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Tide Sea Water for Power Generator

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Abstract - Utilization of renewable energy can be a solution to the limitations of fossil energy. Ocean current energy is renewable energy caused by tides. The purpose of this study is to determine a theoretical planning for tidal energy generation in Mereuke-Papua district and to analyze the potential power that can be generated using tidal data in Merauke district. The method used in this study is the Qualitative Method. , which only requires processing the data that is already available. The location for obtaining data related to the problems in this paper is located at the mouth of the Merauke river and data collection at PT. PELINDO Merauke and BMKG Merauke. The calculation results show that the height of the wave is proportional to the amount of power generated. The greater the wave height, the greater the power generated and with a height between 0.70 - 3.25 meters, it produces a power of 94,115.18 - 5,261,198.29 Watt.

KEYWORDS: Energy, Electricity, Tidal

INTRODUCTION

Tides are a natural phenomenon with periodic ups and downs of sea levels due to the gravitational force between the earth and the moon and the sun which causes the attractive force of astronomical objects, especially by the sun, earth and moon. Tides and currents generated by tides are very dominant in the process of circulating water masses in coastal waters. A movement that has an impact on the movement of water masses and their relationship with the spread of fluid circulation in a particular container is a lesson from tidal science.

The gravitational force that is presented is greater than the sun. Although the size of the moon is much smaller than the sun, the moon turns out to have a force of attraction that is twice as large as the attraction of the sun in causing tides because it is closer to Earth. This gravitational attraction pulls seawater toward the moon as well as the sun and creates two gravitational tidal bulges or bulges in the ocean.

Papua Province, especially in Merauke Regency, is one of 29 regencies/cities located in the southern part which has the widest area among regencies/cities in Papua Province. Geographically located

Merauke Regency is located between 137º - 141º east longitude and 6º00' - 9º00' south latitude. Merauke Regency is located in the easternmost part of the archipelago with the following boundaries. North: Boven Digoel Regency and Mappi Regency, East: Papua New Guinea, South: Arafura Sea, West: Arafura Sea. Geographically, it has economic development prospects with neighboring PNG, Australia and South Pacific countries. The area of Merauke Regency is 45,071 Km^2 (11% of the province's area). Most of the Merauke Regency area consists of lowlands and swamps, a swamp area of 1,425,000 hectares and highlands in several northern interior districts.

THEORETICAL BASIS

Tidal power is renewable energy, the result of converting tidal energy into electricity. Tidal power is a form of hydropower in which energy is obtained from the energy contained in the tides. Tidal power is a renewable energy source because the tides on Earth are the result of the gravitational interaction of the moon and sun and the rotation of the earth which makes it an almost inexhaustible source of electricity. Tidal power has great potential but much of the tidal power industry is still only a pilot project and has not received worldwide attention.

Tidal energy is able to produce electricity only during high tides which averages about 10 hours every day. This means that tidal energy is an intermittent source of energy (such as solar and wind). therefore require adequate energy storage solutions. This tidal energy is very useful in Indonesia, because Indonesia is an archipelagic country, almost 50% of which is the sea. Therefore, the benefits of tidal energy in Indonesia are very large.

When compared to other power plants, of course, tidal power plants are very superior, namely the tides of water can be predicted because they are influenced by the movement of the earth and also the gravity of the moon and sun, while for other power plants (solar and wind) it is very dependent on weather changes, let alone visible changes in the weather. which is sometimes erratic so it is very difficult to predict [1] .

However, behind these advantages, tidal generators also have disadvantages, namely tidal plants are very expensive to build because the construction field is rather difficult and the turbines needed must also be able to withstand high levels of corrosion. Although the construction is expensive, the tidal generator is only built once and with relatively low maintenance costs.

Tidal energy is a renewable energy. The working principle is the same as a hydroelectric power plant, where water is used to turn turbines and generate electrical energy. Capture the energy contained in the mass transfer of water due to tides

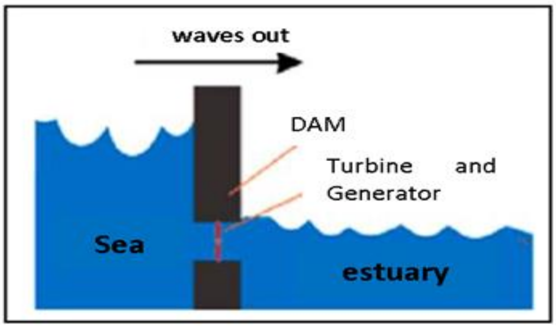

Figure 1. Install Process

In Figure 1, it can be seen that the direction of the waves enters the mouth of the river when there is a high tide. In this process the tidal water will be accommodated into the dam so that at low tide the water in the dam can be channeled to rotate the turbine.

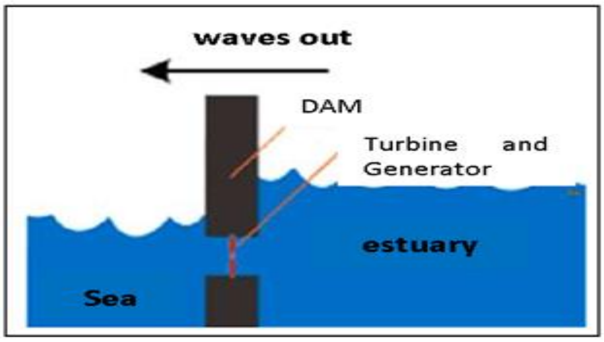

Figure 2. Low Process

When it recedes, the water flows out of the dam into the sea while turning the turbine as shown in Figure 2 above. The tides move large amounts of water every day, and their use can generate considerable amounts of energy. In a day there can be up to two tidal cycles. Because cycle times can be estimated (approximately every 12.5 hours), the electricity supply is relatively more reliable than wave-powered power plants[2].

RESEARCH METHODOLOGY

The research design is the method used to bring the problems under study closer so that they can explain and discuss the problems appropriately. This study uses a qualitative method, which only requires processing the available data. The location for obtaining data related to the problems in this paper is located at the mouth of the Merauke river and data collection at PT. Indonesian harbour (PELINDO) Merauke and Indonesian harbour (BMKG) Merauke. The tidal measurement locations are as shown in the map below:

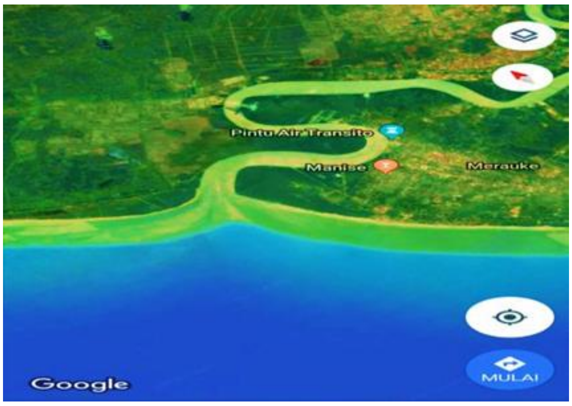

Figure 3. Tidal Data Collection Location

After all the research data has been fulfilled, the next step is to analyze the test data. The analytical method used is the quantitative method in which the calculation and analysis is only based on the data obtained.

RESULTS AND DISCUSSION

RESULTS

Based on secondary data from the Meteorology, Climatology and Geophysics Agency, data is obtained as shown in table 1.

Table 1. Table of Average Wind Speeds and Average Sea Wave Heights – Average Coastal Merauke Period January – December 2018

Month	Merauke Waters		
	Wind velocity Average (Knot)	Average Wave Height (Meter)	
		Min	Maks
January	6,00 – 18,00	0,70	2,00
February	6,00 – 18,00	0,70	2,25
March	7,50 – 19,00	1,25	3,00
April	7,50 – 19,00	1,25	3,25
May	7,50 – 19,00	1,25	3,25
June	7,00 – 19,00	1,25	3,00
July	7,00 – 19,00	1,25	3,00
August	7,00 – 19,00	1,25	3,50
September	7,00 – 19,00	1,20	3,50
October	6,00 – 18,50	1,05	2,75
November	5,50 – 18,00	0,75	2,00
December	6,00 – 18,00	1,00	2,00

***Source:** BMKG Merauke*

Potential sea waves in January:

1. Calculation of potential energy of ocean waves (minimum) in January in the waters

$$P.E = \frac{1}{4}\, w\, \rho\, a^2\, \lambda$$

$$P.E = \frac{1}{4}\,(10\,m)\,(1030\,\frac{kg}{m^3})\,\left(\frac{0.7}{2}\right)\,(45.17\,m)$$

$$P.E = 139767{,}77\,Joule$$

From the results of the calculations above, other data results can be made as in table 2 for the results data for January – December 2018.

Table 2. The results of the calculation of the amount of potential energy for ocean waves for the period January – December 2018

No	Month	Potential energy potential of southern coastal ocean waves (Joule)	
		Min	Max
1	January	139.767,77	3.259.889,68
2	February	139.767,77	4.641.522,62
3	March	795.871,50	11.002.127,68
4	April	795.871,50	13.988.237,57
5	May	795.871,50	13.988.237,57
6	June	795.871,50	11.002.127,68
7	July	795.871,50	11.002.127,68
8	August	795.871,50	17.470.971,27
9	September	704.136,17	17.470.971,27
10	October	471.716,22	8.474.439,78
11	November	171.908,25	3.259.889,68
12	December	407.486,21	3.259.889,68

To calculate the amount of kinetic energy produced by ocean waves using the oscillating water column system, the following equation is used:

$K.E = \frac{1}{4}\, w\, \rho\, a^2\, \lambda$

Calculation of the kinetic energy of ocean waves in January:

1. Calculation of kinetic energy of ocean waves (minimum) in January in Merauke waters.

$K.E = \frac{1}{4}\, w\, \rho\, a^2\, \lambda$

$K.E =$

$\frac{1}{4}\,(10\ m)\left(1030\,\frac{kg}{m^3}\right)\left(9{,}81\,\frac{m}{sec}\right)\left(\frac{0{,}7}{2}\right)(45{,}17\ m)$

$K.E = 139767{,}77\ Joule$

From the results of the calculations above, other data results can be made as in table 3 for the results data for January – December 2018.

Table 3. The results of the calculation of the kinetic energy of ocean waves for the period January – December 2018

No	Month	Potential energy potential of southern coastal ocean waves (Joule)	
		Min	Max
1	January	139.767,77	3.259.889,68
2	February	139.767,77	4.641.522,62
3	March	795.871,50	11.002.127,68
4	April	795.871,50	13.988.237,57
5	May	795.871,50	13.988.237,57
6	June	795.871,50	11.002.127,68
7	July	795.871,50	11.002.127,68
8	August	795.871,50	17.470.971,27
9	September	704.136,17	17.470.971,27
10	October	471.716,22	8.474.439,78
11	November	171.908,25	3.259.889,68
12	December	407.486,21	3.259.889,68

Table 4. The results of the calculation of the amount of ocean wave energy period January – December 2018

No	Month	Potential energy potential of southern coastal ocean waves (Joule)	
		Min	Max
1	January	279.535,54	6.519.779,37
2	February	279.535,54	9.283.045,23
3	March	1.591.743,01	22.004.255,36
4	April	1.591.743,01	27.976.475,13

5	May	1.591.743,01	27.976.475,13
6	June	1.591.743,01	22.004.255,36
7	July	1.591.743,01	22.004.255,36
8	August	1.591.743,01	34.941.942,54
9	September	1.408.272,34	34.941.942,54
10	October	943.432,45	16.948.879,56
11	November	343.816,49	6.519.779,37
12	December	814.972,42	6.519.779,37

To calculate the total power generated by ocean waves using oscillating water column technology at the planned location, the following equation is used:
Pw= Ew/T (Watts)

From the results of the calculations above, other data results can be made as in table 5 for the results data for January – December 2018 (Table 5)

Table 5. The results of the calculation of the potential for ocean wave power period January – December 2018

No	Month	Potential power generated on the coast South (Watt)	
		Min	Max
1	January	94.115,18	1.298.642,31
2	February	94.115,18	1.743.294,88
3	March	401.041,75	3.578.637,40
4	April	401.041,75	4.371.424,29
5	May	401.041,75	4.371.424,29
6	June	401.041,75	3.578.637,40
7	July	401.041,75	3.578.637,40
8	August	401.041,75	5.261.198,29
9	September	362.132,64	5.261.198,29
10	October	259.350,93	2.879.030,69
11	November	111.832,42	1.298.642,31
12	December	229.569,70	1.298.642,31

From the above results it can be stated that the wave height is proportional to the amount of power generated. The greater the wave height, the greater the power generated and with a height between 0.70 - 3.25 meters, it produces a power of 94,115.18 - 5,261,198.29 Watt.

DISCUSSION

Based on the type of ebb and flow, the tidal current pattern in Merauke waters occurs in two different flow directions twice within 24 hours, namely at low tide the flow pattern is to the west while at high tide the flow pattern is to the east. Based on the length of time the position of the water will be at high tide until the maximum tide is between 7-8 hours, while the length of time for the position of the water when it will recede to the minimum low tide is between 5-6 hours. The highest water level at the time of tidal observation is 10 m on the reading signs and the lowest water level is 2 m on the reading signs. The position of the water level shows that the movement of the volume of water at high tide is greater than the movement of the volume of water at low tide.

Based on the results and discussion, it can be concluded that with a range of wind speeds between 6.00 knots to 19.00 knots and a range of wave heights between 0.70 meters to 3.25 meters on the southern coast of Malang (South coast of East Java) it can produce the range of power is 94,115.18 Watts to 5,261,198,29 Watts. Thus, the greater the height of the wave, the more electrical power generated.

CONCLUSION

From the results of calculations and discussions, the following conclusions can be drawn:

1. Based on the length of time the position of the water will be at high tide until the maximum tide is between 7-8 hours, while the length of time for the position of the water when it will recede to the minimum low tide is between 5-6 hours. The highest water level at the time of tidal observation is 10 m on the reading signs and the lowest water level is 2 m on the reading signs. The position of the water level shows that the movement of the volume of water at high tide is greater than the movement of the volume of water at low tide. From this data, a power plant plan will be generated using tidal energy.
2. The potential for tidal energy is able to produce a power range of 94,115.18 Watts to 5,261,198.29 Watts.

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