Tidal Wave Energy Large Scale Conversion Technology.

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ABSTRACT

The objective of this paper is a brief on 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, a brief on the theory of how unnecessary forces can be opposed, except the useful forces and how these useful forces can be increased hugely, how we can use this force safely. Afterward about the method and then a calculation for a 21.5MW hydropower from the tidal wave. Using a freehand sketch and some pictures. Finally, the conclusion states the possibilities and 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 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-based 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

It is very clear: we need to go through a clean energy economy to overcome the worst impacts of climate change. Renewable energy has tremendous economic development, public health, and environmental benefits. Wave energy is unique because it is the most concentrated form of renewable energy on earth, with power density much higher than that of wind and solar energy.

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 creates by tidal wave with gravity. (Figure: 1).

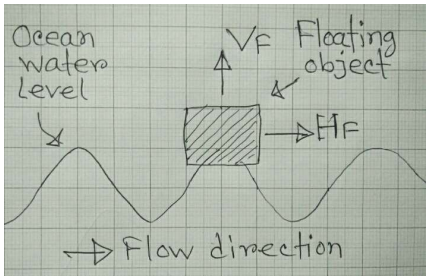

Figure 1: Tidal forces on a floating object.

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

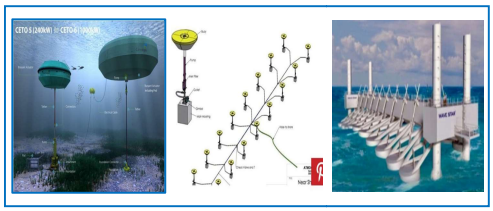

Figure 2a: Application of Vertical force (V_F)

Figure 2b: Application of Horizontal force

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 horizontal/ long-distance anchors) so that the vertical force (V_F) remain almost same, as Figure 5. 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 purposes (Figure 3)[1].

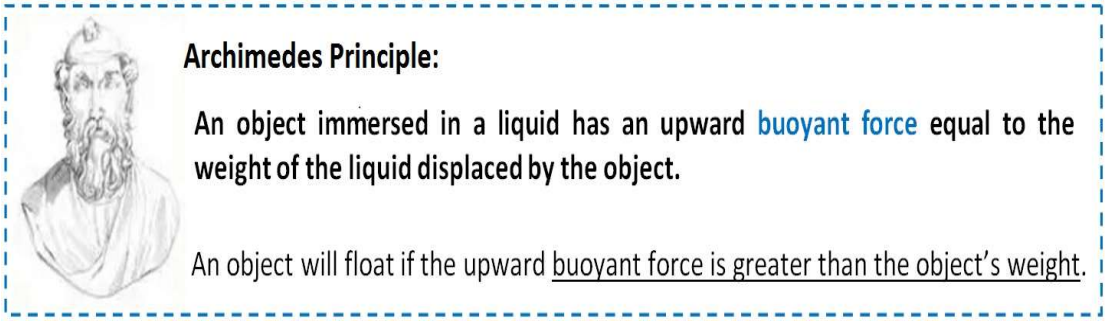

Figure 3: Archimedes Principle.

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

METHOD

If we place a ship on the big wave of the ocean and horizontally anchor the ship from four sides then the ship will move vertically with huge energy, we can use that energy for pumping water to the reservoir of hydropower station and water supply authority.
Movement of this anchored ship (Figure 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 (Figure 5).

Figure 4: Anchored Ship.

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

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

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 and or desalination as shown in Figure:7.

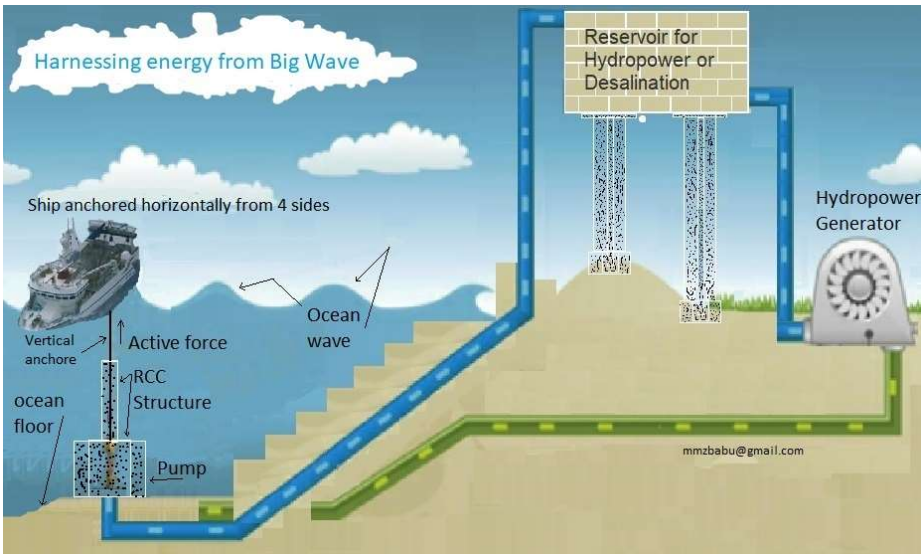

Figure 7: The vertical force of Tidal waves are pumping water to the reservoir.

CALCULATION

Consider a piston-cylinder, diameter Dc = 10 m. and cylinder height ≥ maximum wave height.

So the cross-section area of the 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 wáter will pump is

$Q = Ac*Hc$ per wave = 78.54 X 3 m^3/wave = 235.62 m^3/wave

If the wave period is 10 seconds,[2]

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

= 98067.1kN……...(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.[3]

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 waterfall height

H = 127-13 = 114m. ……..…….(4)

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

$P_{gen} = Q*\rho*g*H*\eta$ watt, …….(5)

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

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

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 will be:

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.

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 where wave height is 3 m, need to build a 119m*119m*3m size reservoir from (127-3) = 120 m above the sea level, have to 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.

The Earth is a watery place. About 71 percent of the Earth's surface is water-covered, and the oceans hold about 96.5 percent of all Earth's water. Considering the open space available in the ocean, we can easily install the required numbers of ships to achieve 100% renewable energy. 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 here no need for any dam, big reservoir, and big catchment area, so cost-effective. Also, no need to think about the related problems like obstructing fish migration, changing natural water temperatures, water chemistry, river flow characteristics, silt loads, the effect on ecology, physical characteristics of the river, negative effects on native plants, on animals in & around the river, problems on important natural areas, agricultural land, archeological sites, relocation of people, etc.

Advantages:
#Zero emission. #Low-cost renewable energy. #Very safe.
#Economic. #Easy technology. #Reliable. #Unlimited.
#Reject ships can be used as a floating object so that form a ship city.
#To mitigate the floating plastic pollution, floating plastics can be put inside the rejected vessel's hold and other free spaces, and then the ship/vessel can be used as a floating object.
#Very simple pumping operation, so that the pump can be designed for all sizes of the waves.
#Continuous pumping so no need a big reservoir for hydropower station and or desalination.
#Sufficient surface water can avoid the lifting of underground water.

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

Acknowledgment:

Google Images, Marine energy/ship companies.

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