DESIGN AND DEVELOPMENT OF TIDAL ENERGY GENERATION SYSTEM

Chetan Mahajan, Sumanth Katkamwar, Varad Shirshat, Manas Jadhav, Prof.BG Patil

[1]*mechanical Engineering, k.k wagh Institute of Engineering and Research, Nashik*
[2]*mechanical Engineering, k.k wagh Institute of Engineering and Research, Nashik*
[3]*mechanical Engineering, k.k wagh Institute of Engineering and Research, Nashik*
[4]*mechanical Engineering, k.k wagh Institute of Engineering and Research, Nashik*
[5]*mechanical Engineering, k.k wagh Institute of Engineering and Research, Nashik*

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Abstract - Sustainable energy generation is becoming increasingly important due to the expected limitations in current energy resources and to reduce pollution. Wave energy generation has seen significant development in recent years. Renewable power generation has become increasingly vital in addressing global energy challenges and mitigating the impacts of climate change. Various forms of renewable energy sources, such as solar, wind, and hydroelectric power, have gained prominence in the pursuit of sustainable energy solutions. Among these, tidal power stands out as a promising option due to its predictability and minimal environmental impact. This abstract explores the significance of renewable power generation and introduces the concept of tidal power generation, focusing on the innovative technology of tidal floater turbines. It delves into their construction and operational principles, illustrating their potential as a sustainable energy source. Ultimately, this abstract underscores the growing importance of harnessing tidal power as a clean and reliable source of electricity for the future.

Tidal floater turbines represent an innovative system for harnessing the energy potential of ocean tides. These turbines are strategically constructed on the surface of the sea, where the dynamic ebb and flow of tides generate kinetic energy. The turbines consist of underwater rotors connected to electrical generators, which are capable of converting the mechanical energy of tidal currents into electricity. The operation of tidal floater turbines is driven by the predictable and consistent nature of tidal cycles, making them a dependable source of renewable energy. By exploiting the immense power of the ocean's tides, these turbines offer a sustainable solution for meeting the world's growing energy demands. The result from wave simulator using a real wave profile captured at a location in UK using an ultra sound system it was seen that ±0.8m wave at 10sec time period, produce a condition power output of approximate 22KW at optimum load condition for the tested 3 phase 44KW permanent magnet generator type STK500 the result indicate that this new technology could provide an effective and low cost method of generating electricity from waves.

In conclusion, the utilization of tidal power generation, specifically through the innovative technology of tidal floater turbines, holds significant promise in the realm of renewable energy. As society seeks to reduce its carbon footprint and transition towards cleaner energy sources, the predictability and consistency of tidal power make it an attractive option. Moreover, the construction of these turbines on the sea's surface minimizes ecological disruptions, further emphasizing their environmental sustainability. With ongoing research and development, tidal power generation has the potential to play a pivotal role in our quest for a greener and more sustainable energy future.

***Key Words*: Generator STK500, Sustainable power generation**

1.INTRODUCTION

Tidal power generators are a form of renewable energy that capitalizes on the predictable and consistent nature of tidal currents. Unlike wind or solar energy, tides are highly reliable and occur twice daily, making tidal power a consistent and predictable energy source. Portable tidal generators can be particularly useful for remote coastal communities or temporary installations, providing a sustainable energy source without the need for extensive infrastructure. Additionally, portable systems offer flexibility in deployment, allowing them to be positioned strategically to maximize energy production based on local tidal patterns and environmental factors.

We are overlooking one of the planet Earth's most abundant sources of renewable energy while focusing on solar and wind power as the two primary sources. Another tremendous source of electricity that we are missing out on is tidal power, or sea waves. We can use the enormous power that sea waves may generate as another renewable energy source. Now, we're going to suggest a dual power generator that uses both solar and sea wave energy to produce an infinite amount of energy. With this technique, we will be able to use a certain alternator-based generator arrangement to take use of the third renewable power source on Earth.

The sea wave plus solar generator is a one-of-a-kind, special generator that produces electricity by utilizing two different renewable energy sources. A buoy built into the machine is intended to float and move vertically with the waves at sea. By adopting a rack and pinion configuration, the buoy enables the generator motor to receive power from the sea waves. In order to transmit power efficiently, this shaft does not use a pulley system to transfer power to the motor.

The device generates an extra 50 watts of power for dependable power generation using a second power source, which is solar energy. The machine is designed to be easily portable using a wheel structure. Additionally, the machine is made of lightweight, rustproof materials to prevent rusting while being used in the sea. The device has the potential to save lives and serve as a dependable power source for ships or backup generators in coastal locations.

2. Body of Paper

Kinetic Energy : The energy due to the tidal stream flowing across the cross section with a velocity is given by:

$$P = \frac{\varepsilon \, X \, \rho \, X \, A \, X \, V^3}{2}$$

Where,

P = The power generated (in watts)

ε = The turbine efficiency (Assume 50%)

ρ = The density of seawater (seawater is 1025kg/m^3)

A = The sweep area of the turbine (Assume 0.3x0.3) (m^2)

v = The velocity of the flow. Assume Minimum 1 (m/s)

The turbine design is always proportional to the power output or efficiency of the turbine "ε". The power output of the turbine can be calculated using the equation below:

P = [0.5 x 1025 x (0.3x0.3) x 1^3] / 2

P = 2.5625 Watt.

2.1. Generator Motor Selection:

We know that, Relationship between power, force and velocity given by.

$$P = F \times V$$

$$2.5625 = F \times 1$$

$$F = 2.5625 \text{ N}$$

F = Force to be applied on Float =

T = Torque transmitted to the Generator motor N.m.

$$T = 2.5625 \times 0.6$$

$$T = 1.5375 \text{ N.m}$$

P = Power of motor

N = Speed of the generator = 20 rpm

$$\mathbf{P = (2 \pi N T) / 60}$$

$$P = (2 \pi \times 20 \times 1.5375) / 60$$

$$P = 3.2185 \text{ Watt.}$$

Thus, selecting a Generator motor will be produce 32- watt power per sec.

The Generator motor will be of the following specifications

12V DC Motor

Power = 50 watt

Speed = 20 rpm

2.2. Central Shaft Design :

For shaft material C40 P.No. .1.12.DDB.

Sut = 680 Mpa.

$$\tau \text{ max} = \frac{Sut}{2 \times FOS} = \frac{680}{2 \times 2} = 170 \text{ N/mm}^2$$

Design torque T = 15 N.m.

Tensional shear stress T = □/16 x τ xd³

$$\mathbf{T = \pi /16 \times \tau \times d^3}\ 15 \times 10^3$$

$$T = \pi /16 \times 170 \times d^3$$

d = 7.65 select d = 10mm

2.3. Selection of Ball Bearing:

The primary determining factor in ball bearing selection is the drive's system design, meaning that the bearing's size is crucial. For this reason, we will start by choosing the right ball bearing. Considering how easy it is to mount the ball bearing. Since the shaft diameter is 10 mm, we welded a 10 mm shaft supporter to it and chose a ball bearing with a 10 mm shaft outer diameter to hold the 10 mm shaft.

(PSG Design data book P.No. 4.13.)

2.4. Spur gear system:

Power is transmitted from the rack to generator motor shaft by means of a pinion gear.

No teeth on pinion Zp=25

Material of rack and pinion both are nylon, DDB. P. No. 1.41.

Sut p = 82 N/mm^2

Application factor ka = 2

Load distribution factor km = 1\

Factor of safety Nf = 1.5

BHN =24

Power P = 50 Watt

Np = 20 rpm

Beam strength (δb) :

$6bp = \frac{Sup}{3} = \frac{82}{3} = 27.33\ N/mm^2$

Assuming 20^0 full depth involution system,

$Yp = 0.484 - \frac{2.87}{Zp}$

$= 0.484 - \frac{2.87}{25} = 0.3692$

Now, δ_{bp} . Yp = 27.33 ×0.3692= 10.0902 N/mm^2

Estimate the module on based on beam strength,

Sb ≥ P eff

Sb = beam strength

P eff = effective load on pinion

Sb = P eff x FOS

P eff = Pt

Pt = Tangential load on pinion

$P\ eff = Pt = \frac{2\ X\ maximum\ torque}{No.of\ teeth\ X\ module}$

$= \frac{2\ X\ 15 \times 1000}{25\ X\ m}$

Sr. No.	Operation	Machine	Tool	Time
1	Cutting the material as per our required size.	Cutting machine	Cutting machine	50 min
2	Welding the frame as per required size.	Welding machine	Arc Welding tool	75 min
3	Grinding the frame.	Grinding machine	Grinding machine	20 min

$P\ eff = Pt = \frac{1200}{m}$ = N.mm

Beam strength of pinion.

Sb = module X face width X Max. bending Load X Lewis factor

$Sb = m \times b \times \frac{Sut}{3} \times Yp$ b = 10m

$m = \frac{17.83}{m^2}$

$m^3 = 17.83$ **m = 2.61 ≈ 2.75mm**

Dimensions of gear:

m = 2.75

Zp = 25

B = 10m = 27.5 mm

Dp = m x Zp = 2.75 x 25 = 68.75 mm

ha = 1m = 2.75 mm

hf = 1.2m = 3.3 mm

Table -1

MANUFACTURING PROCESS SHEETS

1. PART NAME: Supporting frame.

Part weight – 10 kg

Part material – M.S.

Part quantity – 1

2. PART NAME: Rack Slider Guide.

Part weight – 1 kg

Part material – M.S.

Part quantity – 1

Sr. No.	Operation	Machine	Tool	Time
1	Cutting the material as per our required size.	Cutting machine	Cutting machine	20 min
2	Welding the frame as per required size.	Welding machine	Arc Welding tool	35 min
3	Grinding the frame.	Grinding machine	Grinding machine	15 min

3. PART NAME: Battery Bracket

Part weight – 0.5kg

Part material – M.S.

Part quantity – 1

Sr. No.	Operation	Machine	Tool	Time
1	Cutting the angle as per our required size.	Cutting machine	Cutting machine	20 min
2	Welding the bracket to main frame.	Welding machine	Arc Welding tool	30 min
3	Grinding the bracket with frame.	Grinding machine	Grinding machine	10 min

4. PART NAME: Solar Frame

Part weight – 1 kg

Part material – M.S.

Part quantity – 1

Sr. No.	Operation	Machine	Tool	Time
1	Cutting the angle as per our required size.	Cutting machine	Cutting machine	15 min
2	Welding the solar frame to main frame.	Welding machine	Arc Welding tool	20 min
3	Grinding the bracket with frame.	Grinding machine	Grinding machine	10 min

5.COST OF MACHINING

Machine Name	Using Time (min)	Rate /hr	Total Rate Rs/-
Cutting	115	500	960
Welding	160	800	2130
Grinding	55	500	460

TOTAL COST OF MACHINING: 3,550/-RS.

Fig -1: TIDAL ENERGY GENERATION SYSTEM

3. CONCLUSIONS

In conclusion, the design and development of tidal energy generation systems present a promising avenue for sustainable energy production. Through innovative engineering and technology, these systems harness the immense power of tidal currents to generate electricity with minimal environmental impact. However, successful implementation requires careful consideration of various factors such as site selection, engineering challenges, economic viability, and environmental sustainability.

As we continue to advance in renewable energy technologies, tidal energy holds significant potential to contribute to the global energy mix and reduce reliance on fossil fuels. With ongoing research and development, coupled with supportive policies and investments, tidal energy generation can play a crucial role in shaping a cleaner and more sustainable energy future.

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