Tidal Wave Energy Large Scale Conversion Technology.

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***Abstract* —** The objective of this paper is to describe how can we get 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 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. And then method, calculation for a 21.5MW hydropower from tidal wave. Using some freehand drawings. Finally conclusion states the advantages.

***Keywords*--** Anchor, Electricity, Floating object, Pump, Ship city. Tidal wave energy.

I. BACKGROUND

The unlimited source of energy ocean tide has the potential to generate 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.

II. INTRODUCTION

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

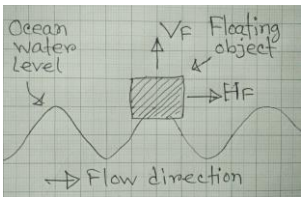


Fig: 1 Tidal force on a floating object.

Application of Vertical force (V_F) and Horizontal force (H_F): Fig 2 & 3 are shows some examples of existing various projects

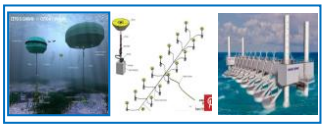
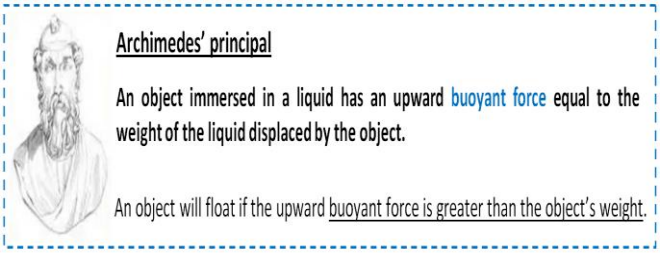


Fig. 2 Application of Vertical force (V_F)

Fig. 3 Application of Horizontal for (H_F)

III. 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.



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

IV. METHOD

Movement of this anchored ship (fig-4) due to the tidal wave is only vertical and the amount of energy it carries is big. The vertical upward force of this ship can be useful.

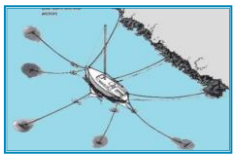


Fig. 4 Anchored ship.

Fig. Useful energy that is our out of 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 hydro power station as shown in Fig: 5.

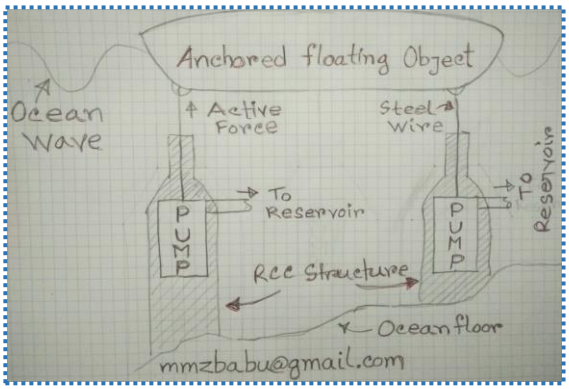


Fig. 5 Vertical force of Tidal waves are pumping water to hydropower station reservoir.

V. CALCULATION

Consider a piston cylinder diameter Dc = 10 m. and cylinder height ≥ maximum wave height. So the cross section area of cylinder $Ac = \pi*(Dc)^2/4 = \pi*(10)^2/4\ m^2$

$= 78.54\ m^2$ ……...….(1)

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

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

$Q = Ac*Hc/wave = 78.54 \text{ X } 3\ m^3/wave = 235.62\ m^3/wave$

If the wave period is 10 seconds,

Then $Q = 235.62\ m^3/10\ sec = 23.56\ m^3/sec$ …….(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 kN……...(3)

If this force acting on the piston then, Pumping pressure

P_{pump}= Force/Area = V_F/A_C

= 98067.1/78.54 kN/m^2 [by eq^n (1) & (3)]

= 1248.63 kN/m^2

As measured by a U-tube manometer, 1kN/m^2 pressure can create a water head 0.102 m.

Then for Pumping pressure P_{pump}=1248.63 kN/m^2, water head

H_{head} = 1248.63*0.102 m = 127m,

Consider head loss 13 m, then water fall height

H = 127-13 = 114m. ……..…….(4)

From formula to calculate hydropower, Generating power

$P_{gen} = Q*\wp*g*H*\eta$ watt,[1] …….(5)

Where, Q = flow rate in m^3/sec. [=23.56 m^3/sec eq^n (2)]

$\wp$ = water density in kg/m^3 (sea water 1020 kg/m^3)

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

H = water fall height in meter. [=127m eq^n (4)]

η = global efficiency ratio. {let here 0.8}

(Usually between 0.7 and 0.9)

Then eq^n (5), Generating power

P_{gen} = 23.56*1020*9.81*(114)*0.8 watt,

= 21,500,954 watt

= <u>21.5 MW</u>

Reservoir size:

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

For 30 min backup operation, Water required

V_{oL} = 23.56*60*30 m^3 = 42,408 m^3

If reservoir depth is 3 m then

Reservoir area = 42,408/3 m^2 = 14,136 m^2,

For square shape area,

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

VI. CONCLUSIONS

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 119m*119m*3m 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 for 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 hydro power 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 hydro power station.

#Economic. #Easy technology. #Reliable and #Unlimited.

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

VII. Acknowledgment

Google Images, Marine energy/ship companies.

VIII. References

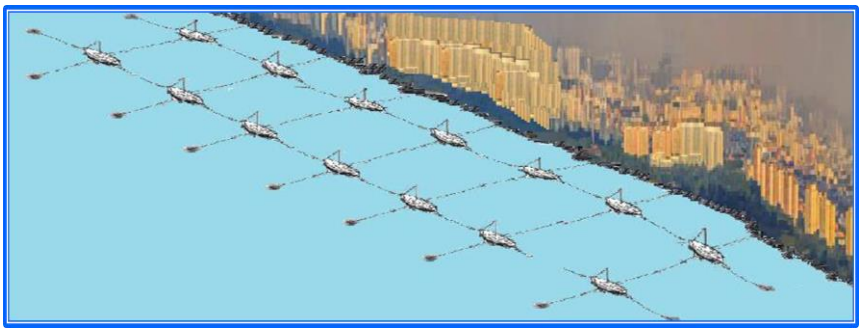
1. Archimedes.
2. Calculation of hydroelectric power and energy principle.(https://power-calculation.com/hydroelectricity-energy-calculator.php) [1]

MAXIM

"Ocean tidal energy has the potential to provide unlimited gigawatts of power worldwide."
https://www.technologyreview.com/s/537656/why-hasnt-tidal-power-taken-off/

"Considering the open space available in the ocean, and the tremendous amount of energy it produces, wave power could one day be a viable source of efficient renewable energy."
http://www.innovationmanagement.se/2017/07/31/the-5-most-innovative-renewable-energy-sources/

"Wave power works when other renewables don't, but energy companies have failed to harness this constant source of energy. Now all that is about to change."
https://www.wired.co.uk/article/eco-wave-power-ocean-energy-harvesting-renewable



Some anchored big ships can provide Electricity and Water demand of a big city.