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# MODEL DESIGN OF HYBRID CARRIER SHIP WITH POWER PRODUCTION

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**Abstract -** The basic idea of this project is to make the sea transport work more efficiently. The idea behind this project is to use the sea water for power generation. Hybrid ships, as the name suggests, are simply vessels designed and constructed to use a combination of alternate means of propulsion mainly from a conventional gas or fuel-powered engine and also, from electrical sources derived from rechargeable means like batteries. The principle behind this project is to install turbine in the ship without any imbalance. At the initial stage the ship is powered by diesel engine, after exhibiting a certain speed limit then we will send the opposing sea water to the ship into the turbines installed in the ship. When the sea water hits the turbine then the turbine starts rotating and we can generate power through this process.

The generated power can be used to supply the power to the propeller or to charge the electrical engine or we can also use the obtained power to the general electricity purposes. This type of hybrid ship consumes more initial power to rotate the turbines as the whole application is totally dependent on the speed of the ship but once the turbine rotate in high speed then we can obtain a more efficient way of sea transport. Through this process we can minimize the exhaust emissions and also, we can increase the diesel engine fuel efficiency.

***Key Words***: Hybrid ship, CATIA, Savonius Turbine, Propulsion, Power Production.

## 1.INTRODUCTION

Hydroelectric power engine was first started in 1878 to power a single lamp in the Crag side country house in Northumberland, England. From that point there are so many advancements in hydroelectric power productions and there are so many working hydro power plants in almost every country but in almost all these power plants the working fluid is either downstream rivers or high stack reservoirs and dams. In general, Hydroelectric power is a renewable energy source that generates electricity by using the kinetic energy of falling water. There are several types of hydro power production, including:

- Conventional Hydroelectric Power
- Pumped Storage Hydroelectric Power
- Run-of-River Hydroelectric Power
- Small-Scale Hydroelectric Power

In all these hydro power plants the common thing is these plants are situated near sources of falling water, such as rivers, dams, and waterfalls. The location of hydro power plants depends on several factors, including the availability of water, the amount of head (vertical drop), and the distance to transmission lines that can transport the electricity to consumers.

About 71% of the Earth's surface is covered by water, while approximately 29% of the Earth's surface is land. This means that the ocean covers about 361 million square kilometers (139 million square miles), while the land covers about 149 million square kilometers (57 million square miles). These hydro power plants mentioned above use the water present in the 29% of land which is very small when compared to the 71% of ocean water. There are very few power production through ocean, also known as ocean energy, refers to the process of converting the energy from the ocean's waves, tides, currents, and temperature differences into usable electricity. There are several ways to harness ocean energy, including:

- Wave Energy
- Tidal Energy
- Ocean Current Energy
- Ocean Thermal Energy Conversion (OTEC)

These are the mainly used ocean power plants and the power produced from these operations are very low when compared to the hydroelectric power plants. Through this project we can have new power generation technique where we can observe an approximate level of power production when compared to the hydroelectric power plants but this operation takes place in ocean and it is only beneficial for hybrid ships, if we can store the power generated from this mechanism then we can also use it for other applications also.

In our day-to-day life, there is an increase in demand for hybrid vehicles and now-a-days many industries are using hybrid ships for transportations and for other applications. In general hybrid ships contain combination of alternate means of propulsion mainly from a conventional gas or fuel-powered engine and also, from electrical sources derived from rechargeable means like batteries. Sea transport is responsible for 80% of transport worldwide and if there is way to charge these hybrid ships economically, then we can complete the respective operation in a efficient and productive way. Hybrid ships are vessels that use a combination of two or more power sources to propel themselves. Typically, hybrid ships use a combination of diesel engines and electric motors. The diesel engines provide the primary source of power, while the electric motors provide additional power when needed. The electric motors in hybrid ships are typically powered by batteries that are charged either by the diesel engines or through regenerative braking.

When the ship is at low speeds or at rest, the electric motors can be used exclusively, which reduces emissions and noise. Hybrid ships offer several advantages over traditional ships that rely solely on diesel engines. These advantages include improved fuel efficiency, reduced emissions, and lower noise levels. Additionally, hybrid ships can operate in electric-only mode when entering sensitive environmental areas or when in port, which further reduces their environmental impact. The main purpose of this project is to create power for a hybrid ship from the ocean while the ship is in motion by using the opposing sea water energy to the ship.

## 2.METHODOLOGY

### 2.1 HYDROSTATICS:

Hydrostatics is a branch of fluid mechanics that deals with the study of fluids at rest or in equilibrium. It involves the study of pressure, density, and buoyancy of fluids, which are essential for understanding the behavior of liquids and gases in a static or stationary state.

### 2.2 HYDRODYNAMICS:

Hydrodynamics is the study of the motion and behavior of fluids, including liquids and gases, in motion. It involves the application of principles of fluid mechanics, including conservation of mass, momentum, and energy, to study the behavior of fluids in motion.

### 2.3 STRUCTURAL DESIGN:

Structural design is the process of designing the structural elements of a system or a structure to resist the loads and forces that it will experience during its lifetime. In the context of naval architecture, structural design refers to the process of designing the hull and other structural components of a ship to withstand the loads and stresses that they will experience in service.

### 2.4 MECHANICAL SYSTEMS DESIGN:

Mechanical systems design is the process of designing and developing the mechanical components and systems that make up a machine or a device. It involves the application of principles of mechanics, materials science, and thermodynamics to design, analyze, and optimize the performance of mechanical systems.

### 2.5 ENVIRONMENTAL IMPACT ASSESSMENT:

Environmental Impact Assessment (EIA) is the process of evaluating the potential environmental impacts of a proposed project or development. In the context of naval architecture, an EIA may be conducted for a ship construction or refurbishment project to assess the potential environmental impacts of the project and to identify measures to mitigate these impacts.

### 2.6 COST ANALYSIS:

Cost analysis is a method of evaluating the costs associated with a project, process, or activity. In the context of naval architecture, cost analysis is an important part of ship design and construction, and involves estimating the costs associated with building and operating a ship.

### 2.7 SAVONIUS TURBINE:

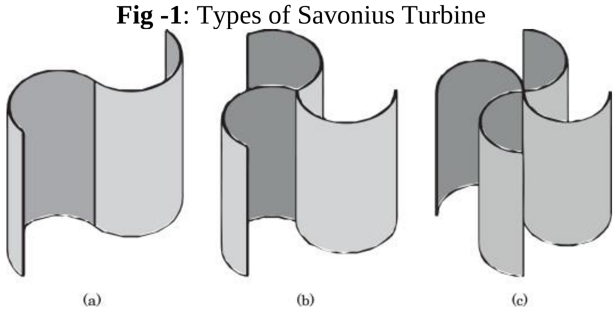
The turbine we use for the power production in this process is savonius turbine, in general it is used as wind turbine but as we are trying to generate the power from ocean water the normal savonius turbine does not survive the impact so we are only using the design of the savonius turbine.

A Savonius turbine is a type of vertical-axis wind turbine that is named after its inventor, Finnish engineer Sigurd Savonius. It is a simple, low-cost wind turbine that is often used for small-scale power generation applications.

The Savonius turbine consists of two or more curved blades that are arranged in a vertical cylinder. The blades are shaped like half-cylinders and are arranged so that they overlap each other. As wind blows over the blades, they rotate around a central shaft, generating torque that can be used to drive a generator or other mechanical device.

One of the advantages of the Savonius turbine is its simplicity and ease of construction. It can be built using simple materials and does not require complex machinery or manufacturing processes. It is also relatively compact and can be installed in urban or suburban areas where space is limited.

**Fig -1**: Types of Savonius Turbine



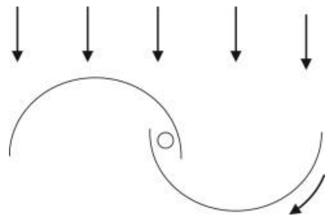



**Fig -2**: Savonius Turbine

However, the Savonius turbine has some disadvantages compared to other types of wind turbines. It has a relatively low efficiency, which means that it generates less power for a given wind speed compared to other types of turbines. It is also sensitive to changes in wind direction and may not perform well in areas with highly variable wind conditions.

Overall, the Savonius turbine is a simple and low-cost option for small-scale wind power generation applications, but may not be as suitable for larger-scale or more demanding applications.

## 3.WORKING OPERATION FOR POWER PRODUCTION

To achieve power production through ocean water in a ship we should make some changes in the ship i.e installation of the turbine on the sides of the ship and making sure that the turbines are completely immersed in the ocean. The ship we are considering is a hybrid ship so that the produced energy can be used to power the electric battery of the ship.

The steps to achieve the power production are listed below:

- Initially the ships run on the alternate engine i.e either conventional gas or fuel-powered engine from the port or shore up to certain distance in the sea.
- As the speed increases the opposing water force will also increase and we are going to use this energy for power production.
- After attaining some speed, the inserted turbines will start to spin, as the ship moves forward the opposing water will enter the turbine which results in the movement of the turbine.
- When the turbine is rotating, due to the common shaft connected to the turbine and rotor, the rotor will also rotate which results in the production of electricity.
- The obtained electricity is stored in the form of electric batteries which can be used for the charging of electric engine of the hybrid ship and it can also be used for General Electric uses in the ship.
- The power production through this process is totally dependent on the speed of the ship, as the speed increases the opposing force increases and due to this there will increase in turbine rotation which leads to more power production.

## 4.POWER PRODUCTION EQUATION

The Savonius turbine is a type of vertical-axis wind turbine (VAWT) that was invented by Finnish engineer Sigurd Johannes Savonius in the 1920s. It consists of two or more S-shaped blades that rotate around a central axis when wind blows on them. The shape of the blades creates a lift force that causes the turbine to spin. According to Betz's law, the maximum power that is possible to extract from a theoretical ideal rotor of a savonius turbine is $\frac{16}{27}\frac{1}{2}.\rho.h.d.v^3$.

where, $\rho$ = Density of water

$h$ = Height of the rotor

$d$ = Diameter of the rotor

$v$ = Speed of the water input

Now by considering the experimental values of variables like:

- Density of water ( $\rho$ ) = 1036 kg/m3
- Height of the rotor ( $h$ ) = 400 mm
- Diameter of the rotor ( $d$ ) = 400 mm
- Speed of the water inlet ( $v$ ) = 37 km/hr or 10.277 m/sec

Now by substituting all the values in the savonius power equation, we get:

$$P_{max} = 53.309 \text{ KW}$$

According the operation, design, and power equation we can say that the power production is directly proportional to the speed of the water inlet into the turbine. As the speed of the inlet water increases the power production rate increases and if the speed of the water inlet decreases then the power production rate will also decrease. The approximate power production values are listed below in the tabular form according to the increase in the speed of the water inlet.

Tabular data for increase in speed inlet to the power production:

| S. NO. | Speed of the water inlet ($v$) | Power Production ($P$max) |
|---|---|---|
| 1 | 10.277 m/sec | 53.309 KW |
| 2 | 12.277 m/sec | 90.833 KW |
| 3 | 13 m/sec | 107.903 KW |
| 4 | 14 m/sec | 132.676 KW |

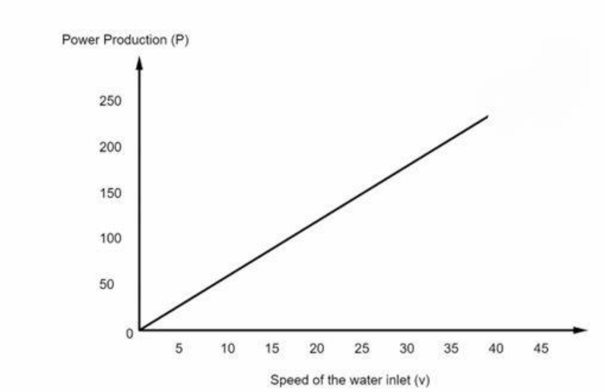



**Fig -3**: Graphical representation of the Inlet speed and power production ratio.

## 5. DESIGN OF THE MODEL

All the design work is done in CATIA V5 and the initial model of the hybrid carrier ship model ship is given below:

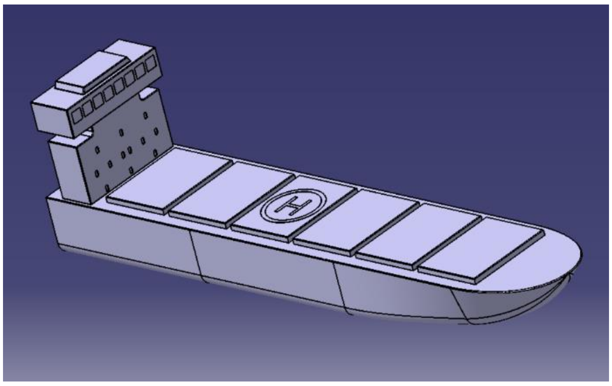


**Fig -4**: Initial design of the hybrid Carrier ship model.

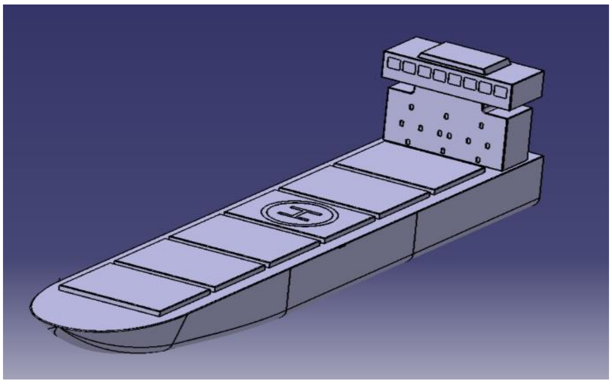


**Fig -5**: Initial design of the hybrid Carrier ship model.

The design of the Savonius Turbine is given below:

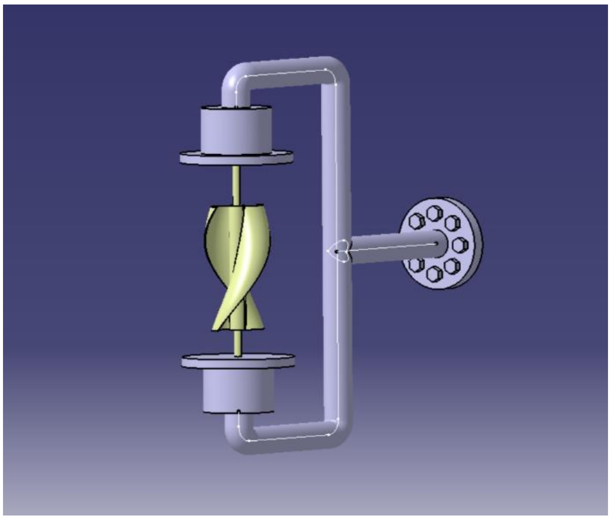


**Fig -6**: Design of Savonius Turbine.

The final model or the modified hybrid carrier ship with Savonius Turbine is given below:

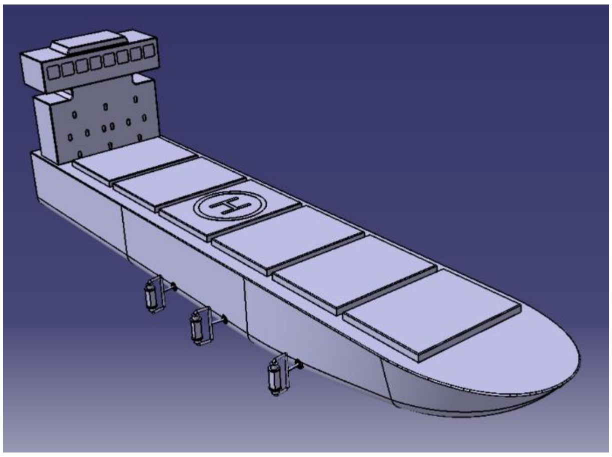


**Fig -7**: Final design of the hybrid Carrier ship model with Savonius Turbine.

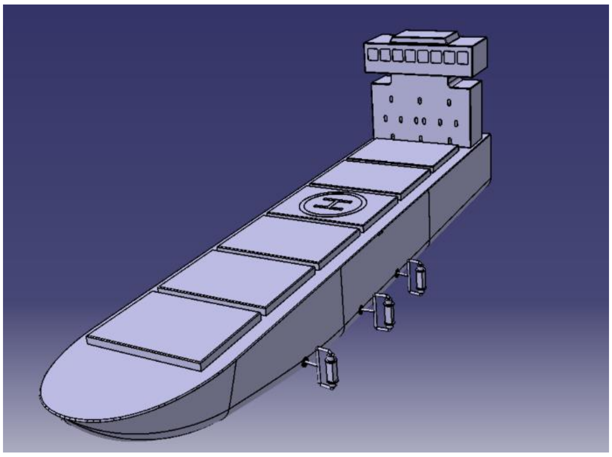


**Fig -8**: Final design of the hybrid Carrier ship model with Savonius Turbine.

## 6. CONCLUSION

The design of the final ship model is compact and efficient. The installation of turbines are in such a way that the water will be entering the turbine at a maximum speed possible and the design can be upgraded by installing a fence like structure around the turbine so that there will no disruption in the rotation of the turbine due to the sea wastes and animals.

The main objective of the project is to produce power from this operation, we can observe the power production which is approximately 53.309 KW which may not be sufficient for direct connection to the propeller of the ship, but for a hybrid ship we can charge electric battery of the ship with this energy and we also use it for other electric applications. As the ship initially runs on fuel-gas engine after attaining certain speed limit then it changes to electric engine and with constant speed the turbine rotates and power production takes place. This power is to be stored in the form of batteries so that they can be used to charge the electric batteries after usage.

There can be some changes in the design like in this project we can see that the turbine used is a savonius turbine design which are generally used for wind power applications but if we can have a more efficient way for producing power, we can consider an alternate turbine. The main goal of the project is to use the energy of the opposing force of the sea water on the ship productively and an additional power can help us in many aspects like time saving, less emissions, less usage of fossil-fuels and renewable power source.

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