POWER GENERATOR FROM OCEAN WAVE ENERGY CONVERSION

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ABSTRACT

The need for electrical energy has increased every year. On the other hand, the largest power plants in Indonesia still use non-renewable energy sources such as coal and petroleum, while these non-renewable energy sources will eventually run out. To anticipate running out of this energy, a renewable energy source is needed. This existence will not run out even though it is consumed every day. Renewable energy that can be used for conversion into electrical energy in coastal areas is wave power. The waves that always crash on the shoreline can be used to drive turbines. The turbine rotates due to the crashing waves connected to a DC generator. It will convert mechanical energy into electrical energy. The electrical energy generated by the DC generator is used to charge the battery. The purpose of this research is the know-how to design a wave power generator and to determine the performance. The experimental method is used in this study. In the results, the generator works optimally during the day with the resulting voltage of 10.6V to 10.7V with rotation speed of 623 Rpm to 710 Rpm.
Keywords: power generator, wave energy, ocean energy, generator dc, renewable energy

1. INTRODUCTION

Abundant energy sources are marine energy and geothermal energy. There are several types of ocean energy, namely waves, tides, heat gradients and salinity gradients. All of this energy is renewable. Another form of solar energy is ocean energy in the form of waves, tides, and ocean heat. Whereas tides are the effects of sun-moon gravitational interactions. Geothermal energy comes primarily from radioactive decay deep within the earth and residual heat from the formation of the earth.

Ocean wave energy is a combination of potential and kinetic energy in moving water and the height of the waves. Tides is the kinetic energy from the movement of water. While ocean thermal energy is energy caused by differences in water temperature on the warm surface and cold water inside.

Electrical energy in Indonesia is an increasing need every year followed by economic growth which has also increased. In 2018 Indonesia requires electricity of 232,416 MWh and in 2019 it will increase to 247,416 MWh [1].

Almost all of Indonesia's generators are use non-renewable natural energy sources, such as coal and petroleum, where these energy sources will continue to decrease every year or even run out [2]. To overcome energy exhaustion, it is necessary to use renewable energy that can meet the needs of electrical energy. In Indonesia, renewable energy sources are very large, including solar power, wind power, wave power, and geothermal power [3].

One of the renewable energies that can be utilized is waves. This can be utilized by converting waves into electrical energy. This takes advantage of the waves to drive a turbine that can drive a generator. Generator converts wave energy into electrical energy.

This research will make a prototype of a power plant using wave power. In this experiment, the wind speed will be measured. In addition, this study also measures the voltage and current generated. Wind speed greatly affects the speed of the waves crashing.

2. METHOD

The methodology used is through measurement and direct observation of turbine testing in Talang Siring, Montok Village, Larangan District, Pamekasan Regency. The speed of ocean currents that occur every day is the result of tidal conditions under the influence of gravitational force. In this research, the implementation process pays attention to numerical data and then displays it using graphs, tables and figures [4]. The technique used in data collection is the observation method. Systematic recording and direct observation of the data required for research is an observational method.

This design tool uses SketchUp software. The next step is to collect the tools and materials needed to make the prototype. It is used for hardware design. The next stage is hardware testing. If the appliance can generate voltage, generate current and charge the battery. The stage continues to the stage of data collection. However, if the device is unable to generate voltage, current and charge the battery. So, the step back to the previous one is to design and repair the tool. Finally, the data obtained were analyzed. Figure 1 is the design of the tool you want to design and the size of the tool.
Figure 1 is the design of the tool you want to design and the size of the tool. As shown in Figure 1, the design of this tool uses two pulleys. The first pulley connected to a generator with a small size with a diameter of 2 inches. The second pulley is connected to a water turbine with a diameter of 9 inch, and the two pulleys are connected to each other by a fanbelt. The function of the generator in Figure 1 is to convert mechanical motion energy into voltage and current. The turbine has the function of converting the wave motion into mechanical rotation. Pully and fanbelt have a function as a link between the turbine and the generator to move the rotation of the turbine to the generator. The generator used has the following specifications:

| Parameter | Value | Unit |
|-----------|-------|------|
| Voltage   | 12    | Volt |
| Speed     | 1600  | Rpm  |
| Current   | 40    | Ampere |
| Power     | 480   | Watt |

In the figure 1, the turbine is 12 cm in diameter by 32 cm in length. So, the outside cross-section of the turbine is 384 cm. In Table 1, the generative voltage is 12V with a rotation of 1600 Rpm and a current of 40A with a power of 480 Watts. Figure 2 is an energy conversion flow. This starts from the turbine being hit by the waves to the energy storage stage of the battery.
In Figure 3, the tool to be used is 75cm long by 45cm wide and 75cm high. The DC generator is connected to the turbine using a fanbelt and two pulleys. If there are waves coming, they will hit the turbine blades and the turbines will spin. The turbine drives the connected pulley and drives the DC generator in the generator. Furthermore, the generator will convert the mechanical energy of motion into electrical energy.
and the electrical energy is used to charge the battery. The measuring instrument used in this tool is an ammeter which functions to measure currents from 0-10A. The voltmeter has a function to measure the output voltage of the generator with a voltage measurement limit from 0-100V, and the tachometer has a function to measure the rotation speed of the generator. Data were collected by measuring the output voltage of the generator, the battery charging current and the generator rotation speed which was carried out for 3 days. Everyday data collection is carried out from 08.00-16.00. The time for charging the battery can be seen from the following equation:

\[
T = \left( \frac{C}{I} \right) + \left( 20\% \cdot \frac{C}{I} \right)
\]  

(1)

Where T is Long time charging the battery (hours). Battery Capacity (Ah) is C. Battery Charging Current (A) is I.

3. RESULT AND DISCUSSION

Table 2 shows the results of the tool testing on the first day.

**Table 2. Test Results on The First Day**

| Time  | Voltage Output Generator | Voltage Output Buck-Boost Converter | Speed Of Generator | Current Generator |
|-------|--------------------------|----------------------------------|-------------------|------------------|
| 08.00 | 8.2 V                    | 13.8 V                           | 524 Rpm           | 430 mA           |
| 09.00 | 8.0 V                    | 13.8 V                           | 497 Rpm           | 415 mA           |
| 10.00 | 8.8 V                    | 13.8 V                           | 590 Rpm           | 520 mA           |
| 11.00 | 9.1 V                    | 13.8 V                           | 637 Rpm           | 572 mA           |
| 12.00 | 10.6 V                   | 13.8 V                           | 732 Rpm           | 610 mA           |
| 13.00 | 10.7 V                   | 13.8 V                           | 693 Rpm           | 618 mA           |
| 14.00 | 10 V                     | 13.8 V                           | 710 Rpm           | 596 mA           |
| 15.00 | 9.5 V                    | 13.8 V                           | 684 Rpm           | 520 mA           |
| 16.00 | 8.5 V                    | 13.8 V                           | 534 Rpm           | 490 mA           |

In Table 2, it can be seen that the maximum result of the tool testing on the first day is at 13:00 with the resulting voltage of 10.7V with a generator rotating speed of 693 Rpm and a large current flowing of 618 mA. Testing tools on the second day can be seen in Table 3. Maximum results are at 14.00 with the resulting voltage of 10.6V with a generator rotating speed of 515 Rpm and a current flowing of 613 mA.
Table 3. Test Results on The Second Day

| Time  | Voltage Output Generator | Voltage Output Buck-Boost Converter | Speed Of Generator | Current Generator |
|-------|--------------------------|-------------------------------------|--------------------|-------------------|
| 08.00 | 8 V                      | 13.8 V                              | 412 Rpm            | 420 mA            |
| 09.00 | 8 V                      | 13.8 V                              | 432 Rpm            | 430 mA            |
| 10.00 | 8.5 V                    | 13.8 V                              | 478 Rpm            | 445 mA            |
| 11.00 | 10.2 V                   | 13.8 V                              | 511 Rpm            | 596 mA            |
| 12.00 | 9.8 V                    | 13.8 V                              | 495 Rpm            | 574 mA            |
| 13.00 | 9.5 V                    | 13.8 V                              | 534 Rpm            | 565 mA            |
| 14.00 | 10.6 V                   | 13.8 V                              | 515 Rpm            | 613 mA            |
| 15.00 | 10 V                     | 13.8 V                              | 592 Rpm            | 587 mA            |
| 16.00 | 9 V                      | 13.8 V                              | 465 Rpm            | 495 mA            |

From Table 4, the generator works optimally during the day at 15.00 with the resulting voltage of 10.6V, the generator rotation speed of 623 Rpm, and the current flowing is 603 mA.

Table 4. Test Results on The Third Day

| Time  | Voltage Output Generator | Voltage Output Buck-Boost Converter | Speed Of Generator | Current Generator |
|-------|--------------------------|-------------------------------------|--------------------|-------------------|
| 08.00 | 8.1 V                    | 13.8 V                              | 390 Rpm            | 408 mA            |
| 09.00 | 8.5 V                    | 13.8 V                              | 396 Rpm            | 413 mA            |
| 10.00 | 8.8 V                    | 13.8 V                              | 410 Rpm            | 456 mA            |
| 11.00 | 9 V                      | 13.8 V                              | 587 Rpm            | 535 mA            |
| 12.00 | 8.7 V                    | 13.8 V                              | 511 Rpm            | 502 mA            |
| 13.00 | 9.6 V                    | 13.8 V                              | 573 Rpm            | 545 mA            |
| 14.00 | 9.4 V                    | 13.8 V                              | 596 Rpm            | 524 mA            |
| 15.00 | 10.6 V                   | 13.8 V                              | 623 Rpm            | 603 mA            |
| 16.00 | 9.3 V                    | 13.8 V                              | 568 Rpm            | 511 mA            |
The next stage is battery testing. This battery charging test aims to find out how long the battery can be fully charged. The results of the battery charging test can be seen in table 5.

| No | Volt  | Current | Charging |
|----|-------|---------|----------|
| 1  | 13.8V | 0.4A    | 10 Hour  |
| 2  | 13.8V | 0.5A    | 8.5 Hour |
| 3  | 13.8V | 0.6A    | 7 Hour   |

4. CONCLUSION

This study aims to create and test the performance of the wave power generator design. The test location is in Talang Siring, Montok Village, Larangan District, Pamekasan Regency, East Java. Testing the design of the wave power plant is to work optimally during the day with the resulting voltage of 10.6V and 10.7V with a generator speed of 623 to 710 Rpm.

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