledge of renewable energy [5]. An Oscillating Water Column (OWC) designed for a special purpose offers an energy source that does not produce CO_2, which is an attractive solution to the problem of "green" electricity power. In such equipment, power is produced by the incoming plane surface waves that give rise to a shocking pressure part within the air cylinder.

The development of wave-energy conversion of the OWC type is under pressure for practical use. The purpose of this study is to organize and unfold a model for the branch of physics dealing with matter in motion of energy connected to OWC wave energy abstraction systems. The study puts forward a model for consideration to improve all the different aspects of the quality of the device.

Many experts have considered wave energy as one of the most promising technologies, although there are some significant challenges to the technology's large-scale adoption. Moreover, numerous researchers and policy makers have strongly supported wave energy technology owing to its extremely low environmental impact. In particular, the oscillating water column (OWC) represents a well-researched and widely used ocean wave energy conversion technology. To validate the experimental method employed, measurements are made for the time series of the incident waves, the wave height in the OWC chamber. The experimental data are contrasted with numerical results, and considerably good agreement is found for the chamber-wave height.

2. Experimental investigation

The experimental setup comprised a 18 × 0.5 × 0.4 m channel shown in Fig. 1 and fitted with a wave generator at one end of the channel, as shown in Fig. 2. An made by the art of man land bordering on the sea was located at the other end of the water tank to protect the wave-return by absorbing the oncoming wave. The OWC experiment model was constructed from Acrylic within an iron frame.

3. Wave power

The potential energy of a small upright pillar of water is as follows:

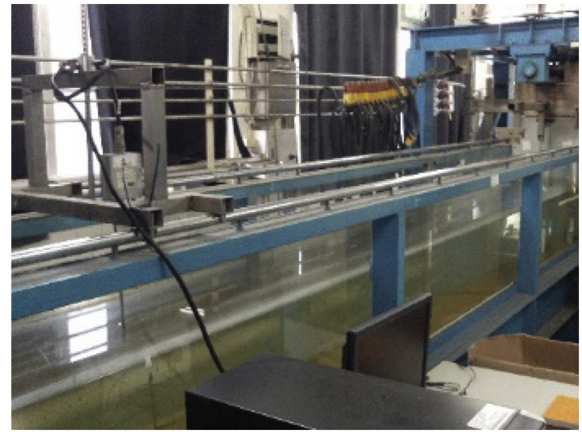

Fig. 1. Open tank in the laboratory.

Fig. 2. Wave generator installed at the end of open channel shown in Fig. 1.

$$d(PE) = dm\,g\,z \tag{1}$$

where *dm* is the quantity of material in a body measured by its resistance to the change in motion of the small water column, *g* is the gravitational acceleration, *z* is the height to the center of force of attraction between any two objects, especially that force which attracts objects towards the center of the earth of the mass dm, and this can be written as:

$$z = \frac{h+\eta}{2} \tag{2}$$

where *h* is the mean water depth, η is the free water surface displacement. The differential mass per unit width is:

$$dm = \rho(h+\eta)dx \tag{3}$$

The potential energy is:

$$\overline{(PE)}_T = \frac{1}{L}\int_x^{x+L} d(PE) = \frac{1}{L}\int_x^{x+L} \rho g \frac{(h+\eta)^2}{2}dx = \frac{\rho g}{L}\int_x^{x+L}\left[\frac{1}{2}\left(h^2+2\eta h+\eta^2\right)\right]dx \tag{4}$$

where *L* is the wave length and the subscript T signifies that the