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Review of Wave Energy Converter Technology

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Abstract—*The increase in global temperature and change in climate are the main issues that are being faced by many countries. Policy makers have accepted that it is very important to reduce greenhouse gas emission, mainly from power generation industries therefore the important role of renewable energy is obvious. Wave energy is a kind of renewable energy source. It has enough potential to play an important role in sustainable energy future. It is the source that depends on the oscillations of the surface water. Electricity generation from wave energy is increased rapidly from last few years worldwide. Many methods have been introduced for wave energy conversion, such as fixed structure OWC, floating structure OWC, oscillation body system, over topping convertor. In every system the optimal absorption of energy includes some kinds of resonance, which implies size and geometry of structure are linked to wavelength.*

1. INTRODUCTION

The requirement to clean sources of energy and their conversion technologies is obvious due to increasing the power demands in the world and global concerns about the greenhouse gases that released from burning the fossil fuels. Solar radiation is the most plentiful renewable energy source in our planet: 170,000 TW fall on Earth. Because of its dilute and erratic nature harvesting this energy is difficult. 71% of Earth's surface is covered by ocean. In the tropics, they absorb sunlight, and the top layers heat up to some 25°C. Warm surface waters from the equatorial belt flow pole ward, melting both the arctic and the Antarctic ice. The subsequent cold waters return to the equator at great depth, completing a huge planetary thermo syphon. There are many techniques for deriving electricity from the ocean such as tidal power, wave power, ocean thermal energy transformation, ocean currents, ocean winds and salinity gradients. Of these, the three greatest well-advanced technologies are tidal energy, wave energy and ocean thermal energy alteration. The kinetic energy present in marine and tidal currents can be converted to electricity using relatively expectable turbine technology. Joining the kinetic energy in waves presents a different set of technical challenges and a wide diversity of designs have been suggested. Ocean thermal energy conversion is possible in locations with large variety temperatures, getting energy using a heat engine. Salinity gradients can be oppressed for energy extraction through the reverse electro dialysis and osmotic process. In comparison to alternative sources of renewable energy the ocean power technologies are poised on the threshold of commercial development. The stronger winds blowing over the water's surface are cased to creating the more powerful waves. These primarily occur in the areas between 30º and 60º latitude, both north and south. According to the U.S. Department of Energy, traditional (barrage) tidal power requires a difference between high tide and low tide of at least 16 feet.

2. SEVERAL TECHNOLOGIES

On the basis of working principle, location and size, there are several methods to receiving energy from wave energy for example: oscillating bodies, oscillating water column, overtopping.

2.1. Fixed-structure OWC

On the basis of various energy-extracting means, Fixed-structure OWC has been advanced and builds in open coastal waters. Fixed-structure OWC is mostly located on the shoreline. Fixed-structure OWCs are generally stranded on the sea bottom or are fixed to a rocky cliff. There are various benefits in the shoreline devices such as easier installation and maintenance, and they do not require deep-water moorings and long underwater electrical cables. The oscillating water column (OWC) device includes a partly submerged concrete or steel structure, open under the water surface, in which air is trapped beyond the water free surface. The fluctuating motion of the inner free surface that is formed by the waves makes the air to flow over a turbine that drives an electrical generator. Their installed power capacity is (or was) in the range 60–500 kW.

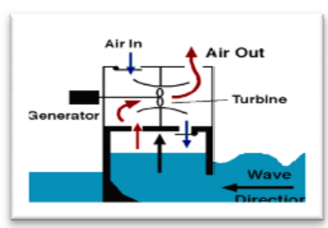


Fig. 1: Cross sectional view of a bottom-standing OWC.

2.2. Floating-structure OWC

One of the geometry for a floating OWC is the reluctant bent duct buoy (BBDB). In this geometry (BBDB), the OWC duct is bent backward from the incident wave direction. In this way, the length of the water column could be made satisfactorily large for resonance to be achieved, while keeping the draught of the floating structure with undesirable limits. The BBDB converter was studied and was used to power about one thousand navigation buoys in Japan and China. It is a multi-resonance converter with numerous vertical OWCs of altered lengths, each chamber being connected to an air turbine.

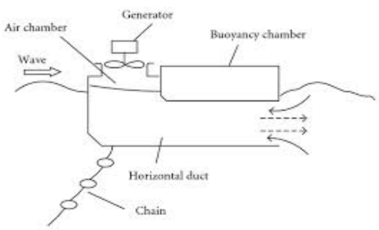


Fig. 2: Schematic representation of the Backward Bent Duct Buoy

3. OSCILLATING BODY SYSTEM

Offshore devices are mainly oscillating bodies. In comparison to first generation scheme the offshore wave energy converters are more compounds. There are surplus problem such as mooring, access for preservation and the need of long underwater electrical cables that cased to hindered their progress.

3.1. Single-body heaving buoys

The heaving buoy reacting against a fixed frame of reference is the simplest oscillating-body device. The buoy was equipped through an air turbine and could be phase-controlled by latching. A version of the taut-moored buoy concept is actuality advanced at Uppsala University, Sweden, and uses a linear electrical generator placed on the ocean floor. By following the Fig., springs involved to the translator of the generator supply energy during half a wave cycle and instantaneously act as a restoring force in the wave trenches. Sea assessments off the western shore ofSweden of a 3meter diameter cylindrical buoy are testified in.

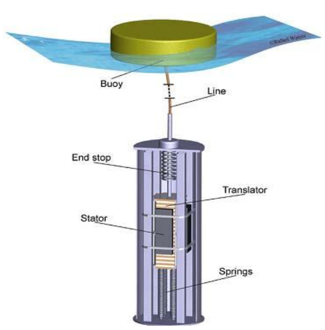


Fig. 3: Swedish heaving buoy with linear electrical generator (courtesy of Uppsala University)

3.2. Two-body heaving systems

In the two-body heaving system energy is converted from the comparative motion between two bodies oscillating otherwise. The Graphic representation of the IPS buoy is shown in Fig., is one of the most exciting absorbers for wave energy conversion that contains a buoy rigidly connected to a fully submerged vertical tube open at mutually ends. The tube has a piston whose motion reasonable to the floater-tube system drives a power take-off mechanist.

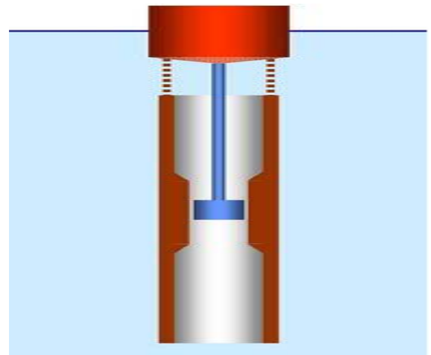
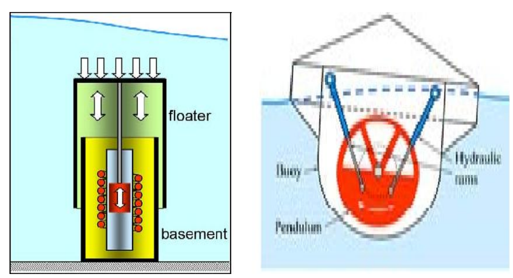


Fig. 4: Schematic representation of the IPS buoy

3.3. Fully submerged heaving system

The Archimedes Wave Swing (AWS) was the first converter with a linear electrical generator. It is fully submerged heaving device that was mainly developed in Holland and consist of an oscillating upper apart (the floater) and a bottom-fixed lower part (the basement). The wave crest and wave trough cased to floater be pushed down and travels up and this motion is resisted by a linear electrical generator with the interior air pressure acting as a spring.



(a) (b)

Fig. 5(a) Schematic representation of the Archimedes Wave Swing; 5(b) Schematic representation of the Searev.

3.4. Pitching devices

In the above systems the energy conversion is related to a relative translational motion but in the pitching device systems it is based on relative rotation (mostly pitch) rather than translation. This is the remarkable case of the nodding Duck, that has been acting since the1970s and early1980s, that are probably the best known offshore devices among those, and which of several versions were developed in the following years. One of thesampleof this oscillating-body systems is

Searev Wave energy converter developed at EcoleCentrale de Nantes, France, it is a floating devices that consist of a heavy horizontal-axis wheel serving as an internal gravity reference.

3.5. Bottom-hinged system

These devices are established on the inverted pendulum hinged at the sea bed theory. The mace is invented by Stephen Salter. As shown in Fig., the bottom-hinged system contains a buoyant spar, with symmetry about a universal mutual at the sea vertical axis that can swing about a universal joint at the sea bottom. The power take-off reaction to the sea bed is through a set of cables. The cables wound several times round a winch-drum leading both fore and aft in the prevalent wave direction. The wave-activated reciprocating rotation of the drum is converted into useful energy by means of a hydraulic system.

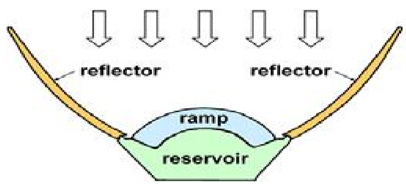


Fig. 6: The swinging mace in three angular positions.

4. OVER TOPPING CONVERTERS

The catching the water that is close to top of wave and introduce it, by over spilling into a pool where it is stored at a level higher than the average free-surface level of the neighbouring sea is a different way of converting the wave energy. Different the cases of oscillating body and OWC wave energy convertors, the hydrodynamics of overtopping devices are intensely non-linear. One example of the over topping converters is the Wave Drang floating that consists of two wave reflectors focusing the incoming waves to a doubly curved ramp, a basin and a set of short-head hydraulic turbines.

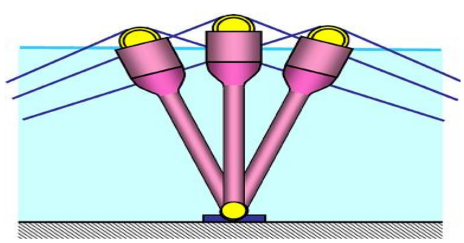


Fig. 7: Plan view of Wave Dragon.

5. CONCLUSION

The wave energy systems for generation electricity in the past few years had been rising rapidly and also energy consumption in other parts of the world has been developing rapidly. The testing under real sea condition is final stage of demonstrating wave energy converts. In nearly every system, optimal wave energy absorption contains some kind of resonance, which indicates that the size and geometry of the structure are linked to wavelength. For these causes, if pilot plants are to be experienced in the open ocean, they must be big structures. There is certain snag that has hindered the progress of wave energy systems like: the high costs of constructing, positioning, maintaining and testing large prototypes under sometimes very harsh environmental situations. In maximum cases the one resolution of these problems was possible one with substantial financial care from governments.

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