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Utilization of Energy from Sea Waves-A Review of Technologies and Prospectus in India

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ABSTRACT

Current Energy resources are having limitations on their use. These continuously reducing resources have increased importance of sustainable energy resources. Generating electricity from sea waves is one of the alternatives available and significant studies have been carried out on various technologies for the same. This paper takes review of technologies which are used to utilize the tremendous amount of energy available in sea waves as well as equipments which are used in wave energy utilization plant. Wave energy is available for India with vast coast line. Thisis going to be an alternative to meet increasing power demand and also for remote islands.

***Keywords:* Renewable energy, wave energy, wave energy generation, equipments, review**

1. INTRODUCTION

Among different types of ocean waves, wind generated waves have the highest energy concentration. Wind waves are derived from the winds as they blow across the oceans. This energy transfer provides a naturalstorage of wind energy in the water near the free surface. Once created, wind waves can travel thousands of kilometres with little energy losses, unless they encounter head winds. Nearer the coastline the wave energy intensity decreases due to interaction with the seabed. Energy dissipation near shore can be compensated by natural phenomena as refraction or reflection, leading to energy concentration ("hot spots"). The power in a wave is proportional to the square of the amplitude and to the period of the motion. Long period (~7-10 s), large amplitude (~2 m) waves have energy fluxes commonly exceeding 40-50 kWper meter width of oncoming wave.

1.1. Wave Energy Seasons

As most forms of renewable, wave energy is unevenly distributed over the globe. Increased wave activity is found between the latitudes of ~30° and ~60° on both hemispheres, induced by the prevailing western winds (Westerlies)blowing in these regions.

Power in wave is expressed as [2]:

$P=0.55 * H_s^2 * T_z$ KW per metre of crest length
Where H_s=Significant wave height in metres, T_z=Zero crossing period in seconds

I. WAVE ENERGY TECHNOLOGY:

With the substantial resource potential, a wide variety of methods for extracting wave energy have been developed. The different devices and systems not onlyemploy different techniques for “capturing” the wave energy, but also employ a large variety of different methods for converting it to electricity (i.e., the “power take-off” system). Some previous studies have classified wave energy devices according to their capture method (shape and method of front-end converter movement). While useful, this classification is subject to limitations due to the large diversity of wave energy device designs, some of which involve unique shapes and mechanisms that do not fall into established categories. These factors tend to blur the boundaries between categories when a large number of systems are considered.
Wave technology is accompanied by wave data collection which is collected along all coast line. In India it is collected by ship observation and wave rider buoy

Figure 1: Ultrasonic senor used to measure the height and time period of waves.

Wave technologies have been designed to be installed in, far offshore, near shore and offshore locations. Near shore devices are deployed at moderate water depths (~20-25), at distances up to ~500 m from the shore. They have nearly the same advantages as shoreline devices, being at the same time exposed to higher power levels. Several point absorber systems are near shore devices.

Offshore devices exploit the morepowerful wave regimes available in deep water (> 25 m depth). Far offshore devices are located much farther.

The following are the wave energy technology types based on location:

1. OWC (Oscillating Water Column) Systems
   a) OWC – Onshore
   b) OWC – Near-shore
   c) OWC – Floating
2. Absorber Systems
   a) Absorber – Point
   b) Absorber – Multi Point
   c) Absorber – DirectionalFloat
3. Inverted Pendulum Devices
4. Overtopping Devices

OWC (OSCILLATING WATERCOLUMN) SYSTEMS

In general these devices stand on the sea bottom or are fixed to a rocky cliff. Shoreline devices have the advantage of easier installation and maintenance, and do not require deep-water moorings and long underwater electrical cables. The less energetic wave climate at the shoreline can be partly compensated by natural wave energy concentration due to refraction and/or diffraction (if the device is suitably located for that purpose). The typical first generation device is the oscillating water column.

The oscillating water column (OWC) device comprises a partly submerged concrete or steel structure, open below the water surface, inside which air is trapped above the water free surface. The oscillating motion of the internal free surface produced by the incident waves makes the air to flow through a turbine that drives an electrical generator.

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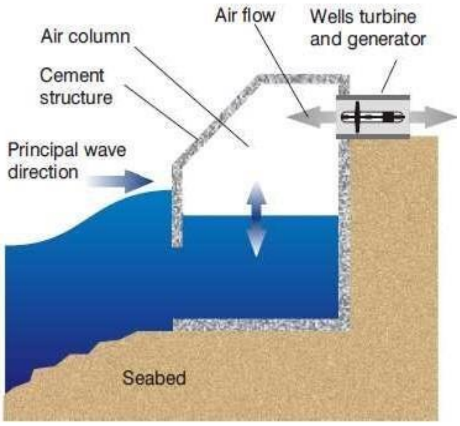

Figure 2: Working of OWC

i.) Near-Shore Devices

The main prototype device for moderate water depths (i.e. up to ~20 m) is theOSPREY, developed by Wavegen Ltd. In the UK. It is designed for deployment on the seabed.

ii.) Offshore Devices

This class of device exploits the morepowerful wave regimes available in deep water (>40m depth). More recent designs for offshore devices concentrate on small, modular devices, yielding high power output when deployed in arrays.

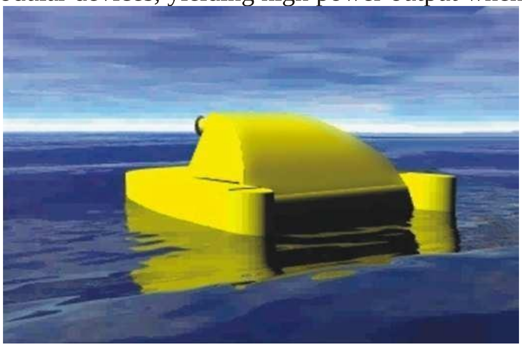

Figure 3. Near Shore Device

Figure 4. Offshore Deviceiii.) Floating devices

The Floating Wave Power Vessel is an overtopping device for offshore operation developed by Sea Power International, Sweden. It consists of a floating basin supported by ballast tanks in four sections. A patented anchor system allows the orientation of the vessel to the most energetic wave direction

ABSORBER SYSTEMS

Point Absorber Wave Energy Converter developed by Rambøll in Denmark, consists of a float connected to a suction cup anchor by a polyester rope. The relative motion between the float on the sea surface and the seabed structure activates a piston pump (actuator) inserted between then rope and the float. Point absorbers have a small horizontal dimension compared with the vertical dimension and utilize the rise and fall of the wave height at a single point for WEC.

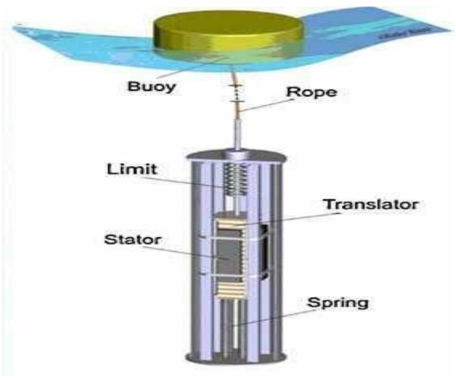

Fig.6. Schematic figure of AbsorberSystem

Fig.7: Absorber System Photo

INVERTED PENDULUM DEVICES

This is a floating device enclosing a heavy horizontal-axis wheel serving as an internal gravity reference. The centre of gravity of the wheel being off- centred, this component behaves mechanically like a pendulum. The rotational motion of this pendular wheel relative to the hull activates a hydraulic PTO which, in turn, sets an electrical generator into motion. Major advantages of this arrangement are that (i) (like the Frog) all the moving parts (mechanic, hydraulic, electrical components) are sheltered from the action of the sea inside a closed hull, and (ii) the choice of a wheel working as a pendulum involve neither end-stops nor anysecurity system limiting the stroke.

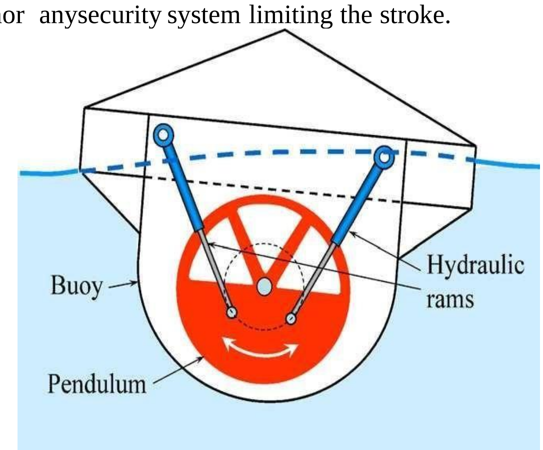

Fig 8: Schematic figure of Inverted Pendulum Devices.

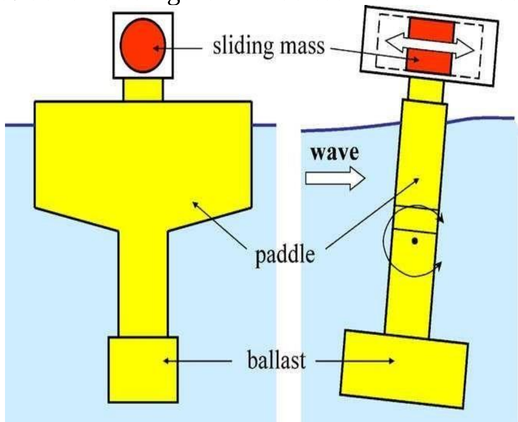

Fig 9: Front view & Side View of Inverted Pendulum Devices.

OVERTOPPING DEVICES

Overtopping devices have reservoirs that are filled by impinging waves to levels above the average surrounding ocean. The released reservoir water is used to drive hydro turbines or other conversion devices. Overtopping devices have been designed and tested for both onshore and floating offshore applications.

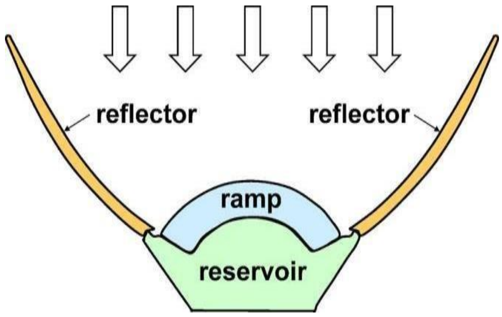

Fig.10: Plan of Wave DragonEQUIPMENTS

BUOYS

The buoy has permanent linear magnets that are attached to the shaft. These magnets induce a current in the coil that's housed inside the buoy. This unregulated AC voltage (from the buoys) is fed via a cable to a junction box on the seabed where it is converted to 12000V DC. The DC voltage will be changed back into AC on the shore before its fed into the grid.

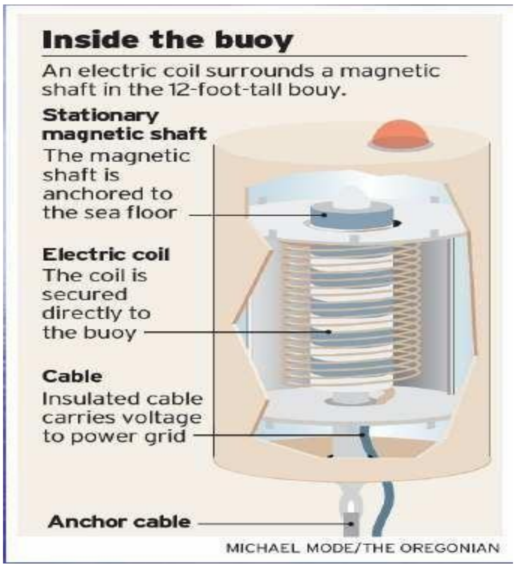

Fig.11:Inside View of Buoy

HYDRAULIC TURBINES

[1]As in conventional mini-hydroelectric low-head plants axial-flow reaction turbines are used to convert the head (typically 3–4 mat full size) created between the reservoir of an overtopping device and the mean sea level. The flow may be controlled by adjustable inlet guide vanes. In some cases the blades of the runner can also be adjusted (Kaplan turbines) which greatly improves efficiency over a wide range of flows; however this can be costly and is not normally employed in the small turbines typical of wave energy applications.

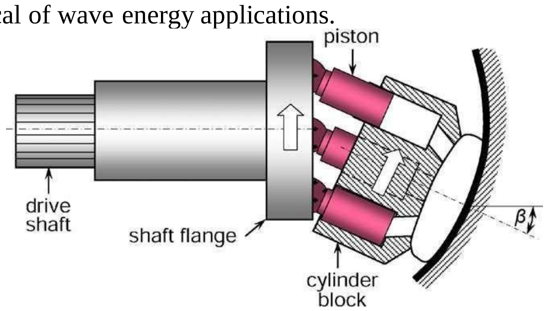

Fig.12: Hydraulic Turbine

High-pressure oil-hydraulics

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High-pressure oil systems are particularly suitable to convert energy from the very large forces or moments applied by the waves on slowly oscillating bodies (in translation or rotation). The hydraulic circuit usually includes a gas accumulator system capable of storing energy over a few wave periods, which can smooth out the very irregular power absorbed from the waves. The body motion is converted into hydraulic energy by a hydraulic cylinder or ram (or a set of them). A fast hydraulic motor drives a conventional electrical generator.

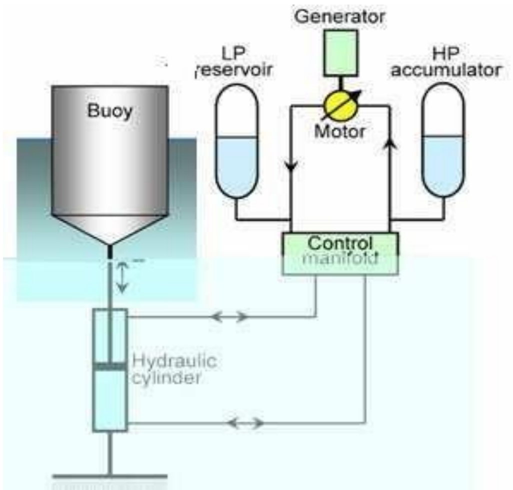


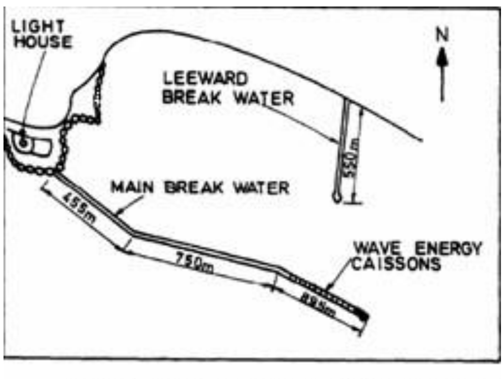
Fig.13:High Pressure HudraulicSystem

ELECTRICAL EQUIPMENT

In most wave energy converters, a rotating electrical generator is driven by a mechanical machine: air or hydraulic turbine, hydraulic motor. The electrical equipment, including variable rotational speed and power electronics, is mostly conventional and largely similar to wind energy conversion. If the driving machine is a variable displacement hydraulic motor, it is possible to keep the rotational speed fixed while controlling the flow rate and power by adjusting the motor geometry

WAVE ENERGY PROSPECTUS IN INDIA
Background

Research on wave energy started in 1984 in India at Indian Institute if Technology Madras (IITM) and this research lead to conclusion that Oscillating water column type wave energy converter is suitable for Indian environment and based on this research 150 KW power plant was established in 1991 in Vizijhan fisheries harbor near Trivendrum in Kerala.



LAYOUT OF THANGASSERY HARBOUR

National Institute of Ocean Technology (NIOT) was established within IITM campus continues research on wave power and in 1996 an improved plantwas installed in Vizijhan. Further improvement in this field a site for 1 to 2 MW plant was established at Thangassery harbor in west coast of India and Mus bay in Car Nikobar Island.

Potential In India

The potential along the 6000 Km of coast is about 40,000 MW. This energy is however less intensive than what is available in more northern and southern latitudes.

In India the research and development activity for exploring wave energy started at the Ocean Engineering Centre, Indian

Institute of Technology, Madras in 1982. Primary estimates indicate that the annual wave energy potential along the Indian coast is between 5 MW to 15 MW per meter, thus a theoretical potential for a coast line of nearly 6000 KW works out to 40000-60000 MW approximately. However, the realistic and economical potential is likely to be considerably less.

2. CONCLUSIONS

This paper takes review of the technologies available for producing energy from sea important energy sources which must be utilized. Though there are some factors which limit the development of these wave energy plants such as higher construction cost and difficulties in construction and testing of these energy converters. India is having vast coast line and number of wave energy plants installed will help meet the increasing power requirementwith eco friendly approach. And most important this source is never going to cease. A sound effort will give a bestalternative to depleting conventional sources. From India's point of view still not much progress made in wave power technology and large capacity plants haven't been installed. Oscillating column converters are suitable for Indian environment and there is tremendous scope for development and power generation.

3. ACKNOWLEDGMENT

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