Vertical Axis Wind Mill: A Review

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Abstract— Energy crises is the major problem all over the world. Most of energy requirement is fulfilled by thermal power plants based on coal and diesel. To avoid these polluting and limited sources should be adopted alternative power sources like wind energy. Wind power is an important source of environmental-friendly energy and has become more and more important in the recent years. The amount of installed wind power is increasing every year and many nations have made plans to make large investments in wind power in the near future. The wind mills which are used for energy generations have heavy framework and is limited because of their heavy designs. The domestic wind mills can be used for domestic purpose by making a suitable prototype for considerable load and will serve benefit to the resources that are limited to earth surface .This will also minimize the dependency on power stations and thus will serve a great advantage to our nation. There is an important requirement for a domestic wind turbine, which can be used for domestic application because of the limited availability of the resources. This project is limited to designing and development of wind mill by using CAD and CFD software for domestic application.

Key words: VAWT, Wind Mill, CAD, CFD

I. INTRODUCTION

Energy is the primary and most universal measure of all kinds of work by human beings and nature. Everything that happens in the world is the expression of flow of energy in one of its forms Energy is an important input in all sectors of a country's economy. The standard of living is directly related to per capita energy consumption. Due to rapid increase in the population and standard of living, we are faced with energy crisis. Conventional sources of energy are increasingly depleted. Hence, Non-Conventional Energy Sources have emerged as potential source of energy in India and world at large. Among the various non-conventional energy sources, wind energy is emerging as the potential major source of energy for growth.

Wind mills produce electricity by using the natural power of the wind to drive a generator. The wind is a clean and sustainable fuel source, it does not create emissions and it will never run out as it is constantly replenished by energy from the sun. Generating electricity from the wind is simple: Wind passes over the blades exerting a turning force. The rotating blades turn a shaft inside the nacelle, which goes into a gearbox. The gearbox increases the rotation speed for the generator, which uses magnetic fields to convert the rotational energy into electrical energy.

The rising greenhouse gas emission from fossil fuel energy resources and the uncertainty of energy supplies have forced to explore alternative renewable energy sources for power generation. Most developed including Australia and emerging economies adopted a renewable energy target. Power extraction from wind has achieved significant improvement over the decade, making it more economically competitive over other renewable energy sources for power generation.

The utilization of wind to generate power provides an alternative and renewable energy source compared to current fossil fuels based power generation. The world's fossil fuel energy is finite and is depleting at a faster rate. Moreover, the fossil fuel is directly related to air pollution, land and water degradation. Despite significant progresses have been made in power generation using large scale wind turbines recently, domestic scale wind turbines especially vertical scale wind turbines have been received less attention which have immense potentials for standalone power generation

Fig. 1: Domestic Wind Mill

Fig. 2: Domestic Wind Mill

II. LITERATURE REVIEW

Mrs. Aslam Bhutta, Nasir Hayat [1] Vertical axis wind turbine offer economically viable energy solution for remote areas away from the integrated grid systems. In order to spread the use of VAWT, the problems associated with various configurations, i.e. poor self-starting and low initial torque, low coefficient of power, poor building integration should be overcome.

Various vertical axis wind turbines can offer solution to the energy requirements ranging from 2 kW to 4 MW with a reasonable payback period.

CFD is capable of designing the VAWT with higher degree of accuracy. It can also be used for the optimization of blade design. Moreover, flow field around various configurations' blades can also be visualized with the help of CFD. It has not only accelerated the design process of VAWT but also has brought down the overall cost of designing

Sandra Eriksson, Hans Bernhoff, Mats Leijon [2] This comparative study has shown that VAWTs are advantageous to HAWTs in several aspects. Furthermore, common misjudgements about VAWTs have been discussed. When comparing the two types of VAWTs considered here, the H-rotor seems more advantageous than the Darrieus turbine. The strength of the H-rotor concept is the possibility to keep the structure simple. The H-rotor does not require any yaw mechanism, pitch regulation or gearbox and therefore has few movable parts. Another advantage is its expected low need of maintenance. The case study presented a comparison between three turbines. Here, an example of an H-rotor that can be a competitor to HAWTs is presented. It has about the same weight as the HAWT but has a simpler overall structure. Some further simplifications of the suggested H-rotor have been proposed, for instance to make the support arms lighter. It has also been suggested that the H-rotor should have three blades instead of two.

Andrea Alaimo, Antonio Esposito, Antonio Messineo [3] in the present paper, a comparative evaluation of a small Helical-VAWT and of a Straight-VAWT has been performed. Preliminary two-dimensional and subsequent three-dimensional CFD analyses have been carried out. From steady simulations, over a complete cycle, it has been observed that the helical blades have an average torque coefficient increment equal to 8.75%. This leads the Helical VAWT to a low speed of start-up (this is confirmed by dynamic results at low rotational speed) and then to a higher number of operational hours in similar environmental conditions.

K. Sunil Kumar and R. Palanisamy, S. Aravindh, G. S. Mohan [4] The optimum twist of a windmill blade is examined on the basis of elementary blade element theory. For a given wind speed and blade angular velocity, it is shown that the maximum power efficiency is achieved when the blade is twisted according to a program that depends upon the variation of the sectional lift and drag coefficients with angle of attack. The analysis of windmill blade we found that the STAINLESS STEEL material have a good physical properties and it have a less deformation under the moment and velocity, than the other two materials and finally the deformation, stress, strain of the STAINLESS STEEL material is low compared to the materials. The analysis carried out by us will make an impressing mark in the field of renewable energy.

Firoz Alam , Abdulkadir Ali [5] The primary objective of this study is to review and analyse the potentials for power generation by domestic scale wind turbines for the residential and semi-commercial applications. The study reviews the current status of wind characteristics in built up areas, economic feasibility, aerodynamic and technological limits, local government planning requirement, local and foreign small scale wind turbine manufacturers.. The cost of wind turbines is still higher compared to PV panels, which needs to be within the financial capacity of common people. At present, no government rebates or subsidies are available for domestic scale wind turbines for urban applications. Government incentives will encourage people to install the turbine as such incentives are available for PV panel installation Government policies and regulations are required to be enacted for better utilisation of domestic scale wind turbines and removing any ambiguity in this regard. More importantly, significant research and development are required for improving the efficiency and power generation capacity of domestic scale wind turbines.

Mahalingam P P1 Vijian P [6] The main objective of this study is to better understandings the effects of various parameters like airfoil shape/type, Reynolds number, angle of attack, wind speed on the performances of these turbines. These effects are investigated on a straight bladed vertical axis wind turbine which leads to variations of pressure distribution on upper and lower surface of the blade section. A numerical study was carried out to investigate the effects of a blade profile on the performance of a straight bladed Darrieus Vertical Axis Wind Turbine. The numerical results confirm that the blade profile directly affects the performance of the straight-type Darrieus Vertical Axis Wind Turbine, i.e., the high-digit NACA profile provides higher pressure than the low-digit symmetrical NACA profile.

Vertical Axis Wind Turbine with NACA 0009 and NACA 23018 airfoil geometry was analyzed by numerically .The simulation results shows that the pressure can vary for different velocity.

Mr.Laxmikant N.Dhoble1, Dr.A.K.Mahalle [7] This paper presents review on performance and testing methodology of savonius vertical axis wind turbine. Numerical method is very effective for testing the flow and turbine performance. The three bladed savonius wind turbine has best performance at high tip speed ratio & four bladed savonius turbine has good performance at lower tip speed ratio. When wind is coming from several & constant direction then four deflector blades gives good performance over conventional savonius turbine. Effective rotor angle 45° & 90° gives improved performance of savonius rotor. Without shaft interface provides better results than with shaft interface. Aspect ratio increases coefficient of performance also increases. Rotor with overlap ratio gives poor performance than without overlap ratio. Design and optimization can be done by using Computational Fluid Dynamic analysis. Two stage rotor has best performance than single stage savonius rotor.

M.Salman Siddiquia, Adil Rasheedb [8] The very essence of a wind turbine is to convert kinetic energy in the wind field to mechanical energy (through torque) and then to electrical energy. Thus, a given turbine designs ability to generate large torque during operation is an important performance indicator. Herein, we have studied the influence of turbulence intensity in the incoming flow field on the generation of torque for a H-type VAWT. As the torque varies significantly during the rotation of the VAWTs impeller we have focused on the average torque per cycle. In our numerical study we investigated the effect for turbulent intensity levels of 0%, 5%, 15% and 25% in the incoming flow field. The results shows that the average torque over an cycle decreases by almost 23%, 33% and 42% compared to no turbulent flow, respectively. A reduction in toque is expected as having turbulent inflow conditions may be compared to the wind turbine being in the wake downstream another wind turbine. However, the size of the reduction has up to now not been studied in detail for H-type VAWT, and we think that our study is an interesting contribution in this regard.

Sonu Sharma, Rajesh Kumar Sharma [9] this paper is focused on the estimation and comparison of the performance in terms of Coefficient of Performance (COP) of a new configuration of Savonius rotor with the conventional one, using numerical simulation approach. A methodology for the numerical simulation of Savonius rotor is developed and validated, that can be employed for comparative study of different design configurations for design based optimization of Savonius rotor. Present work employs Shear Stress Transport (SST) model for modeling turbulence. Meshing parameters include correct estimation of first layer thickness for boundary layer on the blades based on the desired y+ value. An improvement in Coefficient of Performance ranging between 8.89% and 13.69% for different inlet velocities is observed for new configuration over the conventional configuration.

Kadhim Suffer , Ryspek Usubamatov [10] The main goal of this current research is to investigate numerically the aerodynamic performance of a newly designed cavity type vertical axis wind turbine. In the current new design the power generated depends on the drag force generated by the individual blades and interactions between them in a rotating configuration. The predicted results show that the drag coefficient increases with the increase in turbine frontal area and decreases with the decrease in its frontal area.

III. Proposed Work

The present work aims to report the various findings by investigation pertaining to vertical axis wind mill.

IV. Conclusion

From the research studies it is concluded that

- Ample wind energy potential is available in the world to make good use of it efficient designs of wind turbines need to be developed.
- VAWT are great for use in residential areas when compared to horizontal axis wind turbines.
- Less horizontal area required as compared with the horizontal wind turbine.
- The three bladed savonius wind turbine has best performance at high tip speed ratio & four bladed savonius turbine has good performance at lower tip speed ratio
- The wind energy is inexhaustible and is one of the lowest-cost renewable energy technologies.
- Numerical method is very effective for testing the flow and turbine performance.
- The power generation depends on the drag force generated by the individual blades and interactions between them in a rotating configuration.
- Wind energy is a clean fuel source and therefore it can be deployed for domestic purposes.
- Wind energy doesn't pollute the air like power plants that rely on combustion of fossil fuels, such as coal or natural gas.
- Wind turbines don't produce atmospheric emissions that increase health problems like asthma or create acid rain or greenhouse gases.
- Wind power is cost-effective. It is one of the lowest-cost renewable energy technologies available today.
- Wind power uses zero water in its energy generation.

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