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EXTRACTING THE OCEAN: WAVE ENERGY

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ABSTRACT

For thousands of years, the ocean has provided people with food and transportation. Beside this the ocean contains large amount of renewable energy in the form of temperature gradients, waves, tides, and ocean currents. At present the ocean thermal energy conversion is limited due to large. Tchnological gaps and absence of infrastructure needed for it. The wave energy is caused by the action of wind blowing over the sea surface (because of temperature difference between land and sea, by solar heating). Ocean waves are created by wind interaction with the ocean surface and is an indirect form of utilizing the solar energy, because the wind is created by pressure differences in the earth atmosphere, due to unequal solar heating. The energy which is transferred to the water by wind is kinetic as well as potential and it depends upon the wind speed, blowing time of wind, and distance of wind travel over the sea. The blowing wind creates a pressure over the surface of the ocean water and air pushes down each particle, which again comes up. So, it actually moves up and down in circular path. Every particle passes on its motion to the next. This movement of the water particles produces a pattern, which we see as wave. These waves travel a long distance as they propagate and are continuously strengthened by the new wind as they pass and retain their energy even winds die down. The ocean wave energy is created because of periodic to-and-fro, up and down motion of water particles in the form of progressive waves. It is important to note that water does not travel with wave while the disturbance or wave travels in wind direction. The height of the waves depends on the speed of the wind. These waves develop for a few seconds and get super imposed on ocean water.

Keywords: Temperature Ggradients, Renewable Energy, Solar Energyetc.

Figure.1: Wave Energy

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I INTRODUCTION

The power of wave can be converted to electricity by mechanical means and harnessing this oceanic energy of waves has been developed over the past 30 years using wave machines. The highest energy waves are concentrated off the western coasts in the 40^0 degree - 60^0degree N & S latitude range. The power in the wave fronts varies in these areas between 30 and 70kW/m with peak value 100kW/m in the Atlantic SW of Ireland off Cape Horn. The capability to supply electricity from this resource is such that, if harnessed properly, 10% of the current level of world supply could be provided. Work is still needed to capture by other products (such as pumped water for desalination or electrolysis). The application of wind energy lies in the field of electric generation, seawater desalination, hydrogen production etc. as the waves approach the shorelines, the power output decreases because of frictional losses at sea bed. However, harnessing the power will be easier.

II. OCEAN WAVE ENERGY

Ocean waves are periodic, regular and moving to and fro; in up and down motion in the ocean, large lakes etc. in the form transverse waves. The ocean waves originate at surface of ocean due to local or planetary wind, a storm etc and move in the direction of the wind towards the shore. The period of recurrence of these waves is 4-12 seconds and occurs to the height of 0.2-4.0 m and may reach to the height of 10m, during storm and gust and is dangerous. Figure 1, shows the motion progressive wave propagating in the forward direction forming crust and trough. The direction of wave is perpendicular to the crust line and the crust line moves in a horizontal plane with the velocity (v). The crust and trough repeats after a periodic interval (t).

The velocity of wave is given by, $V=T \times \lambda$ m/s

The wave period, $T= 1/f$ per second

λ = wave length

Where f = frequency of wave.

The wave length, $L =1.56T^2$

The expression for Kinetic energy (J) associated with wave is given as:

$$KE=1/4\ pA^2\ \lambda\ W\ g$$

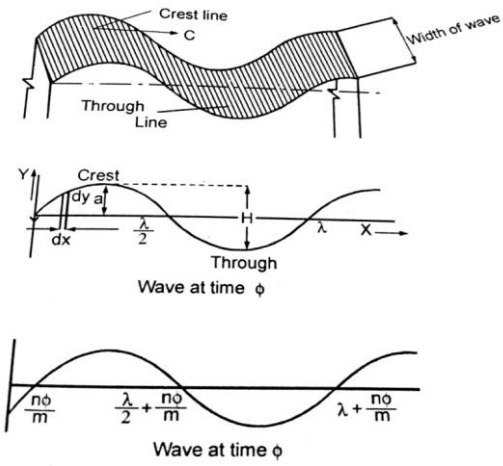

Figure .2: Analysis of Progressive Ocean Wave

The potential energy (J) associated with wave,

$$PE=1/4\ p\ A^2\ \lambda\ W\ g$$

The total energy associated with wave,

$$TE=PE+KE$$

$$TE=1/2\ p\ A^2\ \lambda\ W\ g$$

Where, p=density of water=1025 kg/m^3

A=amplitude of water (m)

W=width of wave parallel to crest line

g= gravitational acceleration

Power associated per unit area per unit time(power density). =Total Energy/ λ WT

$$=1/2\ pgA^2\ f\ (W/m^2)$$

Where λ W= wave area.

The pattern of water particles while propagating is circular or elliptical depending upon the depth of water from mean sea level and as depth (h) increases the particles trace circular path. However the effect of wave is maximum at surface and minimum at bottom and the diameter of circulation increases as the particles travels upwards. The energy available depends on the size and frequency of water and it is estimated that on an average basis it is about10kW for every 1 m of the front wave.

III.WAVE ENERGY SYSTEMS

The wave energy is in the form of motion of the water particles and can be converted to mechanical form or some other form by using wave machines. The wave energy is difficult to collect because of wide fluctuation in frequency and amplitude at any point. There are number of wave energy offshore system used to extract the wave energy via an interface that transfers the force of wave to mechanical motion. The wave energy systems constructed with flexible morning and transmission cable as the devices are floating type and float near or at the surface of ocean to extract maximum power of the incident wave. The most promising devices to meet the demand of local coastal areas are given below:

3.1 OSCILLATING WATER COLUMN DEVICE

figure.3 shows the oscillating water column device. The oscillating column of water pushes the air above the water column and these oscillations of air transferred to the air turbine connected to it. The atmospheric air moves inside the column when waves fall and goes out when waves rise. The velocity of air oscillating can be further increased by decreasing the cross sectional area of the channel through which air passes the turbine and becomes an added advantage.

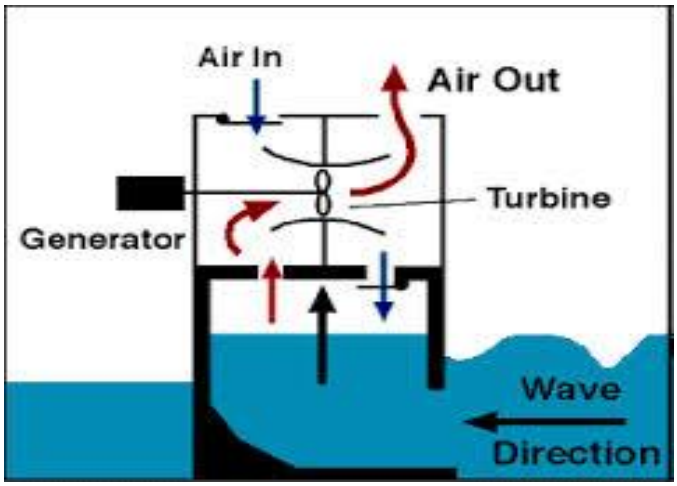

Figure.3:Oscillating Water Column Device

3.2 PELAMIS

The pelamis device shown in figure.4 is intended for general deployment offshore and is designed to use technology already available in the offshore industry. It is composed of hollow cylindrical sections joined by hinged joints .The energy is extracted by hydraulic rams as waves run down the the length of the device and actuate the joints that drive hydraulic motor via an energy-smoothing system.The full-scale version has a continuously rated power output of 0.75MW.The slack-moored device will be around 130m long and 3.5m in diameter.

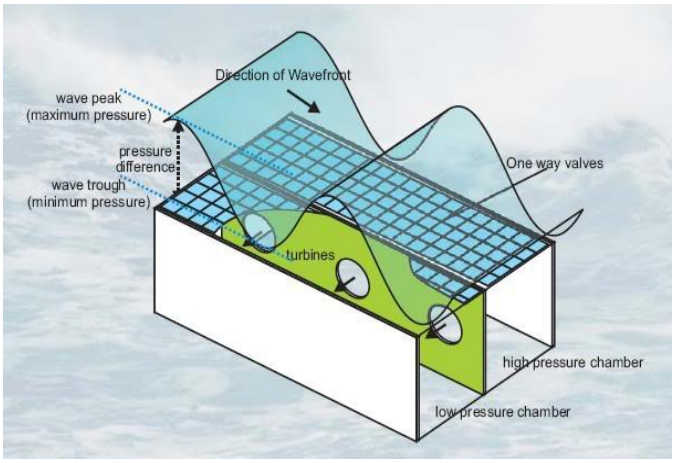

Figure.4: Pelamis System

3.3 HOSE PUMP

The device is shown in figure.5 consists of elastomeric hose, which reduces its volume when stretched .The system floats near the surface by means of float. While oscillating with the surface waves, the water gets pressurized in the hose and is fed to the turbine runner placed at bottom of the hose through non returnable valve.

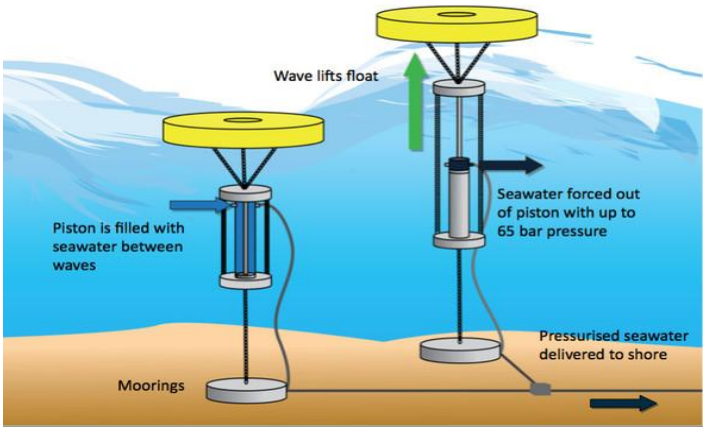

Figure.5:Hose Pmump System

IV.ADVANTAGES AND DISADVANTAGES OF WAVE ENERGY

The wave energy has the following advantages and disadvantages:

ADVANTAGES:

1. It is a concentrated form of energy and can naturally accumulate over time.
2. It is an eco-friendly renewable source of energy.
3. No space coverage on land as required by wind and solar devices.
4. large concentrated power carried in wave's motion.
5. The running cost is negligible as this energy is available free of cost.

DISADVANTAGES:

1. The device operates in ocean and needs consideration for construction, maintenance, and reliability.
2. Wave machines have to withstand the sudden storms and other climate changes that develop fatigue stress on the system and decrease its life.
3. Capital cost of system is more.
4. Problem in maintenance occurs.

V. STATUS OF WAVE ENERGY IN INDIA

The Indian wave energy programs started in 1993 under the scholarship of the department of ocean development, government of India. Initial research was conduct on three types of devices: double float system, single float vertical system and the oscillating water column (owc). It was found that the oscillating water column was the most suitable for Indian conditions and development activities have concentrated on this type of wave machines. The wave power potential of Indian sites varies from 5 kW/m to 47kW/m depending on their location. A 150kW pilot OWC was built on the violent water of the 'Vizhinjam' near Trivandrum in1991.The scheme operated successfully and the design of a superior generator and turbine was started using the data of this plant and an improved power module was installed as 'Vizhinjam' with a total electric capacity of 1.1 MW.

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