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PROTOTYPE OF INTEGRATED POINT AND DUCK WAVE ENERGY CONVERTOR

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ABSTRACT

The research explained in this project was carried out to analyze and design a point absorber wave energy convertor that has ability to survive extreme weather conditions and the need to achieve cost-efficiency while achieving high capacity. In this project an attempt is made to integrate the two technologies of wave energy convertor to achieve greater electricity production. An approach is made to minimize the cost of production of wave energy convertor. The two technologies are merged to gain the advantages of both in simple and efficient way.

KEYWORDS: Buoy, Duck, Point Absorber, Renewable Energy, Wave Energy Converter

INTRODUCTION

With the increasing population use of fossil fuel increases which leads tos green house effect. Different country working on renewable energy sources, wave energy is one of them which have high potential to remove crisis of power. To harness the wave energy convertor are use which convert the kinetic energy of wave into electrical energy with the help of mechanical devices. To efficiently harness the untapped wave energy around the Indian coastline, a wave energy converter is developed as part of this research. This converter should assist the government in reaching its goal of establishing a renewable energy industry. India have large scope in this field because of 7500km of coastal line yet only two experimental project are working in this field by Center for Earth Science Studies, Trivandrum, Kerala and IIT madras based on tidal energy. The Indian ocean have local short wave; lacking in kinetic energy thus devices made only for long and powerful waves won't work although these device costly. The wave converter explain in this research is suitable and sensitive enough for short waves.

PRINCIPLE OF WORKING

Electromagnetic Induction**:** The Integrated point and Duck WEC works on the principle of electromagnetic induction. The Faraday's has given two laws known as Faraday's law of Electromagnetic Induction. First Law:- Whenever the magnetic flux linked with a circuit changes, an e.m.f. is always induced in it. Or whenever a conductor cuts magnetic flux, an e.m.f. is induced in that conductor. Second Law:- The magnitude of the induced e.m.f. is equal to the rate of change of flux-linkages.

CONSTRUCTION

A square buoy is mounted with the generator . Buoy consist of hole at the centre through which the rope is passed, the one end of this rope is fixed to the bottom of sea and other is connected to the generator via rack and pinion mechanism which converts the up and down motion of buoy in rotary motion which rotates the generator shaft. A spring is fixed to recoil the rack on its place. The whole assembly is fixed on the wooden body which is fitted on the buoy. Buoy is an air

filled float that is adjusted to carry the weight of the device efficiently. The four Ducks are pivoted to the Buoy along the four edges using the connecting handles which are mounted with sector pinion mechanism to rotate the generator which is fixed on the handle and rotate with the motion of Duck. All the connections are joined to the battery to store the electric charge. Ducks are the oval shaped devices which are heavy on one side in order to return to their own place after motion is completed. Ducks do not require recall spring in order to recall. Their own weight returns them to their place. The battery and generator above the Buoy can be fixed inside the plastic box in order to prevent them from the rain or splash of water.

WORKING

The main principle of this device is Electromagnetic induction i.e. when coil moves inside the magnetic field an e.m.f. is generated. The device converts K.E. of waves into Electrical energy. With the motion of wave the point absorber wave energy convertor moves vertically to and fro which operates the generator connected to the Buoy by pulling the rope and hence this motion is converted to rotary motion and produce electricity. At the same time the two ducks whose axis is parallel to the wave comes in action and moves the sector pinion on their axis which rotates the fixed generator inside the ducks. At this time the other two ducks provide stability to the device and help it to properly float on the wave.

Figure 1: Model of WEC

EXPERIMENTAL SETUP AND RESULTS

A number of tests were performed to determine the system's performance. The aim was to test the system for various wave profile inputs and to determine the influence of flow. Tests were conducted in the Hingna River to determine the performance of INTEGRATED POINT AND DUCK WAVE ENERGY CONVERTOR system. The behavior was investigated using test instrumentation. In this chapter the test equipment, experimental apparatus and testing procedures, together with the results of these, are discussed for integrated point and duck WEC.

Figure 2: Experimental Model

EXPERIMENTAL APPARATUS AND TEST EQUIPMENT

The mechanical components were mounted on a wooden platform while the Platform is fixed horizontally on buoy .ducks are connected on all four sides. Multimeter, generator, LED, scale, stop watch and note book are used as tool for analyzing the performance of experimental setup.

The multimeter is used to measure the amount of voltage generated with the motion of WEC due to wave motion. Scale is used to measure the height of waves, scale is fixed in water .the above readings are noted LED lights are also used for identification of electricity generation due to waves.

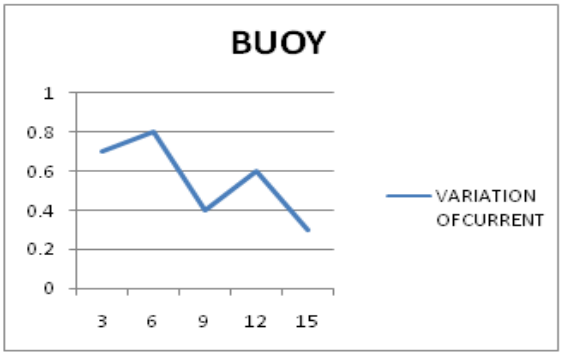
Test Performance

The WEC is laced in the river and the rope of buoy is tied to the rock at the bottom of river .the wave height, displacement of buoy and voltage generated is noted.

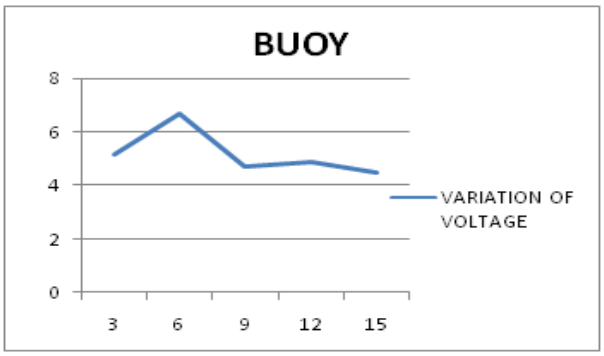
Experimental Observations and Graphs

Table 1: Observation and Graph for the Buoy

Time (In Second)	Voltage (In Volt)	Current(In Amperes)
3	5.2	0.7
6	6.7	0.8
9	4.7	0.4
12	4.9	0.6
15	4.5	0.3



Graph 2: Current vs Time



Graph 1: Voltage vs. Time

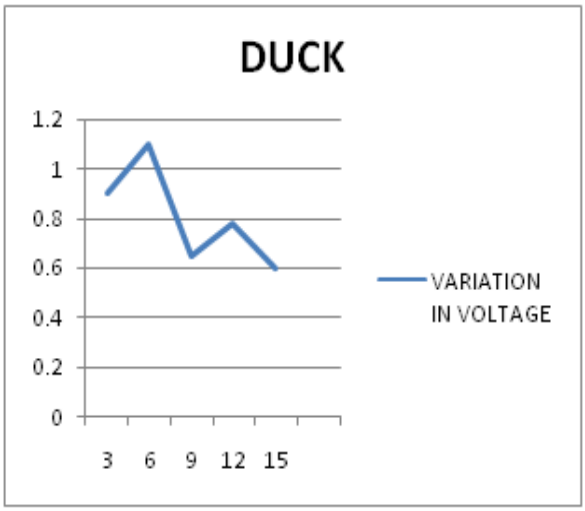
From the above graph, it clear that as the height of the wave fluctuate the voltage as well as current fluctuate with respect to time. Because of the high waves the velocity of rotation of pinion is more .The experimental model generate voltage near about 5-7 Volts and 0.3-0.7 Amperes .maximum power generated 5.44 watt.

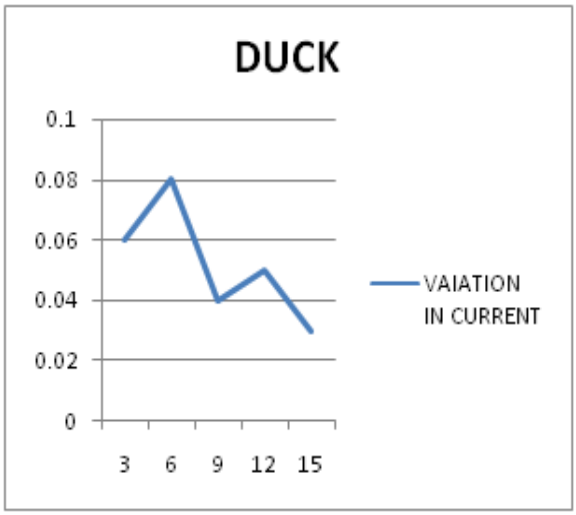
Observations and Graph for the Duck

Table 2

Time(Second)	Voltage (In Volt)	Current(In Amperes)
3	0.9	0.06
6	1.10	0.08
9	0.65	0.04
12	0.78	0.05
15	0.6	0.03

Observation Table





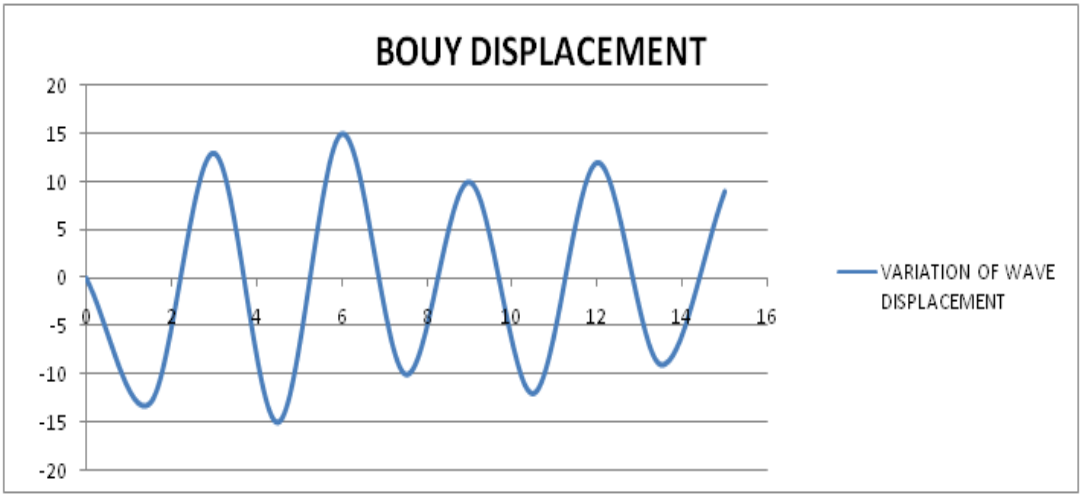
Graph 3: Voltage vs. Time **Graph 4: Current vs Time**

From the above graph, it clear that as the height of the wave fluctuate the voltage as well as current fluctuate with respect to time. The experimental model generate voltage near about 0.6-1.1 Volts and 0.03-0.08 Amperes. maximum power generated 0.088 watt.

Observations and Graph for the Dispacement of Buoy

Table 3

Time(In Second)	Dispacement
3	13
6	15
9	10
12	12
15	9



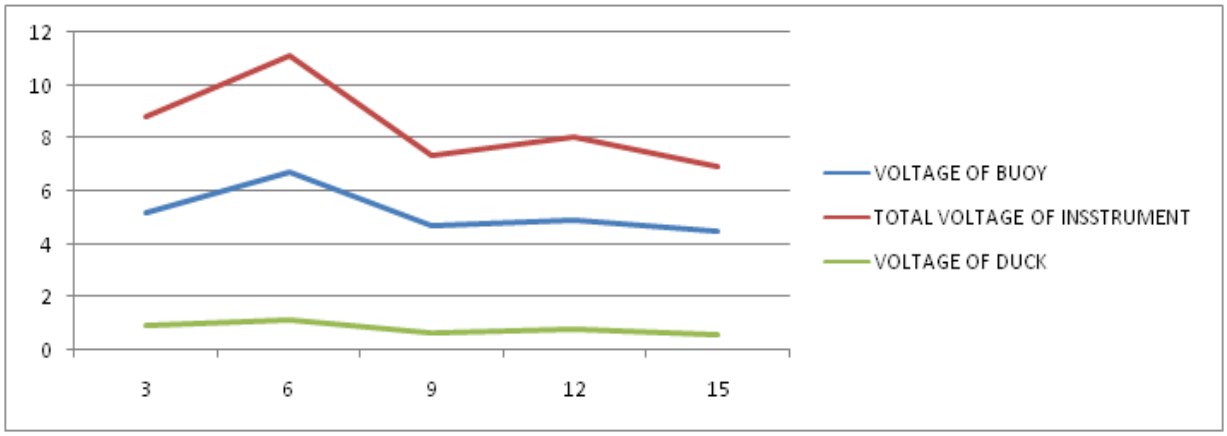
Graph 5: Dispacement vs Time

The above graph shows the displacement of wave with respect to time. It is very essential to determine the length of wave which is directly proportional to the movement of the buoy. As the length of wave increase the motion of rack also increase and transfer motion to the pinion. As much as the waves motion more will be the voltage gain.

Observation and Graph for the Buoy

Table 4: Time Vs Voltage

Time (In Second)	Voltage of Buoy (In Volts)	Voltage of Each Duck(In Volts)	Total Voltage of Instrument
3	5.2	0.9	8.8
6	6.7	1.1	11.1
9	4.7	0.65	7.3
12	4.9	0.78	8.02
15	4.5	0.6	6.9



Graph 6: Time vs Voltage

CONCLUSION: From the above graph it is clear that by integrating the two technologies the total voltage of the instrument has been increased.

RESULT

- The electricity generation increase per unit motion of wave.
- Total voltage generated by the device for the maximum height of the wave during the experiment is 8 to 11 volt.
- Maximum power generated 5.792 watt.

CONCLUSIONS

The use of ocean waves energy is in its infancy today but can lead to clean, affordable and renewable electrical power. Right now, it's probably 15 years behind wind energy, but it has a vast potential. Wave energy is a renewable energy, like solar and wind energy. The idea is that energy can be produced from these abundant natural resources and it helps to reduce the consumption of fossil fuels and pollution. The benefit of this wave project is that collector provides invaluable information about the feasibility of applying wave energy in coastal nations. There is also an educational purpose. A working display of the device helps students and the public to understand how the device works and to learn more about non-solar energy that raise awareness about wave energy among school students. While pursuing research in wave energy convertor we face lot of problems because very less research had been done in this field in India. The technology may take decade to mature but ocean energy is an option worth pursuing. Approximately 8,000-80,000 TWh/yr or 1-10 TW of wave energy is estimated to be in the entire ocean and each wave crests transmits 10-50Kw/m on an average. An estimate in 2004 claimed the expiry of global oil and gas reserves within 45 years and 65 years respectively. The continuously increasing gap between the demand and supply of electricity in India effects industrial and economic growth. The increasing industrialization, urbanization, population and global warming hence calls for an urgent need to speed up the building of emission free sources of energy in India. This will eventually require intensive research and development in wave energy conversion technology, considering its advantages over other renewable energy sources and the available untapped wave potential along the extensive coastlines of India. Such measures would open the gates for effective commercialization of wave energy in India.

In the above mention device the complexity of device is reduce by using simple mechanism for generation of electricity , which ultimately decrease the overall cost of the device and make it affordable than other device available. The device can utilize the shorter wave, due to its high sensitivity because of use of sector and pinion with belt drive. The device has its speciality that its mechanisms are from the waste product which makes it unique.

REFERENCES

1. Neelamani S., R. Natarajan and D.L.Prasanna., “Wave interaction with floating wave energy caisson breakwaters", 8th International Coastal Symposium (ICS 2004) March 14-19, 2004, Itajai-SC, Brazil
2. Raju, Ravindran (1989). The initial research conducted by the Wave Energy Group, IIT Chennai Technical report.
3. M.McCormick, (2007) Ocean Wave Energy Conversion, Dover Publications, Minola NY, ISBN-13:978-0-486-46245-5
4. J.Khan, A. Moshref, and G. Bhuyan (2009). A Generic Outline for Dynamic Modeling of Ocean Wave and Tidal Current Energy Conversion Systems. Institute for Electrical and Electronic Engineering, Piscataway, NJ, USA, pp. 6

5. A. Falcao, (2009). The development of wave energy utilization. In: 2008 Annual Report, A. Brito-Melo and G. Bhuyan (eds.), International Energy Agency Implementing Agreement on Ocean Energy Systems, Lisboa, Portugal, pp. 30-37.Energy from the Ocean and Scope of its Utilization in India 403
6. J. Khan, and G.S. Bhuyan (2009). Ocean Energy: Global Technology Development Status. Report prepared by Powertech Labs for the IEA -OES, Document T0104, Implementing Agreement for a Co-operative Programme on Ocean Energy Systems (OES-IA), Lisboa, Portugal.
7. US DOE (2010). Energy Efficiency and Renewable Energy Marine and Hydrokinetic Database. Energy Efficiency and Renewable Energy, US Department of Energy, Washington, DC, USA.
8. M. Ravindran and V.S. Raju (1997). Wave energy: potential and programme in India. Renewable Energy ;10(2/3), pp.339–45.
9. Wave power generating system, DOD's Home Page: Annual Report (1990 – 91), Section 5.5, dod.nic.in/ayr90-91/ar_env55.htm
10. Indian Wave Energy, National Institute of Ocean Technology, www.niot.res.in/ m1/mm1.html.
11. DART, www.dartdorset.org/html/tidal.shtml.
12. R. Cohen. (2009). An overview of ocean thermal energy technology, potential market applications, and technical challenges. In: Proceedings 2009 Offshore Technology Conference, Houston, TX, USA, 4-7 May 2009.
13. Bond graph modelling of a wave energy conversion system with hydraulic power take-oI Adi Kurniawan a, Eilif Pedersen Torgeir Moan Centre for Ships and Ocean Structures, Trondheim, Norway ,Department of Marine Technology, Norwegian University of Science and Technology, Trondheim, Norway
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15. Linking of wave energy utilization with coastal protection Paimpillil S. Joseph*, Baba.M.* Center for Earth Research and Environment Management, Cochin 17, India, 682017, Email paimjose@sify.com Center for Earth Science Studies, Trivandrum, Kerala, India.