Energy Harvesting from Ocean Waves by SAN-BAWEC (Simple and Nonstop-Buoyant arm Wave Energy Converter)

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Abstract:
This work gives the unique and innovative approach to extract energy from ocean wave to generate electricity, as increasing the power demand day by day in this 20th century can surely overcome by this innovative device and methodology. Many technologies and methods are available among worldwide to harvest the energy from ocean, out of all a new device SAN-BAWEC (simple And Nonstop - Buoyant Arm Wave Energy Converter) is invented, SAN-BAWEC is designed based on The Archimedes principles (say lever, Buoy). The wave energy conversion sequence is wave energy - to - mechanical energy - to - electrical energy. SAN-BAWEC doesn't include any hydraulic pumps and turbines. It just works with kinematic motion mechanism, ocean wave energy and gravitational force.

Keywords: Indian wave energy, Buoy, lever, Permanent magnetic generator, Power generation, Energy Conversion, Compound gear train, ocean wave energy, electricity, PMG

1. Introduction

The huge and enormous power of the ocean currents, waves, tides, and 'Ocean Thermal Energy Conversion' are the most overlooked and under-developed sources of alternative energy. The previous experimental works about 36 years of research on wave energy several wave energy devices are used to extract ocean wave power. (Over 175 wave energy converters devices are in the world wide, and nearly eight types of devices are constructed or proposed they are listed below) [22] [2] and experiences show that the ocean energy is more reliable than wind and solar energy. But however, the extraction of ocean energy is still challenging the engineers and scientists with challenges like, How to store and transfer the energy and as well as to ensure the integrity of the infrastructure under extreme, ocean whether, ocean depths and water conditions, As per the present situation the generation of electricity is a big challenge to the scientists and technologists, at the same time concentrating parallel on the global warming and atmospheric pollution. Wave energy has many characteristics important to the efficient generation of electricity and is considered a potentially significant contributor to the effort to meet growing human energy demands (Barstow et al. 2008).[25] In worldwide over 9 types of wave energy converters are installed in over 175 places [2]. And are popular and are in use worldwide
Those are [2]

- Attenuator
- Point absorber (PA)
- Oscillating wave surge converter (OWSC)
- Oscillating water column (OWC)
- Overtopping/ Terminator device (OTD)
- Submerged pressure differential (SPD)
- Bulge wave (BW)
- Rotation mass (RM)
- Other types

In India the 1st wave energy plant is installed at Vizhinjam, Kerala in 1990, with the capacity of 110 KW. It is OWC type. In this a squirrel case induction generator was used at which works with 1000 rpm and generates 110 KW.
Out of all these wave energy converters SAN-BAWEC is a simple and unique system to extract energy from ocean waves by eliminating the hydraulic pumps and piezoelectric. It is purely designed on basis of Archimedes principle of lever and buoyancy.
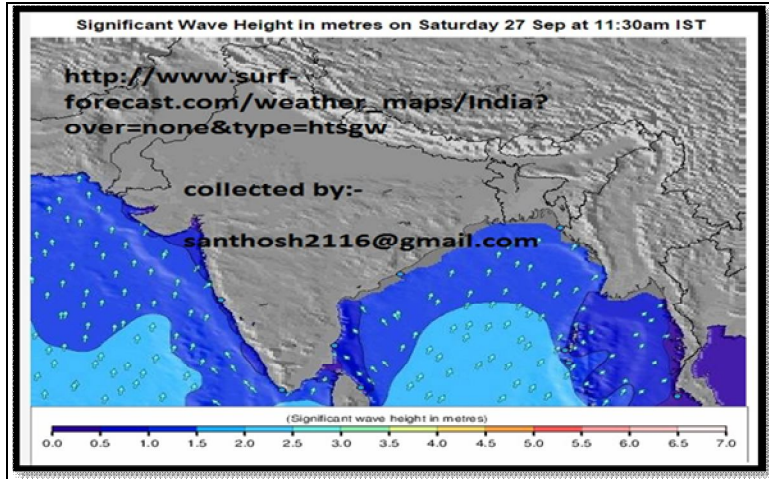
1.1. Wave energy forecasting in India

Figure 1: Wave forecast in India

The Above diagram illustrates the phenomena of wave energy around the Indian Ocean, preferably at Vishakhapatnam.

2. The Unique and Dynamic Model

Totally a new innovative concept was implemented in this paper for wave energy conversion i.e. SAN-BAWEC (Simple and Nonstop Buoyant Arm Wave Energy Converter). It will be the first wave energy converter in the Andhra Pradesh, and as well as it will be the third wave energy device in India, It consists of two parts, The first one converts the wave energy of ocean into mechanical energy .i.e. BUOY, it mainly works on the principle of Archimedes .i.e. here this arm acts as a lever. *"The* second one (Lever) converts the mechanical energy into electrical energy. Together both will be known as buoyant arm (mechanism consists of a buoy and a lever,).TRULY it looks like a simple mechanism but however at situations it is too difficult to understand, its behavior for non professionals.

Figure 2: Design layout of SAN-BAWEC

- **Design of buoyant arm (lever):** The buoyant arm works based on Archimedes lever principle with mechanical advantage of

$$Mechanical\ advantege = \frac{F \times D}{R \times d}$$
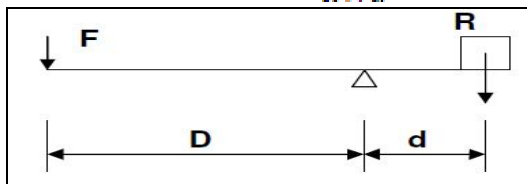
- **Wave chart:** This chart shows the information of waves like frequency and height etc…at particular date at Vishakhapatnam port. According to this chart (wave data) calculation charts has been done and results are shown in following table.
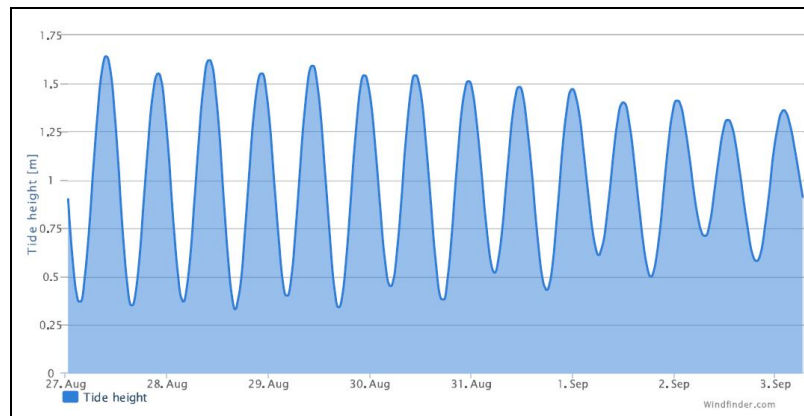
Figure 3

Sunrise: 05:41 ; Sunset: 18:15 ; Local time: 11:13 (UTC +5:30) ; Elevation: 66 m[27]

- **Design of Buoy:** The buoy performs the most important key role in this entire design. It bears the amount of weight which is equal to product of mechanical advantage of the lever to the amount of production of electrical energy from generator. It enables the lever to float on sea floor and oscillate

$$B = \rho_f \, v \, g$$

where $B = Buoyancy$

$\rho_f = density\ of\ water$

$v = volume\ of\ displaced\ water$

$g = gravitational\ force$

By using Archimedes principle:-

$$\rho_f \, v = M$$

(M = mass of buoy + mass of instrument)

(t= thickness of the Buoy shell)

$$\frac{\rho_f}{2} d_0^3 - 3(t)\rho_s d_0^2 + 3t^2 \rho_s d_0^1 - t^3 \rho_s - \frac{M_{inst}}{4\pi}$$ ------- Equation -1]

The diameter as well as the volume of Buoy can be found by using the above formula.

- **Shape of buoy:** The shape of buoy is need not to be a Half sphere but here usually a half sphere is taken for calculation, however in practical any shape can be designed, but the volume of the buoy is must be equal to the product of MA to Generator Power ,if not the design will be fail,
- **Gear train& Fly wheel:** A compound gear train is used here to convert the small deflections as well as the angular moment of the buoyant arm which are occurred by ocean waves, into rotary motion, The gear train (ratio) should be selected according to the Generator requirements (RPM), A sample gear train Ratio according to the generator which is used here is 1:16 ratio.
- **Flywheel:** As it is that the waves are not comes regularly and uniformly, thus the out power also varies according to the wave fluctuations. To prevent this fluctuations a fly wheel is suggested to store the energy and transmit it while slag time of wave,
- **Generator:** Due to the mismatching of working conditions, general generators are eliminated and suggested the specially designed generators like PMG and HTS because these works at low rpm say 11-17rpm and gives high output power1MW – 10MW   [26].

3. Acknowledgement

4. Conclusion

Even though many methods, devices are there to extract the energy from oceans waves[22], SAN-BAWEC is new innovative method to extract the energy from ocean waves, it truly efficient and cost effective, (installation and maintenance cost is truly cheap and simplest, compared to existing methods),in India there is only one WEC is installed, so SAN-BAWEC will be the revolutionary innovative wave energy converter device, and gives optimum and effective results. *For a minimum deflection of 2 m height wave, SAN-BAWEC gives the utmost output is 1.6 mw @ 17 rpm(PMG1650-17) at a minimum (weight) load of 23kN at buoy,*

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