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Tidal Power Generation

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Abstract: Now-a-days renewable energy sources are having a great demand for producing electricity. This is because they are eco-friendly and free of cost which are abundantly available in nature. This paper focuses on hypothetical analysis of power generation by considering high tide values available at Amherst Point, Cumberland Basin, Nova Scotia, Canada.

Keywords: High Tides, Tidal Energy, Power Generation, Tidal Barrage

I. INTRODUCTION

Electricity is the main requirement for our daily needs. So, due to this reason there is a huge demand for electrical energy. Most electrical power generation plants are conventional type which have impact on environment. So, we need to search for some alternative sources of electrical energy generation. In this paper, the tidal power is utilized for power generation.

II. NEED FOR TIDAL BARRAGE POWER GENERATION

The increase in dependence of coal, oil and petroleum have contributed to the global warming which are also limited natural resources and are exhaustible. In order to avoid this situation, the tidal power generation has been utilized.

III. TIDES GENERATION

The high tides and low tides are caused by the moon. The moon gravitational force generates the tidal force. This tidal force is exerted on earth. Due to this, the water present on the surface of the earth becomes bulged out on the side closest to the moon and the side farthest from the moon. These bulges of water are high tides. In other words, the gravitational pull of moon and celestial force of attraction creates the high tide. Generally there are three types of tides: (i) Diurnal- one high tide and low tide each day (ii) Semi-Diurnal- two high tides and low tides each day (iii) Mixed- two high tides and low tides each day with different heights.
The highest tide is called king tide. They are typically the highest spring tide of the year. These exceptional tides happen because the distance between the moon and the earth varies due to the moon's elliptical orbit. The king tides oftenly occurs when the earth, moon and the sun are aligned at perigee and perihelion. A perigean spring tide occurs when the moon is either new or full and closest to the earth. These are often called as perigean spring tides. High tides during perigean spring tides can be significantly higher than during other times of the year.

IV. TIDAL BARRAGE

A tidal barrage is a dam-like structure which is used to capture the energy from the great masses of water moving in and out of the bay or river due to tidal forces.
Instead of pooling the water on one side of the dam like a conventional dam, the structure of tidal barrage is similar to the dam, but the tidal barrage allows water to flow into the bay or river during high tides and it also releases the water during the low tide.
This is done by assessing the tidal flow and controlling the sluice gates at the required key times at the tidal cycle. The huge turbines are placed at these sluices to capture the energy as the water flows in and out of the bay or river. Ebb is the tidal phase wherein the water flows towards the sea. Instead of Turbines are placed at the sluices in order to capture the energy as the water flows in and out. However, the energy of the tides is captured by tidal turbine and tidal surge, the tidal turbine and the tidal barrage.

V. ENERGY GENERATION

Many different type of designs in turbines provide different efficiencies and gives power output variation. Energy available from kinetic system is expressed by,

$$P = \frac{\xi \rho A V^3}{2}$$

where, ξ: Efficiency of turbine
P: Power Generation in Watts

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ρ: Density of seawater 1025kg/m^3
A: Sweep area of turbine in m^2
V: Velocity of flow

Potential energy in a volume of water is,

$$E = \frac{1}{2} A\rho g h^2$$

where, h: Vertical tidal range
A: Horizontal area of barrage basin
ρ: Density of seawater 1025kg/m^3
g: Acceleration due to earth's gravity 9.8 m/s^2

VI. ENERGY CALCULATIONS

Tidal range: 12.6m (approx.)
Surface of tidal energy harnessing plant is 9 sq km
$= 9 \times 10^6\,\mathrm{m}^2$
Density of water = 1025.18 $\mathrm{kg/m^3}$
Mass of sea water
= Volume of sea water × Density of sea water
= (Area × Tidal range) of water × Mass Density
$= (9 \times 10^6\,\mathrm{m}^2 \times 12.6\,\mathrm{m}) \times (1025.18\,\mathrm{kg/m^3})$
$= 116.255 \times 10^9\,\mathrm{kg(approx)}$

Potential Energy content of water in basin at high tide
$= \frac{1}{2} A\rho g(\text{Tidal Range})^2$
$= \frac{1}{2}(9 \times 10^6\,\mathrm{m}^2) \times 1025\,\mathrm{kg/m^3} \times 9.81\,\mathrm{m/s^2}(12.6\mathrm{m})^2$
$= 7.184 \times 10^{12}\,\mathrm{J\ (approx.)}$

Now, we have 2 high tides and 2 low tides every day. At low tide, the potential energy is zero. Hence, low tides are not considered in this case.

Total energy potential per day= Energy for a single high tide × 2
$= 7.184 \times 10^{12}\,\mathrm{J} \times 2$
$= 14.367 \times 10^{12}\,\mathrm{J}$

Mean Power Generation Potential
$= \frac{\text{Energy Generation Potential}}{\text{Time in 1 day}}$
$= \frac{14.367 \times 10^{12}\,\mathrm{J}}{86400\,\mathrm{s}}$
= 166.2887 MW

Assuming the power conversion efficiency to be 30%, the daily average power generated
$= \frac{166.2887\ \mathrm{MW} \times 30\%}{100\%}$
= 49.887 MW
≈ 50 MW

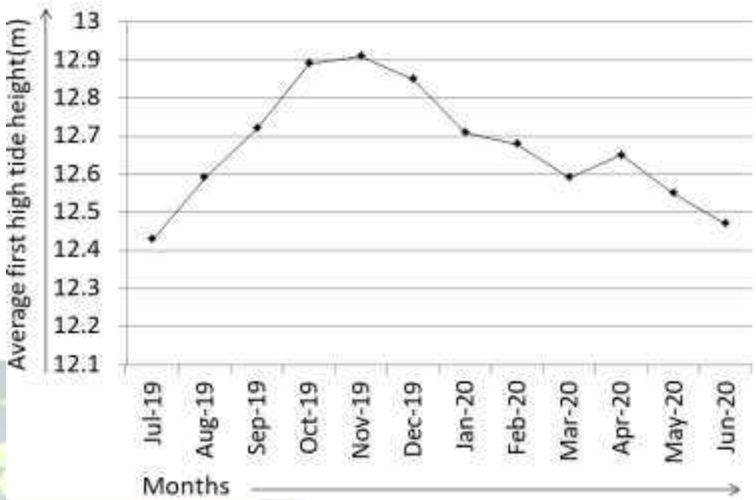

Fig.(i): First High Tide Graph

Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20
12.43	12.59	12.72	12.89	12.91	12.85	12.71	12.68	12.59	12.65	12.55	12.47

Table(i): Average Monthly First High Tide Height (m)

Fig.1 shows the first average high tide graph taken within July- 2019 to June-2020. Table.1 shows the average monthly first high tide height(m). We observe here that, the high tide height is at peak during November- 2019 with 12.91 m. In other words, in this case of first high tide, considering the topography of seabed, the gravitational force and the celestial force of attraction which causes the tide is the highest in this location.

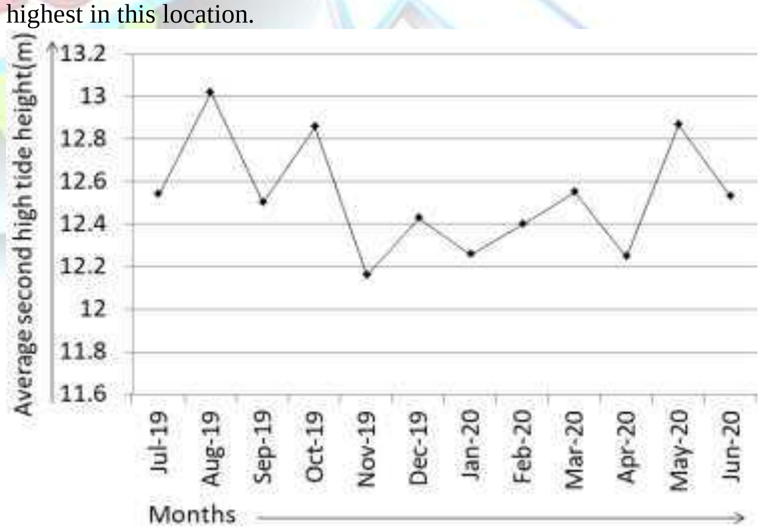

Fig.(ii): Second High Tide Graph

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Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20
12.54	13.02	12.50	12.86	12.16	12.43	12.26	12.40	12.55	12.25	12.87	12.53

Table.2: Average Monthly Second High Tide Height (m)

Fig.(ii) shows the second average high tide graph taken within July- 2019 to June-2020. Table.2 shows the average monthly second high tide height(m). We observe here that, the high tide height is at peak during August- 2019 with 13.02 m. In other words, in this case of second high tide, considering the topography of seabed, the gravitational force and the celestial force of attraction which causes the tide is the highest in this location.

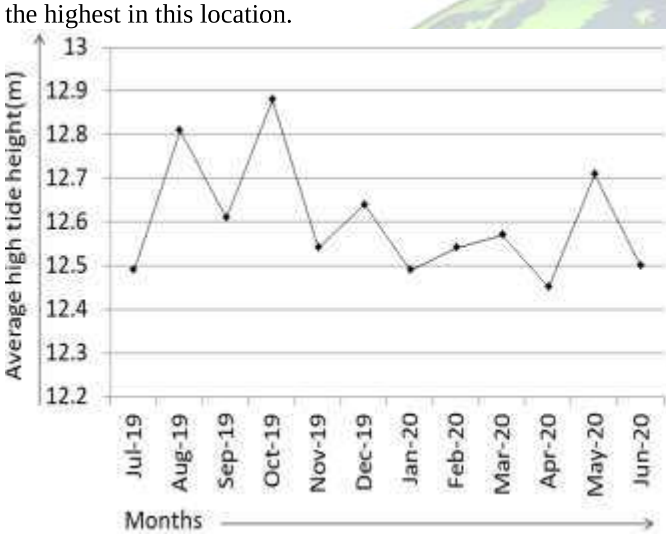

Fig.(iii): Average First and Second High Tide Graph

Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20
12.49	12.81	12.61	12.88	12.54	12.64	12.49	12.54	12.57	12.45	12.71	12.50

Table.3: Average Monthly First and Second High Tide Height (m)

Fig.(iii) shows the first and second average high tide graph taken within July- 2019 to June-2020. Table.3 shows the average monthly first and second high tide height(m). We observe here that, the high tide height is at peak during October- 2019 with 12.88 m.

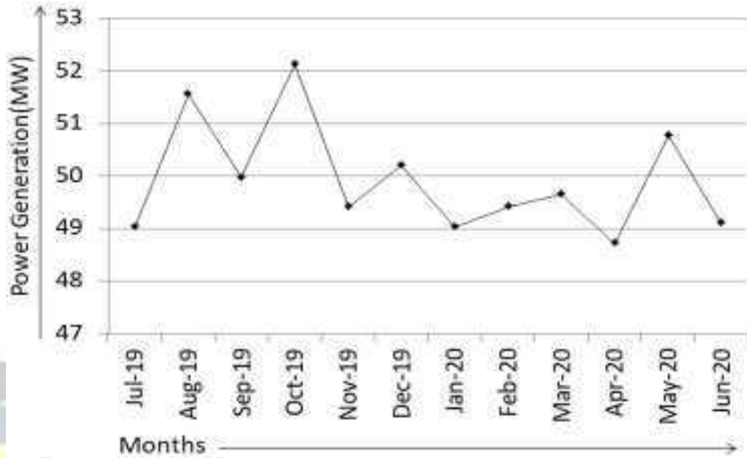

Fig.(iv): Power Generation Graph

Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20
49.02	51.56	49.97	52.13	49.41	50.20	49.02	49.41	49.65	48.71	50.76	49.10

Table.4: Power Generation (MW)

Fig.(iv) shows the power generation graph taken within July- 2019 to June-2020. Table.4 shows the power generation(MW). We observe here that, the high power generation is during October- 2019 with 52.13MW.

VII. ADVANTAGES OF TIDAL ENERGY

- It is a renewable energy source.
- It is environment friendly energy source.
- Tidal currents are highly predictable.
- Tidal energy is better than fossil fuels.
- Tidal energy is effective at low tidal speeds.

VIII. DISADVANTAGES OF TIDAL ENERGY

- High tidal power construction is expensive.
- It has negative influence on marine life.
- Variable intensity of sea waves.
- They have location limitations.
- These can produce electricity during tidal surge only.

IX. FUTURE OF TIDAL ENERGY

Tides have a potential energy which can be harvested from tidal movements on a global scale. It is roughly estimated that around 1TW of exploitable power is stored in the world's oceans.

X. CONCLUSIONS

In this paper, an attempt has been made to study the potential of harnessing tidal energy for the electricity generation. Tidal energy doesn't depend on any climatic conditions. Hence, it is predictable.

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REFERENCES

[1]. Shaikh Md. Rubayiat Tousif, Shaiyek Md. Buland Taslim, "Tidal Power: An Effective Method of Generating Power," International Journal of Scientific & Engineering Research Volume 2, Issue 5, May-2011.

[2]. Prof. S.S. Shevkar, Prof.K.A.Otari "Tidal Energy Harvesting," International Journal of Science, Engineering and Technology Research (IJSETR), Volume 4, Issue 4, April 2015.

[3]. Farhan Lafta, Ahmed Hashim,Power Productiion using Tidal Energy, British Journal of Science, February 2012, Vol.3(2).

[4]. https://tides.mobilegeographics.com/calender/year/183.html?y=2019

[5]. https://scijinks.gov/tides/#:~:text=High%20and%20low%20tides%20are,of%20water%20are%20high%20high%20tides.

BIOGRAPHY

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