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Wave Energy Conversion Device

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Abstract: - **Ocean contains energy in the form of waves and tidal currents. Both can be harnessed to generate electricity. Differential heating of the earth causes pressure differences in the atmosphere which results in the generation of winds. As winds move across the surface of open bodies of water, they transfer some of their energy to the water and results in the formation of waves. The amount of energy transferred and the size of the resulting wave depends on the following factors:-**

a) The wind speed
b) Time for which the wind blows
c) The distance over which the wind blows

In order to extract this energy, wave energy conversion devices must create a system of reacting forces, in which two or more bodies move relative to each other, while at least one body interacts with the waves. There are many waves that such a system can be configured. Wave Energy Conversion (WEC) devices can be characterized in terms of their location. These are:-

a) At the shoreline
b) Near the shoreline
c) Off – shore

Various Wave Energy Conversion devices are classified as follows: Point Absorbers, Attenuators, Overtopping device, Oscillating Surge Water Column (OSWC) and Oscillating Water Column (OWC). Wave power devices extract energy directly from surface waves or from pressure fluctuations below the surface. Energy extracted from the waves is stored in generators. Wave energy can be converted into electricity through both offshore and onshore systems.

Key Words: Generation of Winds, Wave Energy, Wave Power and Oscillating Water Column.

INTRODUCTION

With a vast worldwide resource, (estimated to be of the order of 2 TW), wave energy can contribute significantly to reduce the dependency on the available fossil fuels and thereby decreasing its harmful environmental impact. For wave energy to become a fully-fledged renewable, however, work along two things is very important. First, the resource must be assessed in detail. Second, efficient and reliable wave energy converters (WECs) must be developed. After briefly presenting the fundamentals of the wave resource, this paper examines wave energy conversion technologies from different angles. Four classification criteria are proposed to systematize this variety and these are based on the installation site, the principle of operation, the energy capture system or the position of the latter relative to the waves.[1] Hence, this paper deals with the devices which will harness the wave energy into electricity.

The dependency on fossil fuels for energy production has brought about a number of serious effects on the environment such as: (i) excessive emission of greenhouse gases that contribute to accelerate climate change, (ii) impending exhaustion of fossil fuels, (iii) geopolitical issues related to the control of the reserves of the fossil fuels. Moreover, the continuous fluctuations of the price of oil have a negative impact on the global economy.

Therefore, we have to reduce the dependency on the available fossil fuels by adopting and utilizing the renewable sources of the energy such as wave energy.
There are three different kinds of the waves in the ocean: (1) wind waves, (2) seismic disturbance waves or tsunamis, and (3) tidal waves. The term “wave energy” refers to the energy associated to wind waves. The differential heating of the Earth’s atmosphere by the Sun gives rise to winds, which in turn generate waves in a complex energy transfer. The energy potential of wind waves has long been recognized. For wave energy to become fully-fledged renewable, work along two lines is necessary: (1) the resource must be assessed and (2) reliable and efficient Wave Energy Converters (WECs) must be developed. Research has to be done for developing wave energy conversion devices in order to harness the wave energy into electricity and many other usable forms. It is essential to carefully consider its environmental impact and to ensure that its exploitation is compatible with the preservation of the marine life. Using waves as a source of renewable energy offers significant advantages over other methods of energy generation.
There are a number of technical challenges that need to be overcome to increase the performance and hence the commercial competitiveness of wave power devices in the global energy market.[2] A significant challenge is the conversion of the slow (~0.1 Hz), random, and high-force oscillatory motion into useful motion to drive a generator with output quality acceptable to the utility network. There is a large number of concepts for wave energy conversion; over 1000 wave energy conversion techniques have been patented in Japan, North America, and Europe. Despite this large variation in design, WECs are generally categorized by location and type.

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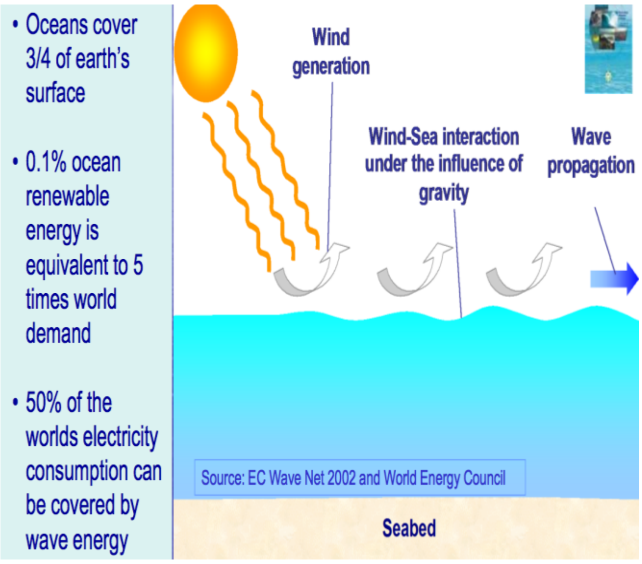
Figure 1: Wind Energy Formation



PROBLEM STATEMENT

The dependency on the available fossil fuels should be reduced and this can be done by utilizing the energy of the waves and transforming it into usable form with the help of Wave Energy Conversion Devices (WECs).[3]

OBJECTIVES

1) To reduce the dependency on the available conventional sources of energy.
2) To utilize the energy of the waves generated in the ocean.
3) To develop Wave Energy Converters (WECs) those harnesses the energy of waves and converts it into electricity.
4) The device should be installed without harming the marine organisms.

LITERATURE REVIEW

• Having discussed several criteria on which WECs can be classified, the aim is not to carry out an exhaustive study of each device but rather to review the state of the art, focusing on the most noteworthy WECs within the large variety of existing designs.
• To systematize the review, the first criterion of classification i.e. installation site is adopted. Then the principle of operation, then energy capture system and lastly according to the position.
• The conversion devices should be selected properly without harming the marine organisms and hence it should be examined.
• The following factors are now well explored and understood in the following books and the research papers:-

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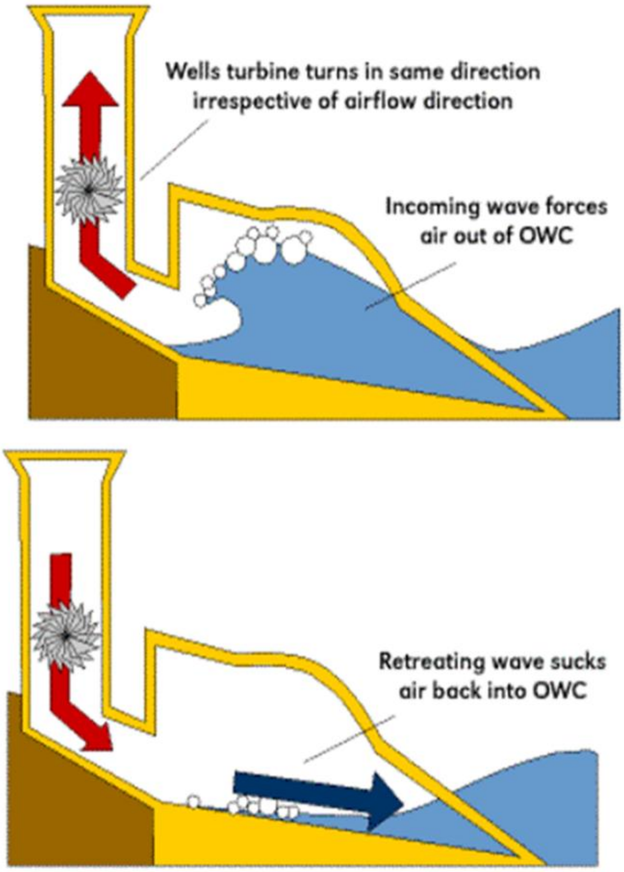
METHODOLOGY

An Oscillating Water Column (OWC) consists of a partially submerged structure that opens to the ocean below the water surface. This structure is called a wave collector. This design creates a water column in the central chamber of the collector, with a volume of air trapped above it. As a wave enters the collector, the surface of the water column rises and compresses the volume of air above it. The compressed air is forced into an aperture at the top of the chamber, moving past a turbine. [6]

As the wave retreats, the air is drawn back through the turbine due to the reduced pressure in the chamber.[4]

An OWC consists of a chamber with an opening to the sea below the water line. As waves approach the device, water is forced into the chamber, applying pressure on the air within the chamber. This air escapes to atmosphere through a turbine. As the water retreats, air is then drawn in through the turbine. A low-pressure Wells turbine is often used in this application as it rotates in the same direction irrespective of the flow direction, removing the need to rectify the airflow. It has been suggested that one of the advantages of the OWC concept is its simplicity and robustness. There are examples of OWCs as point absorbers, as well as being built into the shoreline, where it acts as a terminator. An example of a shore line mounted device is the Wavegen Limpet. The device is installed on the island of Islay,Western Scotland, and produces power for the national grid. Figure 6 shows the design of the Limpet. The OWC concept has also been proposed by Oceanlinx, an Australian wave energy developer, in a nearshore tethered device.[5]
With a user friendly design that maximizes simplicity,
• low cost to manufacture,
• low running / maintenance costs,
• seaworthy, suitable for weathering the worst conditions
• operates in a variety of sea conditions and wave directions, even with small waves
• it is modular and the production rate can easily be increased with additional units
• clean source of energy
• no offshore electrical components
• minimal offshore aesthetic impact
• can be used to desalinate water or to generate electricity

Figure 2: Working of Oscillating Water Column



METHODOLOGY OF WORKING MODEL

The various parts of the working model are as follows:

- PVC pipe: It is 1.5 foots long and the price of the PVC pipe is Rs. 60 per foot.
- Wells Air Turbine: It is a bi-directional turbine which can rotate in both the directions in order to produce the electricity and hence maximum efficiency can be achieved. The cost of the wells turbine is Rs. 2000.
- Regulator: It is a device which is used for controlling the fluid flow. The 12 volt and 1.5 Ampere standard regulator having manufacturer no as L7812CV is shown below. The price of the regulator is Rs. 30 .
- Bridge Rectifier(1N4007): It is used in order to convert AC source into DC source. The cost of the rectifier is Rs 140.
- Alternator: An alternator is an electrical generator that converts mechanical energy to electrical energy in the form of alternating current. The cost of the alternator is Rs. 680.
- LED: It is a 2 W LED which gives the indication whether the current is generated or not.

WORKING OF THE MODEL

- When the air is passed through the blower, it rotates the Wells turbine due to which mechanical energy is converted into the electrical energy in the form of Alternating Current. Due to the use of the bridge rectifier we receive the output in the form of DC.[7]
- The regulator regulates the fluid flow and whenever the current is generated, the LED lights up thereby giving the indication.
- It can generate 15 Watts in one hour at 8000 RPM.

AIR BLOWER

Industrial fans and blowers are machines whose primary function is to provide and accommodate a large flow of air or gas to various processes of many industries. This is achieved by rotating a number of blades, connected to a hub and shaft, and driven by a motor or turbine.

An air blower is basically used to show whether the model is working or not. It acts as the wave energy and therefore the requirement is fulfilled.

Figure 4: Specifications of an Air Blower

Figure 5: Regulator

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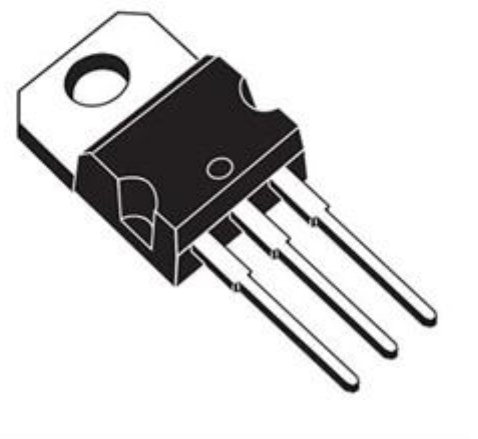

Figure 6: Bridge Rectifier

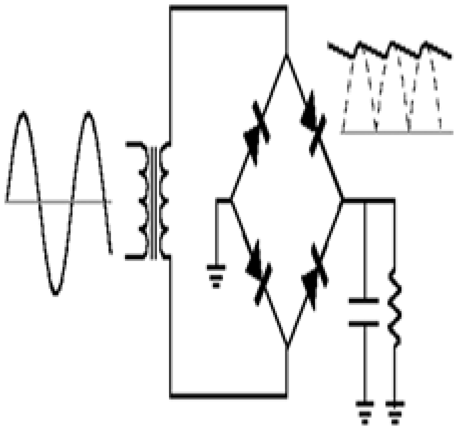

Figure 7: Alternator

Figure 8: Schematic Diagram of Oscillating Water Column

CONCLUSION AND ITS FUTURE SCOPE

The potential for generating electricity from wave energy is considerable. The ocean is a huge resource, and harnessing the energy in ocean waves represents an important step towards meeting renewable energy targets. This review introduces the current status of WEC technology. The different device types are established and evaluated. The institutions and companies involved in WEC development, as well as collaborative wave energy projects, are also identified There are, however, various design challenges such as efficiency and reliability.

A linear electrical generator provides an alternative option, but the technology is less mature. The active control of a WEC can significantly increases its efficiency, and hence cost effectiveness. This research is currently ongoing with latching control being highlighted as a promising, simple method of efficiently extracting energy. Despite considerable research and development, the concept for converting a slow, high-force, reciprocating motion to one useful for generating electricity show no signs of converging to a preferred solution. Future research should take a systems engineering approach, as the individual subsystems of a WEC are all intimately related and any one should not be optimized without considering the other subsystems. Furthermore, individual WECs will often operate as part of a wave farm, so future system analysis must include the interaction between devices.[8]

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