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Generation of Electricity from Ocean Waves

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Abstract -*Electricity has now become the fourth basic need of humans. The sole aim of the project is to generate electricity from a renewable source of energy such as wave energy. In this paper it is discussed that how electricity can be generated from wave power using a combination of an offshore buoyant moored device and an overtopping system. The buoyant moored device basically is a floating type device whichuses the rise and fall of the swells to drive the pumps and is responsible for the conversion of energy in ocean waves to electrical energy.An overtopping system usesthe pumped fluid to fill the reservoir at a level higher than surrounding ocean. The potential energy thus available in the reservoir is captured by the low head turbines which further generates the electricity. The discussion covers the design, assembly and performance calculation of the buoyant moored devicealongwith overtopping system. This paper comprises the working and information of the main components of the system.*

***Key Words*:Buoyant moored device, Overtopping system,Renewable energy, Wave power, Electricity**

1.INTRODUCTION

The consumption of energy all over the world is estimated to rise over the next decades. The conventional methods of energy generation are contributing to severe environmental effects that are still obscure. The jeopardy of further use of fossil fuels have brought renewable energy technologies under a spotlight. The renewable energy resources like wind, solar, ocean, biomass and geothermal heat are among the emerging resources of energy in today's world. After wind, solar and biomass energy, ocean energy is the most imminent resource of energy. Upto 70 percent of earth's surface is covered up with oceans which constitutes ample amount of energy in the form of wave, tidal, marine current and thermal gradient. The wave energy is developed due to the winds interacting with the surface of the ocean. The process of wave power extraction does not produce any waste or emit CO_2; it does not induce any noise pollution and is also ecological. Also, compared to other renewable energy resources, wave energy can yield power throughout the year. The energy flux attainable in the wave energy is more then that attainable from solar, wind, and other renewable sources. Out of the vast amount of energy stored in waves, only a little amount of it is used for commercial electricity generation today. This largely untouched resource could play a vital role not only in compensating for depleting energy sources but provide a solution to the ever-increasing demand for electricity. It is clean and more reliable than other renewable resources such as wind, solar and biomass.

1.1 Buoyant Moored Device

The buoyant moored device is a mechanical device that is responsible for the conversion of energy in ocean waves to electrical energy. It also undergoes motion as per the motion of the waves at a particular time. The device constitutes of a piston-cylinder arrangement, actuating mechanism, foundation and tether pipes. The device is anchored to the sea floor with a strong foundation. Various mechanisms are employed to generate electricity via turbines. The basic mechanism involved is the application of pumps supplying seawater under pressure to the overtopping system in order to drive the turbines.

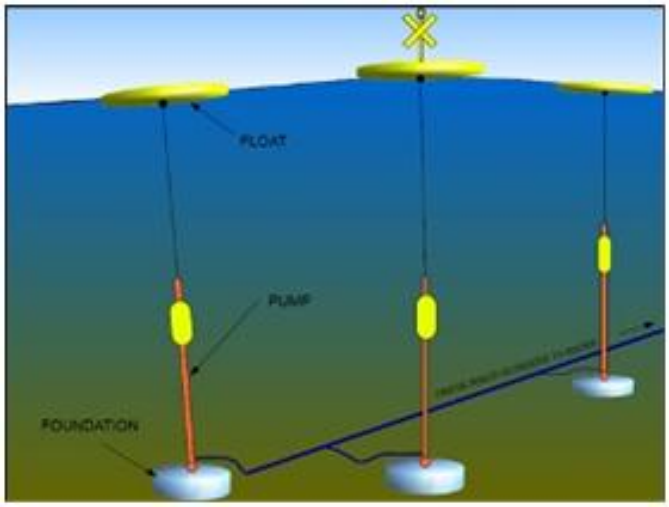

Fig -1: Bouyant moored device

1.2 Overtopping System

The overtopping system uses the wave to fill the reservoir which is at a higher level than surrounding ocean. Due to the water stored at a height there is potential energy flux available in the stored water which is then used to run a turbine having a low head. The system consists of a reservoir, a turbine, a generator coupled with the turbine shaft and connecting pipes. In this project, the design of an overtopping system has been improved in the way that the

seawater which is pumped from the moored device is stored in the reservoir onshore and not within the seabed itself. Also, the turbine and generator assembly is situated near the reservoir so that the water from the turbine exit can be reused for other purpose like desalination of seawater.

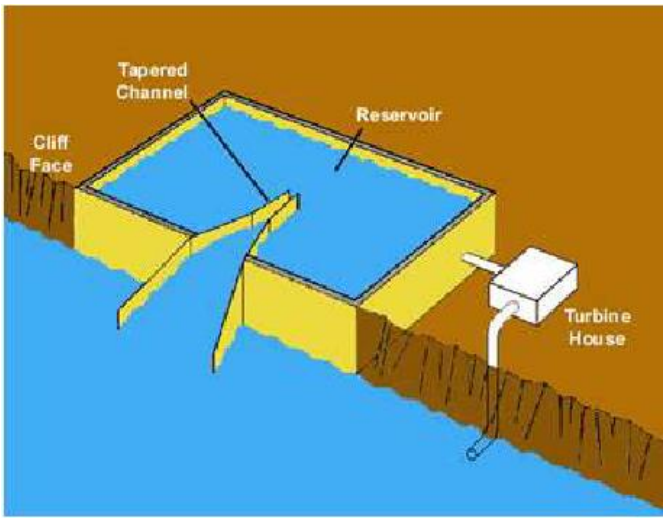

Fig -2: Overtopping system

2. CONSTRUCTIONAL DETAILS

This topic discusses the constructional details, working and information regarding the main components of the system.

2.1 Piston Pump

Piston pump is a piston cylinder arrangement is a part of buoyant moored devicein which piston is arranged to reciprocate as its piston rod is actuated by a float when float moves up as a rising wave passes and it pulls the piston upward. When the float moves down it pushes the piston downward and partial vacuum generated at the end causes the inlet port to open and allow the fluid to flow in. The fluid is then pressurised again by the upward motion of piston which closes the inlet port and opens the outlet port simultaneously to pump the pressurised water. The piston pump mechanism pumps the pressurised water to an elevated overtopping system. The mechanism is made up of acrylic material. The pressurised water is delivered through flexible pipes to the reservoir of overtopping system.

2.2Reservoir tank

The reservoir tank is a part of the overtopping system whose function is to store the pumped water from the piston pump mechanism. It serves to create the potential energy from the stored water. The water is then made to rotate a pelton turbine which is coupled to the generator shaft and finally generate electricity. The tank is made up of plastic. The height of the reservoir tank from ground which is also called the head is 2 metres.

2.3 Turbine

The water stored from reservoir tank is made to pass through delivery pipes to rotate a turbine. The type of turbine used for the project is Pelton wheel turbine. The pelton wheel turbine is made up of nylon 6 material. The pelton wheel rotates the generator shaft which in turn generates electricity.

Technical Specifications:

- Turbine type: Pelton wheel turbine
- Material: Nylon-6
- No. of blades: 10
- Outer Diameter of turbine: 4 inches

Fig -3: Pelton wheel turbine made from Nylon-6

2.4 Generator

The generator or the motor is the final component where the conversion of energy takes place into electricity. The generator used in a permanent magnet type synchronous brushed motor. The generator shaft is coupled to the Pelton wheel turbine whose rotation rotates the shaft which in turn produces the electricity in generator. The generator output terminals are then connected to battery terminals using flexible wires to store the electricity produced.

Technical Specifications:

- Motor type: Permanent Magnet type synchronous brushed motor
- High Torque
- Rated Voltage Current : DC 12V
- No Load Current: 0.2Amps (Max ~1.2 Amps)
- No load Power Consumption: 2.4 Watts (Max ~15 Watts)
- No Load Speed: 4000RPM
- Motor Shaft Diameter: 3.17mm
- Mounting Screw Hole Diameter : 3mm
- Distance between Screw Holes: 25mm
- Diameter of the Motor: 36mm
- Length of the Motor (Body): 50mm
- Length of Shaft: 16mm
- Material : Metal
- Net Weight : 150gm

Fig -4: Permanent magnet brushed motor (Front)

Fig -5: Permanent magnet brushed motor (back)

2.5 Battery

After the electricity is generated from generator it is stored in a battery. The battery used is Accuplus++ AP 12-1.3 maintenance-free sealed lead-acid battery. The battery can store up to 130mA of charge current for 10-14 hours. Since the demonstration is done on a small scale it is convenient to provide power to the testing device through a battery than to give direct power to the device. If direct power is given to the device then it may fail due to sudden changes in potential difference from the generator. While testing the battery will be completely discharged so as to get the exact results. For large scale applications the power output is given to the power grid via various transforming devices.

Technical Specifications:

- Battery type: Sealed Lead-acid battery
- Size: 97 Length (mm) x 43 Width (mm) x 57 Height (mm)
- Charging time: 20hrs
- DC Voltage rating: 12V
- Recharging Voltage: 13.5V
- Amp-Hour Rating: 1.3Ah
- Connection type: Spring terminal
- Charge current: 130mA for 10-14 hours
- Discharge current: 65mA for 20 hours rate
- Max. Discharge current: 40A for 5secs
- Cycle:
  - Voltage 14.4V~15.0V @ 20°C (68°F)
  - Temp Coefficient: - 30mV/°C
- Standby:
  - Voltage 13.5V~13.8V @ 20°C (68°F)
  - Temp Coefficient: - 20mV/°C
- Battery usage: Rechargeable
- Operating Temperatures:
  - Charge 0^{o}- 40^{o} C
  - Discharge -20^{o}- 50^{o}C
  - Standby -20^{o}- 50^{o}C
- Approximate weight: 0.57Kg

Fig -6: Sealed Lead-acid Battery

3. CONCLUSIONS

In this mechanism the loss in transmission is less since the generator unit is situated onshore. Thus we can get clean electricity using wave energy. A huge amount of electric power can be abstracted from waves than from the wind. If we analyze the power concentrated in a wave energy to the corresponding area having wind energy then we will find that wave energy is 10 times larger than wind energy.

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