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## Enhancement of the Efficiency of Windmill Using Helical Designed Savonius Turbine

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**ABSTRACT:** Today the world runs on a platform of energy sources that will not be available forever. That's why it's important to understand and find ways to create energy from sources that are free, constant and would supply us forever. Hence we use windmills to produce energy by using the available motion of air. The air as the driving force agent drives the blades of the wind mill and as a result, the coupled generator generates electricity. Generally, these traditional wind mills require large amount of air driving force. Hence altering the design of those heavy weight blades with weightless helical design with savonius turbine helps us to increase the electricity production and also ensures us the available of the conversion process even with low amount of air driving force. The main components of this wind mill are wind mill sails, main shaft, gear box, generator and external circuit.

### I. INTRODUCTION

#### WIND MILLS :

Today the world runs on a platform of energy sources that will not be available forever. That's why it's important to understand and to find ways to create energy from sources that are free and constant. Just one way of doing this is by harnessing the energy of the wind and converting it into electricity. This is the basic principle on which windmills work. Probably most familiar are the windmills of Holland, which are massive and dot the landscape in large clumps of sometimes hundreds. Windmills are able to use the wind, which is a constant source of natural energy, to create electricity that can power homes and cities, depending on how many there are and how big they are.

#### 1.2 Types :

- a) Horizontal Axis Turbines
- b) Vertical Axis Turbines

There are two types of windmills, called the horizontal axis turbines and vertical axis turbines. Vertical axis turbines are rarely found and have blades that look like an egg beater. Horizontal axis turbines have blades that look like airplane propellers and they work on the same principle. As wind blows into a windmill, the propeller-like blades slow it down and begin to "catch" or harness the wind. The wind blowing over these blades creates lift, which turns the blades, much in the same way as lift helps an airplane fly.

Inside the windmill is where electricity is generated. Connected to the rotating blades, which are constantly busy catching wind as long as there is at least a breeze, is a drive shaft that runs down to a generator inside the windmill's base structure. As the blades spin, the drive shaft begins to turn, which causes the generator to create electricity. This electricity is then run through wires that lead directly into the buildings where the electricity is needed.

Windmills come in many sizes, some of which are used to power a single home and others that are used in a group of windmills to generate enough electricity to power thousands of homes. Small windmills can create about 100 kilowatts of energy and are sometimes used to power farms and other homes. Larger turbines can generate many megawatts of energy. The one catch is that there has to be wind in order for a windmill to operate. If the blades are not able to spin, then there will not be any electricity to generate. Windmills are a simple process, but they are cheap and can create electricity without being harmful to the environment.

Wind power is the conversion of wind energy into a useful form of energy, such as using wind turbines to make electricity, wind mills for mechanical power, wind pumps for pumping water or drainage, or sails to propel ships.

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Large-scale wind farms are connected to the electric power transmission network; smaller facilities are used to provide electricity to isolated locations. Utility companies increasingly buy back surplus electricity produced by small domestic turbines. Wind energy as a power source is attractive as an alternative to fossil fuels, because it is plentiful, renewable, widely distributed, clean and produces no greenhouse gas emissions.

### 1.3 Comparison of HAWT AND VAWT :

The HAWT is the most common turbine configuration. The propellers and turbine mechanisms are mounted high above the ground on a huge pedestal. It is a matter of taste as to whether they enhance the landscape. However, there is no denying that the height at which their mechanisms are located is a disadvantage when servicing is required. Also, they require a mechanical yaw system to orient them such that their horizontal axis is perpendicular to and facing the wind. As potential power generation is related to the swept area (diameter) of the rotor, more power requires a larger diameter. The blades experience large thrust and torque forces, so size is limited by blade strength. A VAWT does not need to be oriented into the wind and the power transition mechanisms can be mounted at ground level for easy access.

### 1.4 Advantages of vertical axis wind turbines :

VAWTs offer a number of advantages over traditional horizontal-axis wind turbines (HAWTs). They can be packed closer together in wind farms, allowing more in a given space. This is not because they are smaller, but rather due to the slowing effect on the air that HAWTs have, forcing designers to separate them by ten times their width. VAWTs are rugged, quiet, omni-directional, and they do not create as much stress on the support structure. They do not require as much wind to generate power, thus allowing them to be closer to the ground. By being closer to the ground they are easily maintained and can be installed on chimneys and similar tall structures.

Researches conducted at California Institute of Technology has also shown that carefully designing wind farms using VAWTs can result in power output ten times

## II. LITERATURE REVIEW

### F. Behrouzi, A. Maimun, M. Nakisa (Review of Various Designs and Development in Hydropower Turbines )

(2014) The growth of population, rising fossil fuel prices (limited and decreasing day by day), pollution problem due to use of fossil fuels and increasing electrical demand are important factors that encourage the use of green and renewable energy technologies. Among the different renewable energy technologies, hydro power generation (large and small scale) is the prime choice in terms of contribution to the world's electricity generation by using water current turbines. Currently, researchers mainly focused on design and development of different kind of turbines to capture hydropower to generate electricity as clean and reliable energy. This paper is a review of the status of research on water current turbines carried out to generate electricity from hydrokinetic energy especially in places where there is no electricity, but there is access to flowing water. The conversion of kinetic energy of water is done by vertical and horizontal turbines where the turbine blades would turn the generator and capture the energy of the water flow to produce electricity. In order to quantify the performance of turbines, many researchers focus on increasing the output power of turbines. The power coefficient ( $C_p$ ) shows that the hydrokinetic turbines can only harness a fraction of the total kinetic power thus; improvement on turbine system is required to reach a high value of performance coefficient (VPC). The Performance coefficient depends on the velocity of current and design of system. Increase of which can be done in two ways . One of them is by increasing the water current velocity by:\

- 1) Installing the turbine system at places where the land slopes or water current velocity are relatively higher.
- 2) Increasing water flow speed by creating man-made channel, where the frictional resistance can be minimized.
- 3) Increasing water flow velocity at the inlet of turbine by using nozzle or duct . Another method is increasing the performance coefficient of the system by improving the blade form, profile or include more information about new design or developing other turbine system.

As a conclusion, Nowadays, growing population, electricity demand and pollution due to fossil fuels have encouraged people encourages to use renewable energy instead of fossil fuels. Hydropower is undeniably the first choice for renewable energy that can harness the kinetic energy of water by implementation of turbines. Improvement of turbines

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is compulsory increase their performance. Today, many researchers attempt to offer new concept, new design or new device to enhance performance coefficient. **Ashitosh Dhadwad (Blade Design of Hydro-Microturbines) (2010)** : Microturbines have wide range of applications in power generation for domestic purpose like lighting, battery charging, for a small scale fridge etc. Large amount of research is in progress for improvement in design of Microturbine in terms of efficiency, self-starting ability and torque. This paper discusses the various types of traditional and hybrid Microturbine. It was found from the review that Darrieus and Savonius hybrid Microturbines removed most of the problem faced by traditional Microturbines. **Mr. Abhijit N Roy (Design and Fabrication of Vertical Axis Economical wind mill)(2010)** From the recent surge in fossil fuels price, demands for cleaner energy sources and government funding incentives, wind turbine are becoming more viable technology for electrical power generation. Fortunately there is an abundance of wind energy to be harnessed. Today, wind turbines have to compete with many other energy sources. It is therefore important to be cost effective and for that there need to meet any load requirements and produce energy at a minimum cost per dollar of investment. Performance characteristics such as power output versus wind speed or versus angular velocity must be optimized in order to compete with other energy sources. Vertical Axis Wind Mill (VAWM) is a type of wind turbine where the main rotor shaft is set vertically. Among the advantages of this arrangement are that generators and gearboxes can be placed close to the ground, and that VAWTs do not need to be pointed into the wind. AVAWT tipped sideways, with the axis perpendicular to the wind streamlines, functions similarly. A more general term that includes this option is 'transverse axis wind turbine'. The main advantage is that, it is economically eco-friendly.

### III. METHODOLOGY

#### 1 WORKING PRINCIPLE OF THE TURBINE :

Savonius turbines are one of the simplest turbines. Aerodynamically, they are drag-type devices, consisting of two or three blades (vertical – half cylinders). A two blades savonius wind turbine would look like an "S" letter shape in cross section. The savonius wind turbine works due to the difference in forces exert on each blade. The lower blade (the concave half to the wind direction) caught the air wind and forces the blade to rotate around its central vertical shaft. Whereas, the upper blade (the convex half to wind direction) hits the blade and causes the air wind to be deflected sideways around it.

Because of the blades curvature, the blades experience less drag force ( $F_{convex}$ ) when moving against the wind than the blades when moving with the wind ( $F_{concave}$ ). Hence, the half cylinder with concave side facing the wind will experience more drag force than the other cylinder, thus forcing the rotor to rotate. The differential drag causes the Savonius turbine to spin. For this reason, Savonius turbines extract much less of the wind's power than other similarly sized lift type turbines because much of the power that might be captured has used up pushing the convex half, so savonius wind turbine has a lower efficiency. Similarly, the three blade savonius wind turbine is constructed from three half cylinders, they are arranged at (120°) relative to each other.

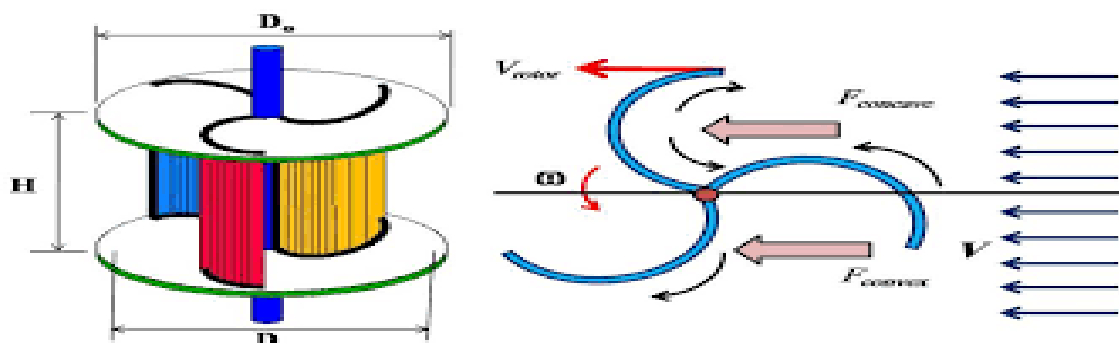


Figure 5.1 Working of the turbine

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## IV. RESULT AND DISCUSSION

### Fabrication Process :

#### 1 DESIGN DIMENSIONS :

Main Shaft Height	= 90 cm
Main Shaft Diameter	= 5 cm
Main Shaft Thickness	= 1.5 mm
Wind Mill Blade Height	= 90 cm
Wind Mill Blade Thickness	= 1 mm
Wind Mill Blade Diameter	= 27 cm
Base Plate Diameter	= 32 cm
Blade Angle	= 60 degree
Number of Blades	= 3

#### WIND ENERGY POWER CALCULATION :

The wind mill works on the principle of converting kinetic energy of the wind into mechanical energy. The kinetic energy of any particle is equal to one half of its mass times the square of its velocity.

$$K.E = \frac{1}{2} m v^2 \dots\dots\dots (1)$$

K.E = Kinetic Energy

m = Mass

v = Velocity

M is equal to its volume multiplied by its density  $\rho$  of air.

$$m = \rho AV \dots\dots\dots (2)$$

Substituting equation (2) in (1),

We get,

$$K.E = \frac{1}{2} \rho AV \cdot V^2$$

$$K.E = \frac{1}{2} \rho A V^3 \text{ watts}$$

P = Density of air (1.225kg/m<sup>3</sup>)

$$A = \frac{\pi D^2}{4}$$

D = Diameter of the blade.

D = 0.27m

$$A = \frac{\pi * (0.27)^2}{4}$$

$$A = 0.057 \text{ sq.m}$$

Available wind power is ,

$$P = (\frac{1}{2} \rho \times (0.057) \times V^3)$$

$$P = (0.0286 \times \rho \times V^3)$$

#### TRAIL 1 :

For Velocity 4.5 m/s,

$$P = (0.0286 \times \rho \times V^3)$$

$$P = (0.0286 \times 1.225 \times 4.5^3)$$

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P = 3.19 watt

## TRAIL 2 :

For Velocity 5 m/s,

$$P = (0.0286 \times \rho \times V^3)$$

$$P = (0.0286 \times 1.225 \times 5^3)$$

P = 4.37 watt

## TRAIL 3 :

For Velocity 5.5 m/s,

$$P = (0.0286 \times \rho \times V^3)$$

$$P = (0.0286 \times 1.225 \times 5.5^3)$$

P = 5.82 watt

In the project three blade with vertical shaft are used, it has a height & width of 18 inches & 13 inches respectively. The angle between two blades is 60°. So if one Blade moves other blades comes in the position of first blade, so the speed is increases.

While designing the shaft of blades it should be properly fitted to the blade. The shaft should be as possible as less in thickness & light in weight for the six blade, the shaft used is very thin in size are all properly fitted. So no problem of slipping & fraction is created, it is made up of hollow Aluminum which is having very light weight. Length of shaft & diameter are 18 inches & 2.54cm respectively. And at the top and bottom ends mild steel of length linch each are respectively are fixed to give strength to the hollow shaft.

For the smooth operation of Shaft, bearing mechanism is used. To have very less friction loss the two ends of shaft are pivoted into the same dimension bearing. The Bearing has diameter of 2.54cm. Bearing are generally provided for supporting the shaft and smooth operation of shaft. We have used ball bearings for the purpose of ease of maintenance

For generation of electricity from the designed our vertical axis wind turbine, we chose a Bicycle dynamo which has the capacity to light a bulb of 12 V.

## IV. CONCLUSION

The progress in science & technology is a non-stop process. New things and new technology are being invented. As the technology grows day by day, we can imagine about the future in which thing we may occupy every place. The proposed system based on wind energy is found to be more compact, user friendly and less complex, due to the availability of continuous wind power. The principle of the development of science is that "nothing is impossible". So we shall look forward to a bright & sophisticated world.

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