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Design of Sea Wave Power Hybrid Power Generation Through Utilization of Wave and Wind Energy as Renewable Electric Energy Sources for Leading, Outermost and Disadvantaged Areas

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ABSTRACT
This study conducts the design of sea wave hybrid power plants by combining wave energy with wind energy. Vertical energy of ocean waves is converted into pressurized water energy to rotate turbines connected to direct current generators, while wind energy uses wind turbines connected to direct current generators, the energy produced by both direct current generators will improve the fluctuations in electrical energy that have been faced by ocean wave energy generator. using research and development methods. The wave power generation unit consists of a buffer, piston and cylinder, inlet and outlet valves, reservoirs, wind turbines and direct current generators, while wind power consists of wind turbine units, gears and direct current generators. Electrical energy generated by the two units is combined in the control module. This research produces energy that is quite stable and is very suitable to be used as an electricity supply for fishermen in Bagan and the leading, outermost and lagging regions of Indonesia, which has been struggling to get electricity supply.

Keywords: Hybrid system, Wave energy, Wind energy, Leading, Outermost, Underdeveloped

1. INTRODUCTION

In general, Sea Wave Power Generation (WEC) is divided into 6 types, namely (1) Point absorber, (2) Oscillating Water Column, (3) Submerger Pressure Differential, (4) Oscillating Wave Surge Converter, (5) Attenuator & Terminator, and (6) Removable Device [1][2]. [3]–[6].

At present there is a Point absorber type wave power plant that has been installed, namely (1) the Power Bouy type developed by Ocean Power Technologies Company of the United States, this type converts vertical energy up and down the waves into rotary energy through a screw mechanism, (2) Seabased type was developed by the Swedish Seabased AB Company, this system utilizes the vertical waveforms of up and down waves to move the rotor on a linear motor, while the stator parts are connected to the seabed, (3) the CETO type was developed by Carnegie Wave Energy Limited Company

Ireland Submerged buoys are driven by ocean waves, a driving pump that pressures seawater that is sent ashore through an underwater pipe. Once on land, high-pressure sea water is used to drive hydro-electric turbines, producing electricity. High pressure seawater can also be used to supply reverse osmosis to desalination plants, produce fresh water, (4) Wave Star type developed by Denmar's Wave Star Energy Company, this system uses floating pontoon energy that fluctuates due to waves to obtain acceptable water and, (5) AquabuOY type developed by Finavera (Aquaenergy) Company of Canada, uses a long pump that is connected to the Pelton turbine. [1]

AquabuOY system has a weakness in the turbine rotation which depends on the wave period that occurs, the slower the wave period that occurs, the turbine rotation that is generated is also getting weaker, therefore it needs to be improved by adding reservoir units to obtain pressure stability and pully units so that the

rotation is generated in a much larger turbine. With this addition, the generator will spin faster and more stable. Coupled with the addition of wind energy paired at the top of the unit makes the plant to be built will produce greater energy, more flexibility can be placed in shallow seas, medium or deep, does not require complicated foundations, relatively inexpensive, is not affected by extreme weather and can be used in all fields of the sea by simply being tied to the ballast and can be used as a sign lamp or a cellular signal transmitter for the benefit of navigation and communication.[7][6], [8].

2. METHOD

Sea Wave Hybrid Power Plant is a combination of Power Wave Generator with a wind turbine, converting vertical wave energy into motion energy to pump seawater into a pressurized reservoir to rotate a water turbine connected to an electric generator by placing the pump piston directly connected to the pontoon and cylinder the pump is mounted on the seabed. The energy generated is combined with the generator energy generated from the wind turbine mounted on the top of the system unit.
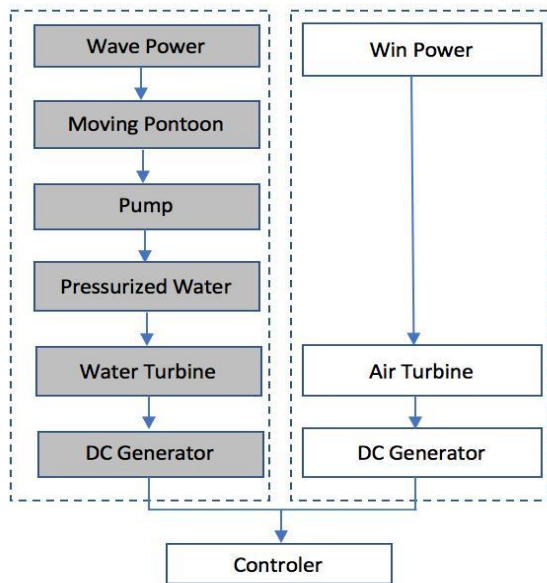

Figure 1 Block diagram of a Hybrid Wave Power Plant

The energy change is shown in the block diagram of a hybrid wave power plant. In the wave power unit, the vertical energy of sea waves is captured by the pontoon, the pontoon to drive the pump to produce pressurized water, pressurized water is used to turn the turbine connected to the generator. while the wind power unit, wind energy is used to rotate the turbine connected to the generator, to get energy stability, the electric power generated by 2 dc generators is regulated using a controller. In this paper, we will present a simulation of the calculation of electrical energy from wave power, the amount of wind energy is presented in different journals.
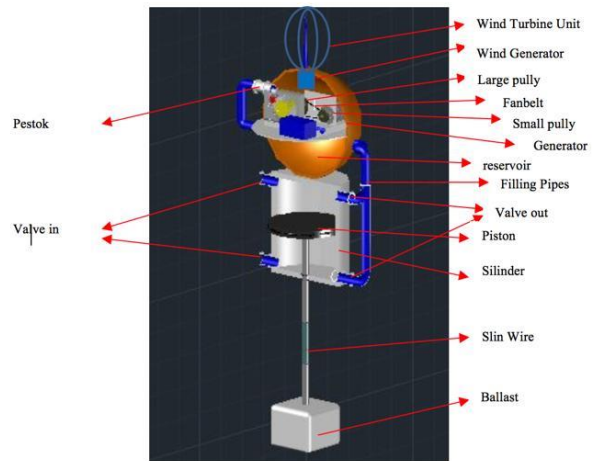

Figure 2 Wave Power Hybrid Power Plant Design

The research flow includes:

1) Design Evaluation & Improvement, this stage carries out an evaluation and refinement of calculations on system design and size. Initial prototypes need improvement by adding wind turbine units as an additional source of electrical energy.

2) Design of ballast and hooks units, this stage is doing ballast designs that will be used to hook units when installed at sea.

3) Design of pontoon and reservoir, this stage is to design the pontoon unit and reservoir based on the calculated model size.

4) Design of Pump unit, this stage performs pump unit design according to the size of the system design.

5) Design of Turbine unit, this stage performs Turbine unit design based on the calculated model size.

6) Selection of the generator unit, this stage does not carry out the manufacture of generators that are already on the market to make it easier for the community to build this system.

7) Simulation calculations, get the amount of electrical power generated based on the system size and wave assumptions based on observations in previous research

8) Analysis, performs an analysis of the amount of electric power generated by a hybrid power plant

9) Conclusion, the conclusion is expected to get the results of calculating the amount of potential electrical energy generated.
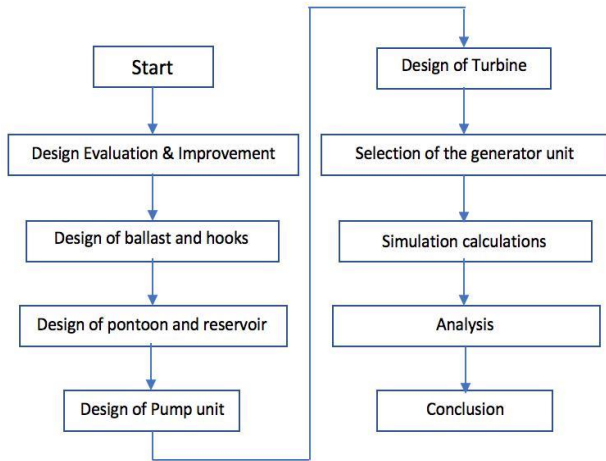
Figure 3 Research Method.

3. RESULT AND DISCUSSION

3.1. Result

1) The constants used in the calculation are Pi (π) = 3.14, gravity 9.8m/s^2 and sea water density = 1.030 kg/m^3, the weight of seawater = 10.094 N/m^3.

2) The assumptions used in the calculations are the wave is assumed linear, maximum wave height (h) = 2.5 m, wave period (T) = 6 s, turbine efficiency of 60 %, generator efficiency of 80 %, transmission efficiency of 90 %

3) System Size, ponton volume 65 liters, Piston diameter (D1) = 8 inches diameter output (Dout) = 1 inch, the length of the piston step = 100 cm.

4) *Buoyant force*, with a volume of 65 liters pontoons produce a buoyancy force of 330 N

5) Incoming water speed (V) is pump stride length per unit time, the water inlet velocity of 0.33 m/s.

6) *Pump inlet pressure (P1)*, With 8 inch, the size of the piston surface area is 0,032 m2. Because the pump inlet pressure is defined as the ratio of force to the surface area of the piston pump, the size of the pump inlet pressure of 10,186 N/m2.

7) *Water exit speed (V2)*, 1-inch diameter pipe output (0,025m), the amount of pump output surface area is 0,001 m2. Because of the magnitude of the speed of the water out is defined as the product of the ratio of the surface area of the piston (A1) and the speed of the water inlet (V1) with a surface area of the pump exit (A2) or V2 = (A1xV1) /A2, then the amount of water exit velocity of 21.3 m/s.

8) *Exit pressure pump (P2),* The magnitude of the pressure pump is a comparison of time pressure and the piston surface area to the surface area of the pipe exit. Exit pressure pump is 651,905 N/m2

9) *The water discharge (Q),* Water discharge is defined as the volume of water displaced into the reservoir per unit time. discharge of water flowing into the reservoir was 0.0054 m3 /s, equivalent to a potential water energy of 65 m

10) *Electric* Output, with *water discharge* of 0.0054 m3/s, water level equal to 65 m and turbine efficiency of 0.6%, the turbine output is 2,398 watts. With generator efficiency of 70% and transmission efficiency of 90%, then the electricity that can be generated is 2,045 watts.

3.2. Discussion

A hybrid power plant consists of 2 main units, a wave power generation unit and a wind power generation unit, in this paper it is more focused on wave power generation units.

Assuming the waves that occur are linear with an average height of 2.5m, period of 6s, pontoon volume of 65 liters, the main diameter of the pump is 8 inches and the output diameter of 1 inch produces a water debit of 0.0054 m3 / s and a water pressure of 651.905 N / m2 or equivalent to water. fall with a height (h) of 65m.

With *water discharge* of 0.0054 m3/s, water level equal to 65 m and turbine efficiency of 0.6%, the turbine output is 2,398 watts. With generator efficiency of 70% and transmission efficiency of 90%, then the electricity that can be generated is 2,045 watts.

4. CONCLUSION

The results of the calculation of the hybrid power plant design on the ocean waves produce a discharge of 0.0054 m3 / s and an equal height of 65 m to produce 2 kW of electrical energy.

The energy produced is highly dependent on the wave fluctuation that occurs, so that by combining it with a wind energy generating unit, it will produce bigger and more stable electrical energy. Hybrid generator is very suitable to be applied for Leading, Outermost and Disadvantaged Areas.

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