MODIFICATION OF WAVE ENERGY CONVERTER USING BUOY

[1]A.ANISH, [2]JEBILASH DAVID.R, [3]GIRISH.V.L

[1]Assistant Professor, Department of Mechanical Engineering, Ponjesly college of Engineering Nagercoil, Kanyakumari, India

[2]Student, Department of Mechanical Engineering, Ponjesly college of Engineering Nagercoil, Kanyakumari, India

[3]Student, Department of Mechanical Engineering, Ponjesly college of Engineering Nagercoil, Kanyakumari, India

Abstract - Electrical power has become a primary necessity. Energy from ocean waves remains largely an untapped resource. The aim of the project is to generate electricity from waves. The wave energy converter (WEC) captures energy contained in the ocean waves to generate electricity. The electrical energy is generated from the mechanical work harnessed from the waves by using generator. The power production depends upon the intensity of the waves. Traditionally, in wave energy converters only the vertical motion of the buoy is converted into electricity. But in this method both the vertical and horizontal motions of the buoy is converted into electricity. The mechanism used here is the rack and pinion mechanism. The setup consists of rack and pinion, gear assembly, DC generator and a rectifier circuit. The buoy is fixed with the rack and pinion setup which in turn is coupled with the gear assembly and it is coupled with the generator. The gear assembly is used to increase the input speed of the generator shaft. The rectifier circuit is used to change the polarity of the current produced. A maximum of 12V can be produced. In this paper both the vertical and horizontal motions of the buoy is converted into electricity.

Keywords – Wave Energy, Wave Energy Convertor, Bouy.

I. INTRODUCTION

Renewable energy is generally generated from natural resources which are replenished such as wind, solar, biomass, and tidal power. A large amount of time and money is getting invested by researchers in designing and improving renewable energy devices, some of which are wave energy harvesters. Wave energy is one of the largest available and consistent energy all year round. Wave energy has more advantages compared to other types of renewable energy. Wave energy has more advantage over solar energy for example it is available at night and not only during the day. Many wave energy devices are being investigated, but many are at the R&D stage, with only a small range of devices having been tested at large scale, deployed in the oceans. Energy density is the high when compared to other renewable energy sources. Ocean wave power can be converted into electrical energy by different methods namely: (i) Oscillating water columns (ii) Oscillating bodies and (iii) Overtopping devices. From the recent studies, the usage of point absorber is used to harness wave power. Wave energy converters can be arranged in number of rows or in a farm to generate a good amount of power. Different types of wave energy converters are classified by their mechanical structure and how they absorb energy from ocean waves. A lack of convergence is there in the best method of extracting energy from the waves but previous innovations are generally focused on the design and concept of the primary interface, questions arises concerning how to optimize the power train to get the best results. This paper concludes with some suggestions about future developments. S. Chandrasekaran[1] at., carried out an experimental investigation on a scaled model of the proposed wave energy converter for different wave period, height, and lever arm length and angle of the buoy with reference to the wave approach angle. Mechanical and electrical outputs of the system were recorded for different wave heights varying from 0.24-0.30 m for a time interval of 3 s. The results showed that there was an increase in the power output for increase in wave heights. Nolte[2] et al., investigated on the real time experimental data collected and analyzed to determine the power generation profile and the WEC system's heave surface elevation, displacements, and heave response amplitude operator (RAO) for both cases. A numerical modelling program was built to perform hydrodynamic analysis in the time domain in irregular seas for the single-body or double-body case. The program solves for each individual body motion. It is used to predict the WEC device's power production over the time period. Joseph Yousse[3] carried out an experimental analysis on a harvesting wave energy convertor by building a prototype and testing it in shallow water near the shore to light up a 3-W lamp. The mechanical design of the device along with the operation process was presented in details and the test results showed increase in power generation. BDrew[4] carried out a review which introduced a general status of wave energy and evaluated the device types that represent current wave energy converter (WEC) technology, particularly focusing on work being undertaken around the United Kingdom. Leao Rodrigues[5] described a brief description about wave formation and their power quantifying across each meter of wave front associated to the wave, it also described several devices used presently to extract mechanical energy from the waves.

II. METHOLOGY

Before fabrication of the project it is important to design the different types of components used in the project. The following design considerations were undertaken before fabrication they are as follows.

1. The device should be suitable for local manufacturing capabilities.
2. The attachment should employ low-cost materials and manufacturing methods.
3. It should be accessible and affordable by low-income groups, and should fulfil their basic need for mechanical power.
4. It should be simple to manufacture, operate, maintain and repair.

The flow diagram at Figure.1 represents the working mechanism of the system.

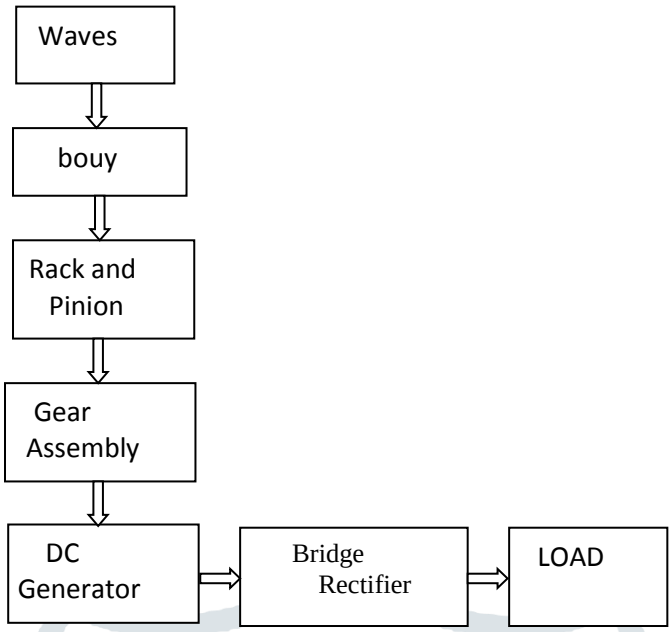

Figure.1. Working Flow Diagram

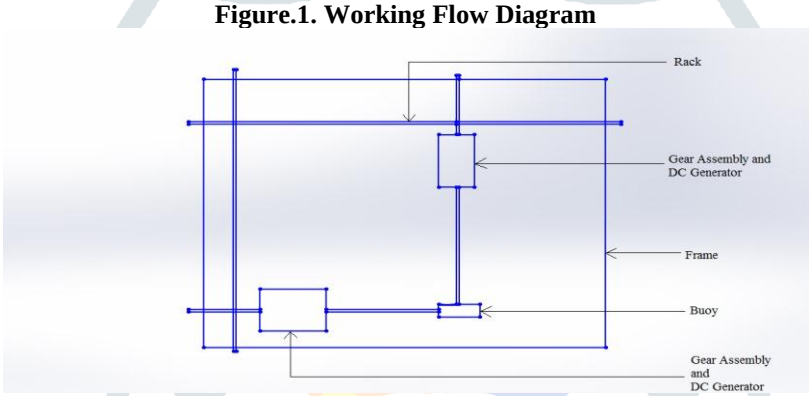

Figure.2. Line Diagram

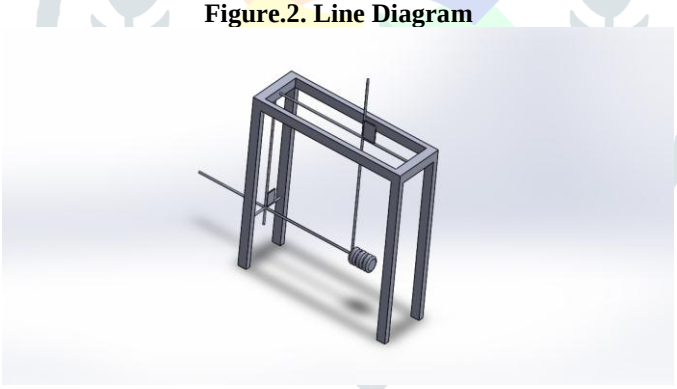

Figure.3. Wave Energy convertor

Components Used

- Frame
- DC Generator
- Buoy
- Gear Assembly
- Rack and Pinion
- Bridge Rectifier

Materials Used

The various components Materials that are used for the fabrication are as follows.

Table.1.Materials used

Components	Materials Used
Frame	Galvanized Iron
Pinion	Plastic
Rack	Stainless Steel
Rod	Mild Steel
Buoy	Polyurethane Elastomer
Gears	Plastic

Component Specifications

1. Frame:
   - Length of frame = 900 mm
   - Breadth of frame = 300 mm
   - Height of frame = 900 mm
2. Buoy:
   - Length of buoy = 200 mm
   - Diameter of buoy = 100 mm
3. Rack and Pinion:
   - Length of rack = 900 mm
   - Number of teeth in pinion(z1)=60
4. Gear Assembly:
   - Number of teeth in gear 1(z2)=20
   - Number of teeth in gear 2(z3)=40
   - Number of teeth in generator
   - Shaft (z4) = 15
5. DC generator:
   - Voltage = 12 volt
   - Torque = 2.1 Nm
   - Input rpm = 1000 rpm
   - Full load current = 0.3 A

Modal Calculations

1. Gear ratio = 1:8
2. Output Speed N = 480 rpm.
3. Torque in buoy:
   Force in wave = 50 N
   Distance moved by buoy =700 mm
4. Torque= Force * Distance moved by buoy
   = 50 * 700
   = 35000 Nmm
5. Input Torque to pinion = 35 Nm
6. Input Torque to Generator:
   Torque = Input Torque * Gear Ratio
   = 35 * 1/8 = 4.375 Nm
7. Power Produced from Generator
   Power = 219.91 * 0.017
   Power produced =3.73 watts

Case (1):

When, H = 3 m and T= 8 sec
Power of wave = 35.46 KW/m

Case (2):

When, H = 8 m and T = 14 sec
Power of wave = 65.56 KW/m

Case (3):

When, H = 15 m and T = 20 sec
Power of wave = 95.78 KW/m

Figure.4. View of the Wave Energy Convertor

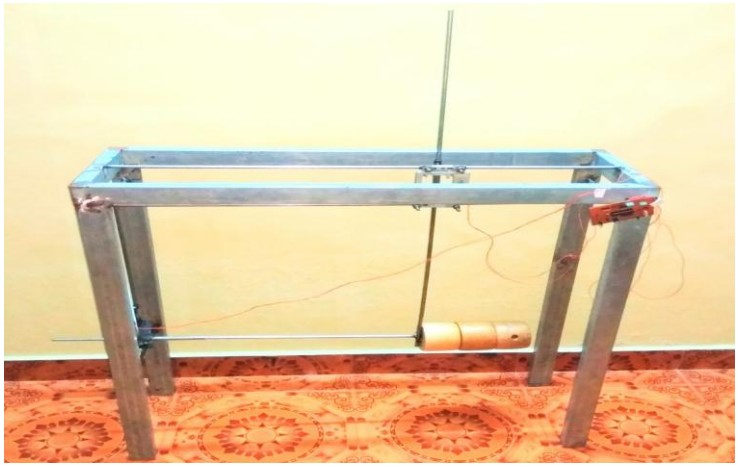

Figure.5. View Of The Wave Energy Convertor

Working Procedure

- The experimental setup is mounted on the ocean floor or at a certain depth from the water level.
- The waves strike the buoy and according to the force exerted by the waves the buoy moves forward, backward, upward and downward.
- First let us consider the vertical motion of the buoy. When a wave strikes the buoy, it pushes the buoy upwards and then pulls downward.
- The pinion in vertical assembly moves over the rack. The pinion is coupled with the gear assembly which in turn is coupled with the DC generator.
- The polarity of the current produced will be changed when the pinion rotates in the opposite direction.
- Hence the current produced by the generator is passed through a bridge rectifier which reverses the polarity. Hence during both the upward and the downward motion of the pinion, electricity can be generated.
- The mechanism used here is the rack and pinion mechanism along with the gear assembly since only few rotations is obtained in the pinion.
- The process is similar in the horizontal motion of the buoy. When a wave strikes the buoy, it pushes the buoy forward and backward.
- Due to this movement, the pinion in the horizontal assembly moves over the rack. Here too, the pinion is coupled with the gear assembly and finally coupled with the DC generator.
- The generator produces electricity during the rotation of the pinion in both directions and hence a bridge rectifier is used.
- Finally, the current generated is given to the load connected in the circuit. Thus the Wave Energy Converter is used for electricity production.

III. CONCLUSION

The initial goal of the project was accomplished, as this is a solution to the sea shore areas. Once you have built it, the energy is free because it comes from the ocean's wave power. The potential of the concept has been proven to function. This design fills the functions required for wave energy conversion in sea shore areas. It represents a new method of generating wave power to produce electricity. The work and the results obtained so far are very encouraging and reinforce the conviction that wave energy conversion systems are practical and potentially very contributive to the production of electricity from the wave even in continuous working conditions. It is proposed that the equipment may be constructed using high-strength, low- weight materials for better power production.

REFERENCE

[1] S. Chandrasekaran and B. Raghavi, "Design, Development and Experimentation of Deep Ocean Wave Energy Converter System.", Energy ProcediaVolume 79, November 2015, Pages 634-640.

[2] Nolte, Jerica Dawn, "In ocean experiments of a wave energy conversion device with a drogue and wave power calculations", [Honolulu], [University of Hawaii at Manoa], [August 2013].

[3] Joseph Youssef, Jean Matar, Pierre Rahme,Charbe Bou-Mosleh, "A Nearshore Heaving-Buoy Sea Wave Energy Converter for Power Production.", Procedia Engineering,Volume 145, 2016, Pages 136-143.

[4] BDrew, A R Plummer, and M N Sahinkay. "A review of wave energy converter technology", Proc.IMechE Vol. 223 Part A: J. Power and Energy.

[5] Leao Rodrigues, "Wave power conversion systems for electrical energy production", RE&PQJ, Vol. 1, No.6, March 2008.

[6] Alain Cle´ment, Pat McCullen, Anto´nio Falca˜o, et al. Wave energy in Europe: current status and perspectives. Renewable and Sustainable Energy Reviews 2002; 6(5):405–431.

[7] T. W. Thorpe. A brief review of wave energy, Technical report no. R120, Energy Technology Support Unit (ETSU), A report produced for the UK Department of Trade and Industry 1999.

[8] B Drew, A R Plummer, M N Sahinkaya, "A review of wave energy converter technology". Proceedings of the Institution of Mechanical Engineers, Part A. Journal of Power and Energy 2009; 223(8):887-902.

[9] R. Sabzehgar and M. Moallem, "A review of ocean wave energy conversion systems," Proceedings of the IEEE Electrical Power and Energy Conference, 2009, pp. 1-6, Montreal, Canada, October 22-23, 2009, doi:10.1109/EPEC 2009.5420927.

[10] J. Falnes. "A review of wave-energy extraction," Mar. Struct., vol. 20, 2007, pp. 185-201.