

## **Design and Setup of Pilot Plan Wave Turbine for Coastal Region Application in Myanmar**

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### **ABSTRACT**

The design and set up of small scale model wave turbine is installed in laboratory. Wave turbine produces electricity by using wave motion up and down. The dynamic response exhibited by buoy acting onto a generator assembly. The mechanical system can produce electricity. This generator is based on wave pushed to buoy and which force drives to move up and down for shaft. The shaft turns to dynamo and produce electricity. In this research, the design of a floating device oscillating and turbine operating under a number of wave propagation is considered. The significant improvements of the system's performance are achieved by any given sea condition. When amplitude of wave is 3 ft, the output power is 2.4 watt. The benefits of this research is that it reduces CO<sub>2</sub> emission and supply electricity for lack of electrified area in our country.

**Key words:** wave, buoy, generator, up and down, electricity

### **INTRODUCTION**

Wave power is the capture of energy of wind waves to do useful work – for example, electricity generation, water desalination, or pumping water. A machine that exploits wave power is a wave energy converter (WEC). Wave power is distinct from tidal power, which captures the energy of the current caused by the gravitational pull of the Sun and Moon. Waves and tides are also distinct from ocean currents which are caused by other forces including breaking waves, wind, the Coriolis effect, cabbeling, and differences in temperature and salinity. Wave-power generation is not a widely-employed commercial technology, although there have been attempts to use it since at least 1890. Wave power devices are generally categorized by the method used to capture the energy of the waves, by location and by the power take-off system. Locations are shoreline, nearshore and offshore. When evaluating wave energy as a technology type, it is important to distinguish between the four most common approaches: point absorber buoys, surface attenuators, oscillating water columns, and overtopping devices. In this research, the system design was based on up and down action by buoy from theoretical formula and test model construction. It is useful for coastal region in Myanmar. The six main parts of this wave turbine are wave tank, buoy, shaft, gear, generator or dynamo and charging controller.

### **Installation of Pilot Plan Wave Energy Generator**

Small scale wave generator was setup in laboratory. Some parts of wave turbine were constructed in Science Workshop, at the Department of Higher Education (Yangon). One-way vertical shaft wave machine is constructed. Waves which move up and down drive the floating device (buoy) of wave turbine. Water tank and wave plate are made of thick fiber (PVC) plate. Wave generator included wave tank, buoy (floating device), axial rod, shaft, ball bearing, gear, pulley, iron stand, dynamo, and charging controller. The waves move up and down and drive the shaft. The shaft is connected to pinion with axial rod and it turns the pulley. Pulley rotates and turns the generator which produces electricity as voltage and current. Finally, we observe that the output voltage and current generated. The output current passes through the charging controller circuit. The circuit converts AC current into DC and passes through regulator portion charged to battery. The charge controller controls input and output voltage and current which

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protects overcharge not to damage the battery. When the battery is fully charged, extra voltage will abandon as heat. The output voltage and current is 5V and 0.48A also the output power is 2.4W in wave tank.

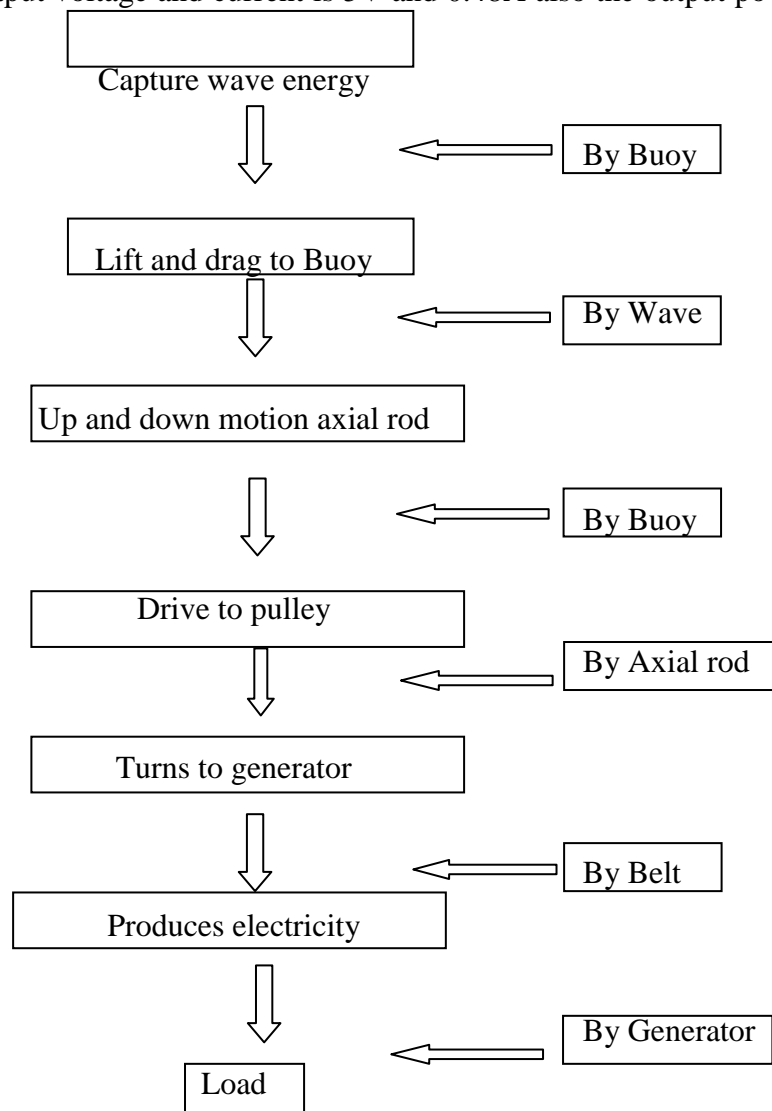


Figure 1 The block diagram of wave energy electricity generator

In order to construct structures and equipment's, it is important to build models of the design to make the experiments and results more predictable. This is especially desirable where the project represents a large investment and where personal safety is at stake. Wave generator can also be constructed on a model scale and this is one way to get confidence in these devices. The buoy type wave generator has been designed and constructed and many new components are used in the fabrication of the complete package of wave energy conversion system, deal with in this work. The components of wave generator functions are shown in Table 1. The eleven main parts consist in this turbine. The detail measurements of wave turbine instruments are shown in Table 2. The power output of wave turbine with different water level and different wave height shown in Table 3 and 4.

Wave power formula is

$$P = \frac{\rho g^2 T h^2 l}{32 \pi}$$

P = power of water wave present in depth (Watts),  $\rho$  = water density (1.025 kg/m<sup>3</sup>),

$g$  = acceleration due to gravity ( $9.81 \text{ m/s}^2$ ),  $T$  = wave period,  $h$  = wave height,  
 $l$  = length of wave front.

**Components of Wave Generator and Functions**

The constructed wave generator is made up of the following mechanical major parts;

**Table 1** Components of wave electric generator and their functions

Sr.	Component	Function
1.	Tank	The water is stored in this tank and uses for sources of wave.
2.	Wave Plate	The wave produces and converts wave energy to kinetic energy.
3.	Floating Device	The floating device move up and down when struck by wave.
4.	Shaft	The shaft moves up and down by wave and drive the pinion.
5.	Pinion	The pinion drives axial rod by the shaft move up and down.
6.	Axial Rod	Supports the rotor and transmits rotary motion to gear. The axial rod rotates pulley.
8.	Ball Bearing	Supports and allows rotary movement of shaft.
9.	Pulley	The pulley rotates dynamo.
10.	Dynamo	Converts rotary motion of shaft to electric power.
11.	Frame/Stand	Takes the machine above the ground level for better and uniform wave from generator.

**Table 2** Measurement of Instruments for wav turbine

Serial	Materials	Length	Width	Height
1	Water Tank	51"	19"	24"
2	Wave Plate	24"	16.5"	0.5"
3	Floating Device	64"	24"	3"
4	Gear	Chain length 27"	Pinion diameter 2.5"	-
5	Pulley	Diameter = 12"	0.5"	
6	Axial Rod (or) Power Shaft	36"	Diameter 0.5"	
7	Ball Bearing	Type = P206		
8	Frame (or) Iron stand	6"	9"	41"
9	Dynamo	Type = AC	Diameter= 3"	

### Wave Turbine Construction Photos



Figure 2 Buoy (floating device), pulley, belt and dynamo of wave generator



Figure 3 Wave generator assembly



Figure 4 Preparation for wave energy generator assembly with setup and testing by wave

### Wave generator Factors and Results

The wave and tide is produce from the gravitational force interaction between earth and moon. The wave has energy and momentum. Myanmar has so many energy resources but try to develop renewable energy sector. The result of this research was support to unelectrified village people. The system is based on floating device and pinion.

Table 3 Power output of wave generator

Sr.	Water Level(cm)	Wave Height(cm)	Current(mA)	Voltage(mV)	Power(mW)
1.	15	2.54	19.02	21.1	0.40
2.	18	3.81	33.35	207.7	6.92
3.	20	5.08	33.63	219.3	7.38
4.	23	7.62	31.17	252.2	7.86
5.	25	10.16	35.16	331.7	11.66
6.	28	9.91	36.86	304.8	11.23
7.	31	3.30	24.95	233.9	5.84
8.	33	3.56	27.84	241.2	6.72
9.	36	4.83	36.91	206.8	7.63

Table 4 Power output of wave generator with different wave height

Sr.	Water Level (cm)	Wave Height (cm)	Current (mA)	Voltage (mV)	Power (mW)
1.	25	6.5	94.9	100.3	9.5184
2.	25	7.5	97.5	120.9	11.7877
3.	25	8.5	103.6	109.7	11.3649
4.	25	9.5	102.3	144.4	14.7721
5.	25	10.5	128.0	134.9	17.267
6.	25	12.0	113.3	187.3	21.2210
7.	25	13.0	112.4	174.2	19.5800

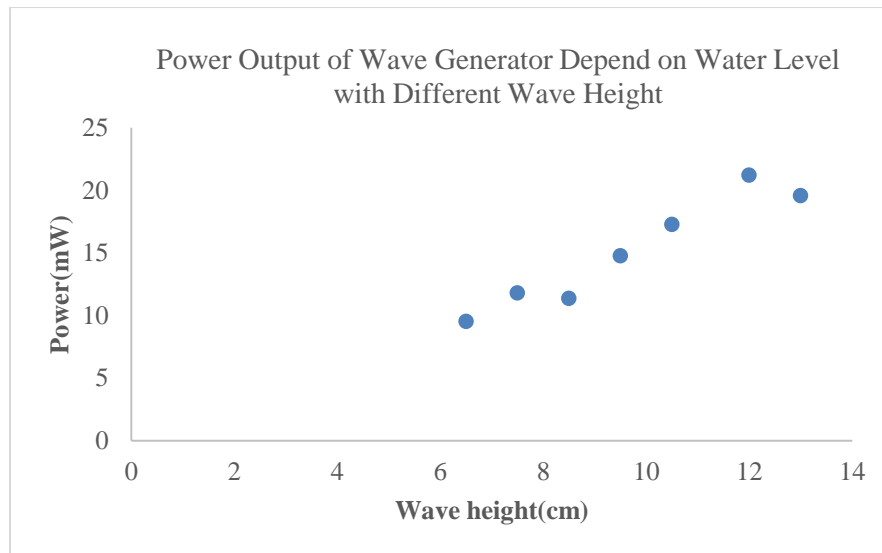


Figure 5 Power output of wave generator depend on water level with different wave height

### Discussion

The system is based on floating device and pinion. All equipment's except AC dynamo are easy to buy and easy to construct in this research. This system is based on calculation results and basic theory. The output voltage can be stored in battery, which is enough for small household uses. The design and optimization of a buoy is used to collect renewable energy from ocean waves. The buoy is a proposed floating device, a device is absorbing wave energy and that transforms the kinetic energy of the vertical motion of surface waves into electrical energy.

The focus of the research is on the mechanical system used to collect the energy, and methods to improve it for eventual use in an actual wave energy harvester. This system can be maintained and repaired by themselves for coastal area settlement people.

### Conclusion

This research introduces an innovative design, development and laboratory prototype of a light-weight, low-cost, small-size wave power electricity generation system which includes a buoy, a set of mechanical devices and a permanent magnetic generator. The wave electricity generator is successfully constructed based on buoy (floating device) wave energy converter. The system is smoothly operated in test run situation. This generator can be used in any coastal region in Myanmar. This model system includes water tank, buoy (floating device), axial rod, ball bearing and dynamo. The various water volumes are inserted to water tank and measure power output in test condition. The water volume  $246.126 \text{ m}^3$  gives maximum power output of wave generator. The optimum power output is 21 mW with wave height is 0.120 m and with water level 0.254 m. This wave turbine can operate by the ocean wave.

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