Vol.6, No.1, 2025, page 31-36
JTTM: Jurnal Terapan Teknik Mesin
p ISSN 2721-5377| e ISSN 2721-7825
http://jurnal.sttmcileungsi.ac.id/index.php/jttm

Tool study of waves energy converter with heaving constant of 3675 N/m

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Submitted: 10/06/2024 Revised: 09/07/2024 Accepted: 20/07/2024

Abstract: As technology develops, the need for renewable energy is increasing. Ocean wave energy is one type of renewable energy and has high potential due to its abundant availability and unlimited potential range. A wave energy converter is a system that can capture wave energy and convert it into electrical energy. A simple form of periodic motion is an object vibrating at the end of a spring. Therefore it is called simple harmonic motion. The purpose of this study is to verify the performance of the wave energy converter (WEC) pontoon lift vibration based on the principle of forced undamped vibration using the spring constant value to produce optimal electrical energy. This research was conducted by experimental tests on land and on the coast of Tanjung Pasir, Tangerang. The heaving method was used to realize the use of springs in the wave energy converter (WEC). Heaving is the vertical up-and-down motion of a floating structure on undulating water. The lifting motion of a floating structure is the vibration that causes a backward force when the structure is moved from its balanced position. The results of data analysis of the identification of the smallest ocean potential energy without planets using planetary energy reached 0.095 watts, the maximum was 0.986 watts, the smallest reached 121 watts, and the largest reached 955 watts. The resulting speed value is 71.57 rpm and the maximum result is 85.12 rpm. Based on these data, we can produce larger data, which is 955 watts.

Keywords: Wave energy converter; heaving; planetary

1. INTRODUCTION

As technology develops, the need for renewable energy is increasing [1]. Ocean wave energy is one type of renewable energy that has high potential due to its abundant availability and unlimited potential area [2]. A wave energy converter is a system that can capture wave energy and convert it into electrical energy [3]. The energy generated is highly dependent on the movement of the pontoon itself. The pontoon can perform two motions: rotational motion and translational motion. These movements are caused by collisions on the wavefront [4]. To calculate the movement of the pontoon, you need to make measurements.

The advantages of this research can be taken into consideration in the development of ocean wave power plants. The Indian Ocean is right next to this ocean. How can the energy be used to create an OWC (Oscillating Water Column) system power plant [5]. The method used is heaving by using a constant spring accompanied by H-Beam pontoons, from the previous method of using I-Beam pontoons [6]. Periodic motion is the motion of an object that returns to a certain position periodically in a certain time interval [7]. When particles move periodically in the same orbit, this motion is called oscillation. A simple form of periodic motion is an object vibrating at the end of a spring. Hence, we call it simple harmonic motion [8].

With 95,181 kilometers of coastline, Indonesia is a maritime country that has the potential to generate renewable energy from the sea [9]. The forces responsible for creating ocean waves include wind, objects moving on the ocean surface, seismic activity, and the pull of the moon and sun's gravitational fields [10]. Ocean wave power plants can generate enough voltage to power electrical devices by utilizing wave energy in the ocean [11]. Wave Power Plant is a type of power plant that utilizes the energy of ocean waves along the coastline or in a watery environment [12].

A spring consists of an elastic material that is easily stretched and always tends to return to its original state so that it provides an elastic reaction force to the stretched tension force. Tension (stress) expresses the magnitude of the forces that cause tension, compression, or twisting and is usually expressed as force per unit area. Torsion is usually expressed as force per unit surface. Whereas strain (distortion) represents the distortion that results from [13].

Each spring has a different constant value depending on the force applied and the length increase that occurs in the spring. So we need to know the value of the spring constant that describes the stiffness of the spring. Meanwhile, springs on the market generally do not have a fixed value, making it difficult to choose which spring to use [14].

The purpose of this study is to verify the performance of the wave energy converter (WEC) pontoon lift vibration based on the principle of forced undamped vibration using the spring constant value to produce optimal electrical energy.

2. METHOD

In the early stages before research, a literature study is carried out, namely studying and observing references from journals, books, the internet, or previous studies from national or international sources. At this stage, it is useful to understand the theories or calculations related to the research being made. In the process of preparing materials to conduct field trials of the wave energy converter machine, for experimental data collection.

Installation of Mechanical Components to the Structure: At the stage of installing mechanical components to the structure, several components are installed in the structure including gearboxes, generators, pontoons, and multimeters.

Wave Energy Converter Machine (WECM) field test; Then in the second session in the field test is a land test on one of the Wave Energy Converter buildings and testing the first session of Constant Spring Measurement [15]. The second session of testing on land and the third session of testing at sea. KEG engine testing is to verify the engine against pitching motion performance and to obtain the amount of voltage and current in the period of wave height on the coast of Muara Baru.

KEG Engine Field Test Data Collection and Data Processing: Data collection is carried out to collect all data to be studied, and data processing is carried out to obtain the results and conclusions of the research carried out, data processing is to be calculated from the data that has been taken during the field test of the wave energy converter machine. What is meant by the word “no” is trouble during testing and what is meant by the word “yes” in the flow chart is that there is no trouble during testing and what is meant by the word “no” is trouble during testing the KEG tool.

Results and Conclusion: After the field trial process of the wave energy converter machine, the results of taking field trial data and processing the wave energy converter machine field trial data, conclusions, and suggestions will then be made in the form of a research report.

Heaving is the vertical up-and-down motion of a floating structure when it is above undulating waters. The heaving motion of a floating structure is an oscillation that has a reverse force when the structure is disturbed from its equilibrium position Shown in Figure 1.

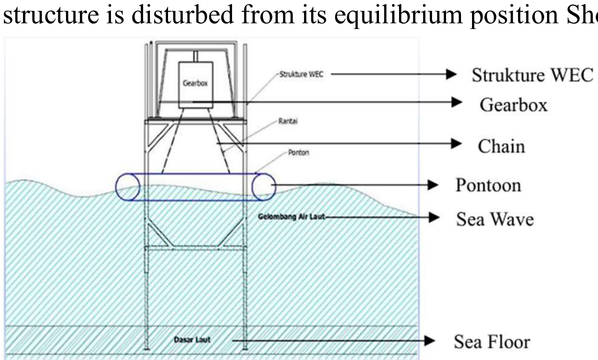

Figure 1. Heaving motion.

$$W = m\,x\,g \tag{1}$$
$$K = \frac{W}{\Delta x}$$

Where:
W = Weight [*Newton*]
M = Mass [kg]

G = Earth's Gravity [m/s²]
Δx = Difference between initial and final spring distance

3. RESULTS AND DISCUSSION

Experiment results of WEC machine performance

Field experiments were conducted before data collection. The purpose of this test was to check the functioning of the KEG machine. The KEG machine is expected to achieve maximum wave energy results. KEG engine testing was carried out on land and the coast of Tanjung Pasir, Tangerang. This KEG engine test was conducted at a sea depth of 1.5 m and a wave height of 0.10 m to 0.40 m using a prototype KEG engine.

SEA experiment analysis

After obtaining the data from the Wave Energy Converter (WEC) device. The experimental results of the Wave Energy Converter (WEC) with a spring constant of 3750 N/m and a load of 150 kg due to heaving motion are presented. The voltage generated in the first hour is 55.53 V, at the second test time in the hour is 47.36 V, at the third test time, in the hour, is 37 V, at the fourth test time in the hour is 82.36 V, at the fifth test time in the hours is 91.36 V, at the 6th test time in the hours, is 102.5 V Shows in Figure 2.

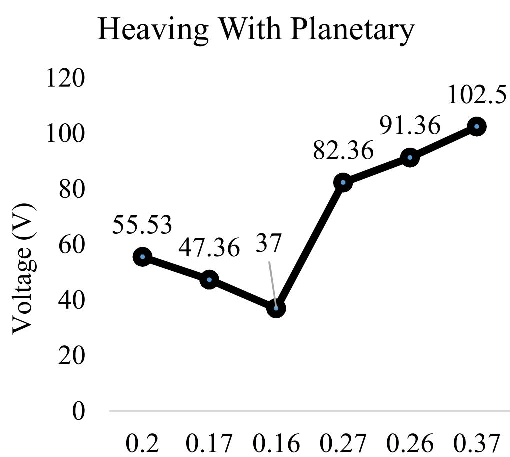

Figure 2. Planetary voltage graph results.

The amperage generated in the first hour is 5.01 A, at the second test time is 4.47 A, at the third test time is 3.28 A, at the fourth test time is 7.13 A, at the fifth test time is 8.23 A, at the sixth test time is 9.32 A Shows in Figure 3.

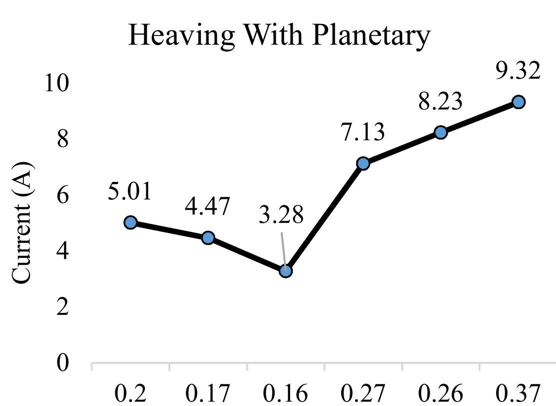

Figure 3. Planetary ampere graph results.

The power generated in the first hour is 278 Watt, in the second test time, is 211 Watt, in the third test time is 121 Watt, in the fourth test time, is 587 Watt, at the fifth test times is 751 Watt, in the sixth test time is 955 Watt Shows in Figure 4.

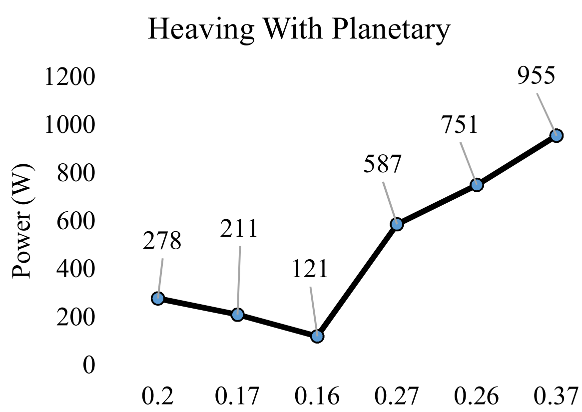

Figure 4. Planetary power result chart.

The experimental results of the Wave Energy Converter (WEC) with a spring constant of 3750 N/m 150 kg load due to heaving motion showed the lowest voltage of 37 V, with a current of 3.28 A and a power of 121 Watt at a wave height of 0.16 m and conversely, the highest value was achieved at a voltage of 102.5 V, with a current of 9.32 A and a power of 955 Watt at a height of 37 cm. Therefore, from the graphical data that researchers have obtained by using a planetary spring of 3750 N/m in heaving, the potential energy generated depends on the height of the seawater waves, the higher the seawater waves, the higher the potential energy generated. The lowest power output, is 0.0095 Watts at a wave height of 16 cm, while the highest power output recorded is 0.986 Watts at a wave height of 27 cm Figure 5 non-planetary illustrates.

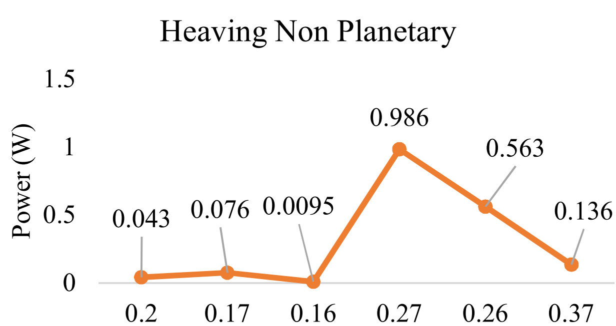

Figure 5. Power graph for non-planetary system.

The lowest voltage value produced is 0.38 Volt at a wave height of 16 cm, while the highest voltage value reached is 1.59 Volt at a wave height of 37 cm Shown in Figure 6 non-planetary.

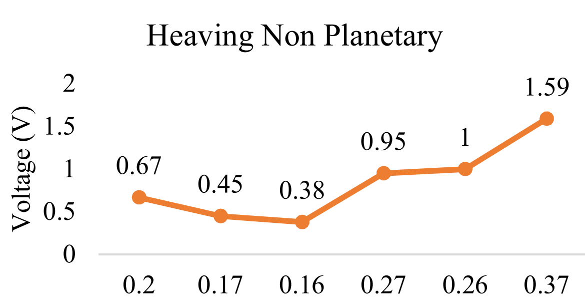

Figure 6. Voltage graph for non-planetary system.

Displays the results of current strength (in Amperes) due to non-planetary heaving motion. The lowest current strength recorded is 0.025 Ampere at a wave height of 16 cm, while the highest current strength achieved is 0.563 Ampere at a wave height of 26 cm Shown in Figure 7 non-planetary.

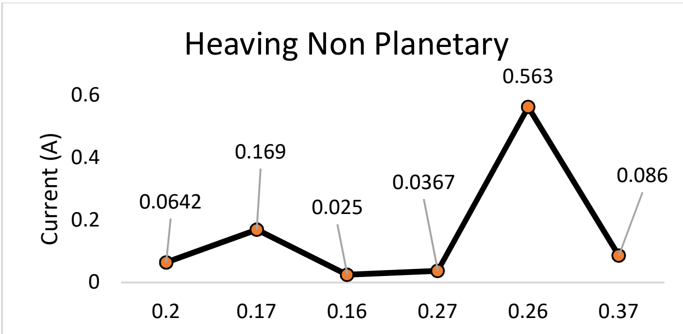

Figure 7. Current strength graph for non-planetary system.

The experimental results of the Wave Energy Converter (WEC) with a spring constant of 3750 N/m 150 kg load due to non-planetary heaving motion showed the lowest voltage value of 0.38 V, with a current of 0.025 A and a power of 0.0095 Watt at a height of 0.16 m and conversely the highest value was achieved 1.59 V at a height of 37 cm, 0.0642A at a height of 16 cm, at a height of 27 cm resulting in a power of 0.986 Watt. Therefore, the graphical data that researchers have obtained by using non-planetary springs of 3750 N / m in heaving potential energy generated depends on the height of the seawater waves, the higher the seawater waves, the higher the potential energy generated. But when compared to the test using planetary which produces 955 watts of power, the use of planetary is very influential, because the test without planetary only produces 0.986 watts of power. The comparison of the results is very significant and the use of planetary is needed in this tool.

In the results of the above non-planetary graph, significant changes are influenced by changes in wavelength, because in the case of waves if the water wave height drops or the wave is flat, the total energy carried by the wave increases, made possible by an increase in wind speed which results in longer and more energetic waves although not so high. that are longer and more energetic even though they are not so high.

4. CONCLUSION

The results of the data analysis of the identification of ocean potential energy without the smallest planetary of 0.095 Watt and the highest of 0.986 Watt, which using planetary produces the smallest power of 121 watts and the largest reaches 955 Watt. Based on this data, it can produce larger data, namely 955 watts. Thus, based on these data, it can be concluded that the maximum power production that can be achieved is 955 Watts. These results show that the potential of ocean energy can be maximized by selecting the right planetaries, to generate significant power for future sustainable energy applications.

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