© 2018 IJSRSET | Volume 4 | Issue 7 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
Themed Section : Engineering and Technology

Design And Fabrication of Innovative Vertical Axis Windturbine : A Review

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ABSTRACT

(VAWT), present technological state, new finding through modelling work and future direction of VAWTs were reviewed. It was observed that VAWT plays a vital role in the present energy crisis. Ones can foresee that human being dwelling in a world with wind turbines and solar panels due to present energy crisis with the non-renewable energy. Wind energy has been identified as a promising renewable option Although the full life cycle accounting shows VAWTs are advantageous on a cost basis or materials basis over horizontal axis wind turbines (HAWTs), Currently the VAWTs do not generate enough electricity due to some challenges which discussed in this paper. Drag driven VAWT (Savonius type), lift driven VAWT (Darrieus type) and hybrid of both (D+S) turbine efficiencies can be increased by adding the deflector system that guides the wind towards the turbine blades. A lot of researches are ongoing at present in this level. From the vast survey of the present technological states of VAWT, it was observed that China is the leading researcher in this field for the past few years while European countries serve their place in this research area. In today's life the demand on electricity is much higher than that of its production the main objective of our project is to produce electricity by using the force of air created by the moving vehicle in highways. In highways the vehicle suffers a lot to travel in night time because of lightning problem. This problem can be overcome by using the VERTICLE AXIS HIGHWAY WINDMILL (VAHW).This is a new unique method of power generation. In this method the windmill blade is designed in a vertical direction and it is kept at the middle of the highway divider by a series combination. The force in the middle portion is higher than the side of the road .This force will rotate the vertical turbine blade. And this blade transmitted these energy by the meshing of spur gear & pinion arrangement is coupled with the generator and this generator will produce electricity. In our method we have coupled one more generator and we have increased its efficiency.

Keywords : Wind energy, (VAWM) DNA helix type, DC generator, shaft, spur gear and pinion arrangement

I. INTRODUCTION

The wind turbines will be placed on the road dividers so that wind flow from both sides of the highway will be acting tangentially in opposite directions on both sides of the turbine [2]. These types of turbines can be installed on express highways and other high speed traffic areas to generate electricity. Ideally, the turbine can be used globally as an unlimited power source for street lights and other public amenities. Also this system can be connected to the grid to supply the increased power demand. In today's life the demand on electricity is much higher than that of its production. One of the biggest issues ever since men realized is that natural resources are going to be finished one day and a replacement is to be found. Apart from that fossil fuels play a major role in pollution, global warming and greenhouse gas. In order to overcome such problems incorporation of more renewable energy sources such as sunlight, wind and biomass is essential in the current century. Energy is very much essential for development of any nation. The global demand for energy is increasing in a rapid rate due to rapid rise in population and industrialization, while the energy sources are depleting in a very fast manner. Currently, more than 68 percent of electrical energy is produced by thermal power plants where fossil fuels such as coal, diesel etc. are used. As we realize that fossil fuels are going to be exhausted, we're trying to develop other means of power generation. Wind energy is considered the fastest growing source of clean energy. However, it is limited by its variable nature. Highways can provide a considerable amount of wind to drive a turbine due to high vehicle traffic. Due to the pressure difference in the air adjoining the vehicle wind will be generated electricity. Wind energy is the most potential renewable energy resource low cost compared with convention fossil resources. Wind energy can help in reducing the dependency on fossil fuel. Wind energy can be utilized to windmills, which in turn drive a generator to produce electricity. It is expected that wind being a non-polluting and non-toxic energy source, will go a long way in solving our energy requirements. Many countries including India realized the importance of wind energy as important power resources. It has been predicted that roughly 10 million MW of wind energy continuously available on surface of earth. India's wind power potential is 45000MWIt is accepted that vertical axis wind turbine represent a suitable alternative for wind power extraction in many developing countries. The reason for this is mainly because of highly efficient rotors and there advantage over the horizontal axis wind turbine such as:

(1) Simple construction

(2) Extremely cost effective

(3) Acceptance of wind flow from any direction without orientation

Fig1 : Assembly of V.A.W.T

II. TYPES OF ROTOR

H-DARRIEUS ROTOR: The energy is taken from the wind by a component of the lift force working in the direction of rotation. Lift force is perpendicular to the resultant of two velocity component of wind velocity and relative velocity of airfoil to the shaft. These types of turbines have highest values of efficiency among VAWTs and the tip speed ratio can be much higher resulting in a much higher rpm. But generally suffer from problems of low starting torque and poor building integration.

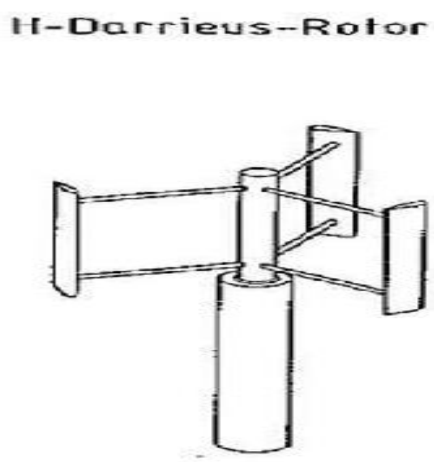
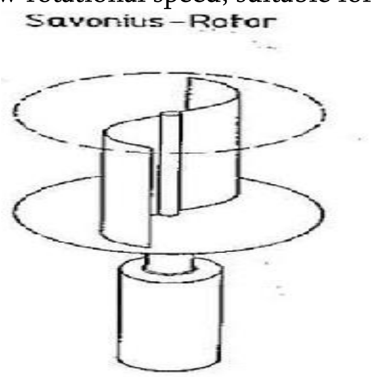


Fig-2: H-Darrieus Rotor

SAVONIUS ROTOR: The operation of Savonius rotor work on the difference of drag force when the wind strikes the concave and convex part of the semi-spherical blades. The flow energy utilization of Savonius rotor is lower than that of Darrieus rotor. So, this type of turbine is generally used for low-power applications and usually used for wind velocimetry applications. The greatest advantage of a Savonius rotor is its ability to self-start in contrast to other 'Lift type' VAWTs. Recently, some generators with high torque at low rotational speed, suitable for small-scale



COMBINED ROTOR: Combined rotors are the combination of two different rotor (Savonius and H-Darrieus) mounted on the same shaft. Mostly combined wind or water rotors are available in the vertical axis configuration.Combined rotors generally combine Darrieus and Savonius type wind rotors. However, many other configurations might be available for designing of combined rotors. A combined rotor overcomes the shortcomings of the one fold airfoil turbine rotors and takes advantage of another turbine rotor. Since the Darrieus rotor is not self-starting, a blended design with Savonius blade can make the combined which can make it self-starting and more power efficient and high torque co-efficient than any of the single rotor

Fig-3: Combined Rotor

Table 1. Merits of vertical axis wind turbines over horizontal axis wind turbines

	Horizontal axis wind turbine (HAWT)	Vertical axis wind turbine (VAWT)
Tower sway	Large	Small
Yaw mechanism	Yes	No
Self-starting	Yes	No
Overall Set-up Formation	Complex	Simple
Generator location	Not on ground	On ground
Height from ground	Large	Small
Blade's operation space	Large	Small
Noise produced	high	Relatively Less
Wind direction	Dependent	Independent
Obstruction for birds	High	Less
Ideal efficiency	50–60%	More than 70%

III. LITERATURE REVIEW

In these studies, a number of scientists have experimentally and numerically examined the effects of various design parameters of Savonius wind rotor such as the rotor aspect ratio, the overlap and the separation gap between the rotor buckets, the profile change of the bucket cross section, the number of buckets, the presence or absence of rotor endplates, and the influence of bucket stacking [93–98]. Many experimental and numerical studies have been carried out on Savonius wind rotors to investigate the flow field and the pressure distribution on blades [99–112]. In addition, the effect of the swinging angle of the rotor blades on rotor characteristics and power has been investigated by Aldos [106]. The optimum swinging angle of rotor blades increased the maximum.

Mohammed Hadi Ali [1]:Has carried out experimental comparison and investigation of performance between two and three blades Savonius wind turbine. Due to this purpose, two models of two and three semi-cylindrical blades were

designed and fabricated from Aluminum sheet, with having an Aspect ratio of (As = H/D =1), the dimension is (H =
200 mm height and diameter D = 200 mm). These two models were assembled to have overlap zero (e = 0) and a separation gap zero (e' = 0). Subsonic wind tunnel is used to investigate these two models under low wind speed condition, which shows that maximum performance at (λ = TSR = 1) and a high starting torque at low wind speed, and also gives reason for three bladed rotors is more efficient than the two blades, that by increasing the number of blades will increase the drag surfaces against the wind air flow and causes to increase the reverse torque and leads to decrease
the net torque working on the blades of Savonius wind turbine.

N.H. Mahmoud [2]: Has conducted an experimental analysis by using, wind tunnel experimental setup, the experimental results shows that -Three bladed Savonius rotors are more efficient than the three and four bladed Savonius rotors. The rotor with end plates gives higher efficiency than the without end plates. Blades having overlap ratios are better than the blades with without overlap ratios. By increasing Aspect Ratio Coefficient of performance (Cp) will also increase.

Javier Castillo [3]:Has carried out that, three-bladed design is more efficient than a four-bladed rotor; a low solidity (σ≥4)wind turbine may present self-starting problems as rotor efficiency. CP also decrease at low tip speed ratio, so optimum tip speed ratio is 2.5-3 for H-rotor. He also conclude that Larger radius turbines are more efficient than small turbines at same rotational speed as the tangential airspeed increase leads to smaller angles of attack, bigger Reynolds numbers and thus bigger blade lift coefficients.

U.K.Saha,S.Thotla, D.Maity [4]:Has conducted that, power coefficient Cp of Savonius rotor depends on number of
stages. When number of stages increased from one to two, the rotor shows better performance characteristics, however the performance get degraded when the number of stages become three. These may be increased in inertia of rotor. So the optimum number of stages for Savonius rotor is two. It also concludes from the experimental evidence that a two blade system gives optimum performance. For two blade two stage Cpis about 30%, V=6-8 m/s.

T.Letcher[5]: Has carried out experiment in three separate directions Computation Fluid Dynamics (CFD) modelling, generator design and materials/manufacturing process. With the experimental data collected during this project, It was concluded that the power output of combined setup is higher than the single Savonius and Darrieus rotor.

M.Abid,K.S.Karimov[6]: Experimental study concluded that, combination of NACA 0030 airfoil and Savonius rotor provided the functions required for a starting mechanism. The Savonius and Darrieus blades should have different

Aerodynamics Theory and Performance Characteristics:

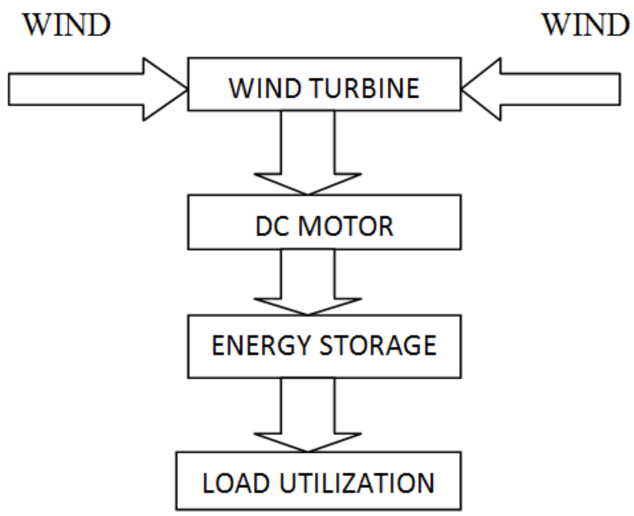
The aerodynamic analysis of VAWTs is complicated due to their orientation to the oncoming wind. The VAWTs have a rotational axis perpendicular to the oncoming airflow. This accounts for aerodynamics that is more complicated as compared to a conventional HAWT. However, the configuration has an independence of wind direction. The main shortfalls of this are the high local angles of attack and the wake coming from the blades in the upwind part and axis. This disadvantage is more pronounced with VAWTs. The power output from the high speed lift VAWT can be appreciable. Understanding the aerodynamics of the pure drag type of VAWT will give important insight for improving the lift coefficient, and designing this turbine for better and more efficient harnessing of the wind power.

Lift Force

The lift force is one of the major force components exerted on an airfoil blade section inserted in a moving fluid. It acts normal to the fluid flow direction. This force is a consequence of the uneven pressure distribution between the upper and lower blade surfaces.

Drag force

The drag force acts in the direction of the fluid flowing. Drag occurs due to the viscous friction forces on the airfoil surfaces, and the unequal pressure on surfaces of the airfoil. Drag is a function of the relative wind velocity at the rotor surface, which is the difference between the wind speed and the speed of the surface, The lift and drag coefficient values are usually obtained experimentally and correlated against the Reynolds number for analysis purpose. This thesis uses a CFD code to predict these coefficient values over a range of operating conditions. The amount of power generated by the vertical axis wind turbine will be analysed through code.



IV. CONCLUSION

From above review, it can be concluded that Vertical Axis Wind Turbines can play an important role in increasing utilization of wind energy in congested urban areas. Their advantages of running on lower wind speeds, ability to work in any direction of wind flow, compact construction an quite operation make them ideal for localized household power generation units. Efficiency of turbine depends upon the velocity of wind and geographical climatic condition. Local authorities in Sri Lanka, as well as the foreign authorities, will face, lots of problem in the near future due to lack of non-renewable energy sources. So, they are moving for the renewable energy sources like wind, solar energy, tides, rain, sea waves, geothermal heat…etc. If we can improve the performance of the Vertical Axis Wind Turbines(VAWTs), it's huge advantage for the authorities. They can implement the VAWTs every possible place and generate the electricity while contributing to the reduction of CO2 production and economic growth. Thus, by the researches related to the VAWTs, it is accepted to substantial step forward in this field in the future.

ADVANTAGES

1) Independence on wind direction, no additional control mechanisms are required.
2) Ability to operate in a wide range of wind conditions (turbulence level, wind speed).
3) Electrical equipment can be placed at ground level.
4) Low noise emission.
5) High starting torque.
6) Simple and cheap construction.
7) A massive tower structure is not required, as are mounted on the ground and hence easier for maintenance.
8) No requirement of yaw mechanisms.
9) Do not kill birds and wild - life - slow moving and highly visible.

APPLICATIONS

1) Electricity from vehicle's wind turbulence in highways.
2) It is used for small amount of electricity generation.
3) Mixing and aerating water bodies.
4) Heating water by wind turbulence.
5) It is used for purposes like street lighting, traffic signals, road

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