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Fabrication of Echofriendly Highway Dynamometer

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A B S T R A C T

Nowadays, as technology, science and population are increasing and getting more and more advance every day, scientist think of manipulating renewable energies because non-renewable energies are running out in the world and needs millions of years to produce again. The main type of renewable energy is wind andthis wind can be converted to electrical energy by the help of wind turbines. There are two types of wind turbines, vertical axis and horizontal axis. HAWT are wind turbines that the blades are rotating horizontally and they are very efficient turbines but occupies large areas, need constant, high velocity wind to operate andthey need regular maintenance. However, Vertical axis wind turbines are also efficient turbines, they are smaller in size and can be installed anywhere in the cities and highways. This type of turbines can be placed in high ways where there is constant wind produced by the fastmoving cars and also the atmosphere. High- Way VAWT like all the wind turbines converts kinetic energy of the blades to electrical energy, but this type is small, the blades are different and they can be placed anywhere to produce electricity for the traffic lights,street lights, security cameras and many other applications. Vortex generators can also be attached to this typeof wind turbines which optimizes it to get the maximum power possible to get from that wind velocity and turbine size.

Keywords :Wind, Turbine, High Speed

1.Introduction

The world is becoming increasingly advanced in technology, manufacturing and agriculture to fullfill the demands of human beings as the population increases. These advancements were mostly accomplished through manipulation of non-renewable energy sources such as petrol and water for daily life purposes of operating factories, vehicles, electrical generators …etc. Upon total consumption of these types of fuel, however, millions of years are required for them to be restored. Furthermore, fuels pollute the environment,cause global warming and numerous diseases. As a substitute for these types of energy sources, alternative energy generators must be used by means of manipulating wind for energy production. Wind turbines are extremely qualified due to their environmentally friendly characteristics and more importantly, their high efficiency and energy generation capability.Wind is highly competent to replace fossil fuel when it comes to electricity production following its conversion to mechanical energy. It is abundant and does not pollute the environment since there is neitherchemical reaction nor emissions nor combustion. Wind energy has been used for thousands of years in many parts of the world. In 11th century, Europe and Middle East, people utilized it in moving boats and in operating agricultural windmills, wood cutting and in pumping water. In 1970's United States, the shortage of oil stimulated the development of the idea of utilizing wind as an alternative energy source and as a result, wind turbines have been produced thereafterit slowly spread out in the world. [1]Wind energy can be exploited when it's converted to mechanical energy. This conversion is performed using wind turbines. The primary types of turbines are Vertical Axis Wind Turbine (VAWT) and HorizontalAxis Wind Turbine (HAWT). Horizontal Axis Turbines contains both downwind and upwind configurations. HAWTs operate only in highspeed wind and are more efficient than VAWT but rendered ineffective during turbulent winds. Vertical Axis Turbines are smaller in size and operate in low-speed wind; their blades are designed in a manner that is able to rotate in any direction and type of wind, whetherturbulent or laminar. VAWTs can be installed in urban areas due to their small size, relatively quiet and safe characteristics, being easy-to-install and cheapness in terms of repairs and maintenance. However, HAWTsare only placed in rural areas where there are no inhabitants due to their massive size and their need forhigh speed wind to operate. [2][3] [4]There are two types of VAWT, drag type and lift type. The drag type has high torque but law rotational speed which can be used for water pumping applications. However, the lift type has low torque but high rotating speed which can be used for producing high electrical power. [5]Vortex Generators (VG) are small aerodynamic devices made of a plate and have an angle. It is placed perpendicular to the surface of the moving object. These devices are used to keep and align the air to be attached on the surface of the moving airfoil and do not allow the air flow to get separated and interrupted. These VGs are used mainly on airplane wings, cars and wind turbines to improve aerodynamics by way of reducing drag increasing lift. Vortex generators can improve the performance of wind turbines significantly when attached to their blades in an appropriate way. The blades of turbines are subject to erosion and roughness which has a negative impact on the performance of the wind turbines because it causes the airflowto detach from the blades. However, installing VGs, which look like small inclined fins, and attaching them on each blade reduces the air flow separation from the blades of the turbines and it optimizes the efficiency and operation of the turbine. As a result, the maximum power of the turbine is increased. [6] [7].

2.Previous work

There are two different styles of vertical wind turbines. One is the Savonius model, which is our project is based on, and the other type is the Darrieus model. The first model lookslike a gallon drum that is been cut in half with the halves placed onto a rotating shaft. The second model is smaller and looks much like an egg beater. Most of the wind turbines being used today are the Savonius models.

Renewable Energy UK website provided some information about these two model. "A Savonius is a type of vertical axis wind turbine (VAWT) generator invented in 1922 by SigurdJohannes Savonius from Finland though similar wind turbine designs had been attempted in previous centuries.

A Darrieus is a type of vertical axis wind turbine (VAWT) generator. Unlike the Savonius wind turbine, the Darrieus is a lift-type VAWT. Rather than collecting the wind in cups dragging the turbine around, a Darrieus uses lift forces generated by the wind hitting aerofoils to create rotation.

"Design, Analysis And Fabrication Of Savonius Vertical Axis Wind Turbine"

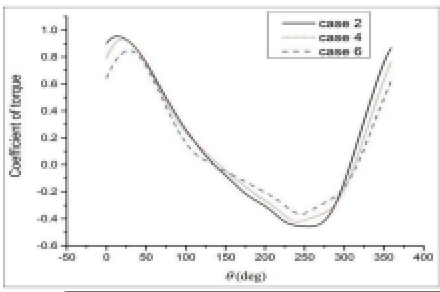
This research discussion was to showcase the efficiency of Savonius model in varying wind conditions as compared to the traditional horizontal axis wind turbine. It evaluated someobservation that showed that at low angles of attack the lift force also contributes to the overalltorque generation. Thus, it can be concluded that the Savonius rotor is not a solely drag-drivenmachine but a combination of a drag- driven and lift-driven device. Therefore, it can go beyondthe limit of Maximum power coefficient Cp established for the purely drag driven machines.

Some of this researched conclusions are that The vertical axis wind turbine is a small power generating unit with the help of free source of wind energy. It is designed under consideration of household use. Generally, At least 10% power of the consumption can be fulfilby the Savonius model. The research has also resulted that this turbine is generally suitable for8 to 10m of height above ground level. Because at ground level velocity of air is very less. And finally the alternate option for turbine blade material is reinforced glass fiber because of its more elastic nature but it is costlier than aluminum alloy.

Effect Of The Blade Arc Angle On The Performance Of A Sevonius Wind Turbine"

This article is focusing on how to improve the efficiency of the turbine by selecting the best blade angle. The effect of the blade arc angle on the performance of a typical twobladed Savonius wind turbine is investigated with a transient computational fluid dynamics method. Simulations were based on the Reynolds Averaged Navier–Stokes equations, and the renormalization group turbulent model was utilized.The numerical method was validated with existing experimental data.

The results of this article indicate that the turbine with a blade arc angle of 160° generates the maximum power coefficient cp 0.2836, which is the highest that gain from the experiment.

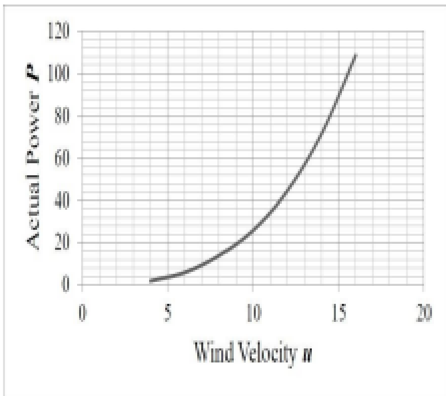


Case	Blade angle	$C_{P_{max}}$	C_P gain percentage (relative to case 4)
1	150	0.2687	2.67%
2	160	0.2836	8.37%
3	170	0.2835	8.33%
4	180	0.2617	0.00%
5	190	0.2521	−3.67%
6	200	0.2271	−13.22%

3.Comparative study

There was a student's project which was about designing and evaluating of twisted savories wind turbine. This work's goal was to testing the self-starting of the turbine, also the work was targeting of the design can be tested under harsh environmental conditions to assesslonger-term reliability.

After fabrication and experiments under different wind conditions, this project presented results as shown in the below table 1.2. The project conclusion was that the turbine has proved to be self-starting under low wind speed.



Wind Speed	
m/s	Volts
0	-0.0091
1.19	0.0765
3.07	0.2223
5.18	0.3826
7.3	0.5371
8.81	0.6601
9.71	0.7381
10.68	0.8162

Another student project we found was titled "design a Savonius Wind Turbine" from Democritus University of Thrace.The objective of this report is to study and manufacturea wind turbine of vertical axis, Savonius type. In particular, what will be studied is which geometrical design of the wings of the wind turbine is the most efficient, while taking into account the cost, the elegance, the simplicity, the feasibility and the durability.

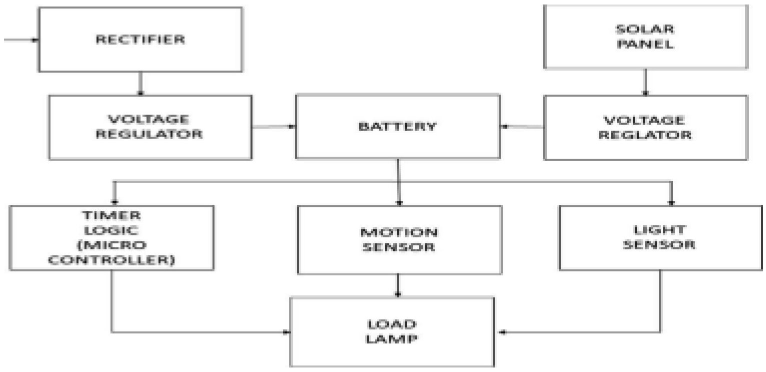
After fabrication and experiment, this project presented a result which shows the relation between the wind velocity and the actual power of the wind turbine.

4.Design challenges

The price of turbines is increasing in accordance with the rising cost of energy and commodities. The cost of designing the turbine, calculated in energy savings must be recovered in a reasonable time period. Each vehicle on the highway offers an intermittent and uncontrolled source of wind power. The design of the wind turbine must include storage of power and a system to distribute the generated power effectively. The wind turbines should have as little negative impact on the placement location as possible. Wind turbines are traditionally used in remote locations. This offers the additional challenge of having to transport the power generated to the location where in it will be utilized. Fortunately, the wind turbine in this project is designed for use in high traffic areas where the demand for power is high. Safety is another major design consideration. The turbinesmust be placed in high traffic areas therefore several safety provisions are incorporated into the design. These safety measures include stationary highway guards surrounding the rotating turbine blades and warning labels.

5.Design methodology

The blades in the wind turbine are connected in the shaft which is coupled to the generator. During air force the blades rotate and in turn which rotates the shaft and hence generator produces power as output. This AC power is converted to DC Power in rectifier unit and stored in battery. Solar panel extracts solar energy from sun light and converted into electrical energy. The DC output from rectifier and solar panel are given to voltage regulator to eliminate fluctuations and to obtain constant voltages. Thus the battery supplies to the load.As shown in above block diagram, the vertical axis wind turbine, produce movement of shaft in generator, which is of AC power, rectifier covert AC to DC power source as output, which will be assume as power to store or operate street lights. Due to fluctuation in wind energy tends to fluctuation in power output, solar panel is connected to get constant output at power storage at battery. The working principle is to converting available wind energy into electrical energy by means of mechanical turbine. Due to moving of continues vehicles on highway, there will be availability of sufficient wind power, by using this wind energy we are designed the turbine which having vertical axis blade for collecting the wind source. As the turbine blade start rotating it rotates the shaft, the power output generated at generator.



Comparative study of different types of generators used in wind turbine and reactive powercompensation**.**

Synchronous generator has two types:

1)Wound rotor generator:

2)Permanent magnet generator:

Wound rotor generator;

This type is of generator uses DC current to excite the rotor windings since it doesn't use permanent magnets. The output electricity from the stator is directly connected to the grid, thus windings since it doesn't use permanent magnets. The output electricity from the stator is directly connected to the grid, thus vertically on a rotor shaft, and functions based on magnetic repulsion of two or more permanent magnets. The designers positioned two ring type neodymium magnets on top of each other in a way that their magnetic fields are opposite so thatthey repel. Based on the threshold of the magnets, the wind turbine will be able to stay suspended in the air without being attached to anything. An axial flux generator is used to benefit compensate for the reactive power. The main advantages of this generator is that a gear box is not required.

Permanent magnet generator;

As the name says, this type is self-exited and benefits from permanent magnets insteadof induction, therefore, the generator is more efficient. "The stator of PMSGs is wound, and the rotor is provided with a permanent magnet pole system." PMSGs operate with variable wind speeds and do not need a gearbox, the rotor can be directly connected to the shaft. The main disadvantage is that the parts used for constructing permanent magnet generators are expensive and complex. Since variable speed is used, a converter is used to regulate the voltage and frequency. On the other hand, the generator can be used for any wind speed.

Asynchronous (induction) generator:

This type does not include permanent magnets. The generators magnetic field is created when an excitation current is applied. There are two types of induction generators:

Squirrel cage induction generator:

This type is actually a motor, however when a speed above the synchronized one is applied, they will turninto a motor. The shape appears to be similar to a squirrel cage. A gearbox is used to increase and keep the speed constant. A capacitor bank is installed in order to make up for the reactive power, and a soft starter is equipped because the generator is directly connected to the grid. The advantages of this generator is the construction simplicity, high efficiency and low maintenance. However, it uses electricity and power factor is relatively low.

Wound rotor induction:

This type of generator is very similar to SCIG, but the concept of variable speed is practiced instead of constant. A variable resistance is installed to regulate the output power and slip. "The advantages of this generator concept are a simple circuit topology, no need for slip rings and an improved operating speed range" the disadvantages of this generator are the limitation of speed range and poor reactive power control. electricity because of not uniform blade rotation which might also harm and break the blades. One other major problem of VAWT is that it needs a push to operate, this problem decreases the generated power because it produces its own produced electricity to initiate the blade's rotation.

.6.Conclusion

From our project many conclusions can be drawn about the efficiency of the VAWT and its improvement. The power output and the efficiency of the VAWT are expected to be higher with the addition of VGs in comparison with those of a VAWT without VGs. As for the construction of the VAWT, the materials and dimensions are chosen based on the literature review and the calculations made, which helped with increasing the overall efficiency of the VAWT.Future experimental data and results will test those assumptions and provide a clearer understanding of the direct effects of the materials, dimensions, and added parts as well a broader understanding of the theories involved.

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