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# Tidal Wave Energy Large Scale Conversion Technology

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## Abstract

The objective of this paper is to describe how we can get the maximum amount of working force from tidal wave energy. The paper starts with defining various forces acting on a floating object. Then describe the theory of how unnecessary forces can be opposed except the force which is useful and how this useful force can be increased hugely, how we can use the force safely. Afterward, method then calculating for a 21.5 MW hydropower from tidal wave, using some freehand drawings. Finally conclusion states the advantages.


**Keywords** Anchor; Electricity; Floating object; Pump; Ship city; Tidal wave energy

## Background

The unlimited source of energy ocean tide has the potential to generate an unlimited amount of electricity and to provide unlimited water demand. Since 1799 till now energy companies are not able to harness sufficient amount of energy from this constant source of energy. Existing projects are small, critical technology and so are not economic.

Tidal energy basically is a physical water movement, so compare to solar and wind, harnessing energy from tide should not so difficult.

## Introduction

Tidal force on a floating object has two elements: 1) Horizontal force ($H_F$): Is a one-directional force creates by tidal flow/current. 2) Vertical force ($V_F$): Is a bidirectional force creating by tidal wave (with gravity) (Figure 1).

Application of Vertical force ($V_F$) and Horizontal force ($H_F$): Figure 2a and 2b shows some examples of existing various projects.

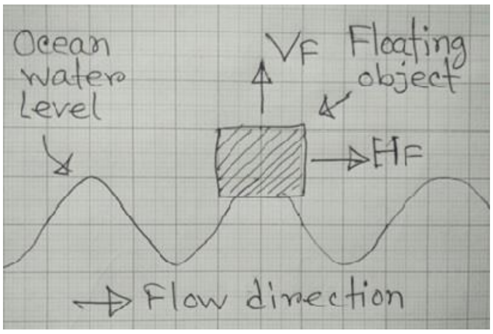


**Figure 1:** Tidal force on a floating object.

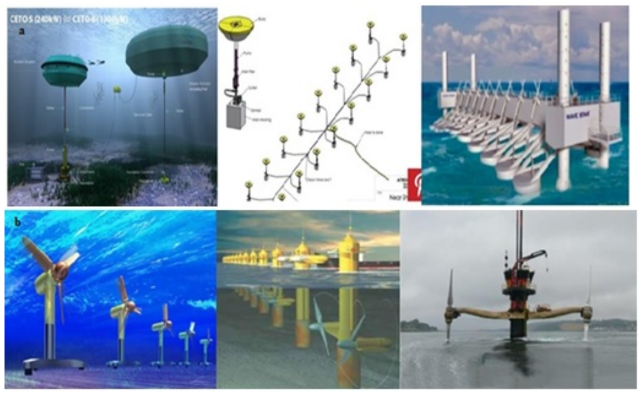

**Figure 2: (a):** Application of Vertical Force ($V_F$); **(b):** Application of Horizontal Force ($H_F$).

## Description

Tidal horizontal force ($H_F$) (and with others external any kind of wind forces) on a floating object can be opposed by anchor it properly (by using minimum four long-distance anchors) so that the vertical force ($V_F$) remain almost same. This vertical force ($V_F$) is useful and it can be very much useful as easily increase this vertical force ($V_F$) by increasing the size of the object. This bidirectional vertical force ($V_F$) is very much suitable for pumping purpose (Figure 3)[1].

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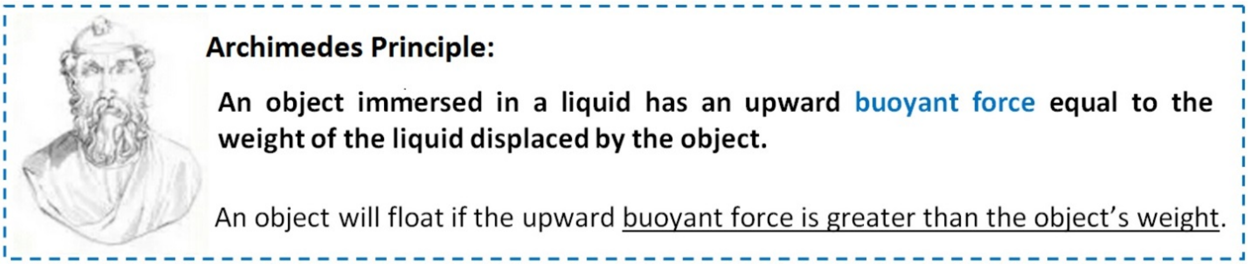


**Figure 3:** Archimedes' Principle.

Therefore, the vertical force ($V_F$) of the tidal wave on a floating object can be huge.

## Method

Movement of this anchored ship (Figure 4) due to the tidal wave is only vertical and the amount of energy it carries is big.

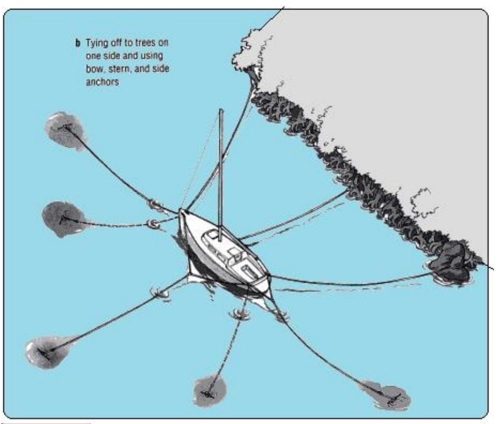


**Figure 4:** Anchored Ship.

The vertical upward force of this ship can be useful (Figure 5).

**Figure 5:** Useful energy that is out of our sight.

By installing pump protected by RCC structure, using the vertical upward force of the wave on an anchored floating object continuously sufficient water pumping possible for hydropower station as shown in Figures 6 and 7.

**Figure 6:** Some anchored big ships can provide electricity and water demand of a big city.

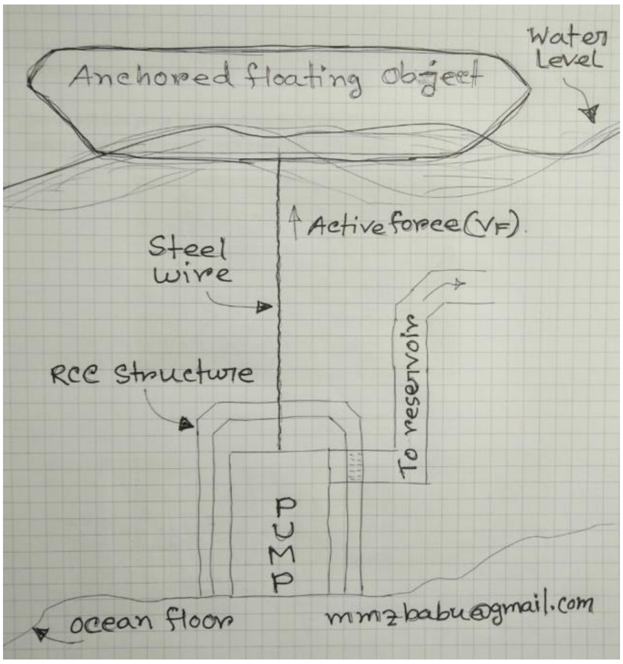


**Figure 7:** Vertical forces of Tidal waves are pumping water to hydropower station reservoir.

## Calculation

Consider a piston-cylinder diameter $D_c$=10 m and cylinder height ≥ maximum wave height. So the cross-section area of cylinder:

$$Ac = \frac{\pi \times (D_c)^2}{4}$$

$$= \frac{\pi \times (10)^2}{4} m^2 \quad = 78.54 m^2 \qquad (1)$$

Let, wave height is 3 m. So the piston can move 3 m, i.e. active length of cylinder $H_c$=3 m.

If the piston is connected with a floating object then due to a tidal wave the amount of water will pump is

$$Q = A_c \times H_c \text{ per wave}$$

$$= 78.54 \times 3 \text{ m}^3 \text{ per wave}$$

$$= 235.62 \text{ m}^3 \text{ per wave}$$

If the wave period is 10 seconds [2], Then

$$Q = \frac{235.62}{10} m^3/sec$$

$$= 23.56 \text{ m}^3/\text{sec} \qquad (2)$$

Consider a floating ship of displacement tonnage 10,000. (i.e. total weight of the ship is 10,000 ton).

According to Archimedes' principle, buoyant force (vertical upward force) on the floating ship due to the tidal wave is ≥ 10,000-ton force, i.e. $V_F \geq$ 10,000 ton-force.

Let, $V_F$=10000 ton force

$$= 98067.1 \text{ kN} \qquad (3)$$

If this force acting on the piston then, Pumping pressure ($P_{pump}$)

$$P_{pump} = \frac{Force}{Area} = \frac{V_F}{A_c}$$

$$= \frac{98067.1}{78.54} kN/m^2 \qquad \text{by equation (1) and (3)}$$

$$= 1248.63 \text{ kN/m}^2$$

As measured by a U-tube manometer, 1 kN/$m^2$ pressure can create a water head 0.102 m [3]. Then for Pumping pressure ($P_{pump}$)=1248.63 kN/$m^2$, water head

$$H_{head} = 1248.63 \times 0.102 \text{ m}$$

$$= 127 \text{m}$$

Consider head loss 13 m, then waterfall height

$$H = 127 - 13 = 114 \text{m} \qquad (4)$$

From formula to calculate hydropower, Generating power ($P_{gen}$) [4]

$$P_{gen} = Q \times \rho \times g \times H \times \eta \text{ watt} \quad (5)$$

Where, Q=flow rate in $m^3$/sec [=23.56 $m^3$/sec, equation (2)]

ρ=water density in kg/$m^3$ (sea water 1020 kg/m3 ) [5]

g=acceleration of gravity in m/$sec^2$ (9.81m/$sec^2$)

H=water fall height in meter [=127m, equation (4)]

η=global efficiency ratio (let here 0.8, usually between 0.7 and 0.9)

Then equation (5), Generating power

$$P_{gen} = 23.56 \times 1020 \times 9.81 \times (114) \times 0.8 \text{ watt},$$

=21,500,954 watt =21.5 MW

Reservoir size:

We have, Q=23.56 $m^3$/sec

For 30 min backup operation, Water required will be:

$$\text{Volume} = 23.56 \times 60 \times 30 \text{ m}^3$$

$$= 42{,}408 \text{ m}^3$$

If reservoir depth is 3 m then,

$$\text{Reservoir area} = \frac{42{,}408}{3} m^2$$

$$= 14{,}136 \text{ m}^2$$

For square shaped area,

Reservoir length=width=√14,136 m=119 m

## Conclusion

Hence, we can conclude that to generate 21.5 MW electricity from tidal wave we have to anchor a ship (total weight 10,000 ton) on the ocean wave height 3 m, need to be build a 119 m × 119 m × 3 m size reservoir from (127-3)=120 m above the sea level, have to be install a pump under the anchored ship of cylinder diameter 10 m, cylinder height ≥ maximum wave height in the installation area and a 21.5 MW water turbine generator.

Considering the open space available in the ocean, we can install lots of ships. Anchored big ships on the big wave can take a big role in the solution of future energy.

This is a very easy technique to harness energy from ocean tidal energy as already running some small projects. Capacity can be increased as required by increasing the size of the object and pump very easily. Expensive waterproof devices are not required for this easy technique. Compare to the existing hydropower stations dam, big reservoir, big catchment area not required so cost-effective.

## Advantages

- Zero-emission
- Low-cost renewable energy
- Very safe
- Reject ships can be used as a floating object so that form a ship city
- Very simple pumping operation so that pump can be design for any size of wave
- Continuous pumping so no need a big reservoir for hydropower station
- Economic
- Easy technology
- Reliable and Unlimited

***This anchored object method can be used in the river for irrigation purpose.

## Acknowledgment

Google Images, Marine energy/ship companies.

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