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Vertical Axis Wind Turbine

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Abstract— In recent times, there has been an increased interest in wind energy due to concerns about the pollution caused by burning fossil fuels and their rising prices. Most wind turbines in use today are conventional wind mills with three airfoil shaped blades arranged around a horizontal axis. The second type of turbine which is transverse to the axis of rotation or whose blades are positioned vertically. These turbines will always rotate in the same direction regardless of the fluid flow. It does not depend on the direction of the fluid flow; these turbines have found applications in tidal and surface current flows. A vertical axis helical blade wind turbine is that where in the blades of the rotor section of the wind turbine comprise sections wherein the blades have a non-linear configuration in the vertical axis. In a preferred manifestation, the blades of the rotor section have a linear trailing edge with a non-linear, and preferably helical, surface configuration. This particular design allows the blades to provide both a rotational force and a negligible lift component. Further, the blades define an open area in the center of the rotor section through which air flow can pass in order to create a vertical vortex of air. As such, a more efficient vertical axis wind turbine can be made.

Key words: Surface current flow, Vortex, Trailing edge, Rotational force

I. INTRODUCTION

Wind energy is an ample and renewable source of green energy. The widespread distribution of suitable wind patterns and the declining cost of wind energy production make wind energy a viable alternative. The main drawbacks to wind generated power are the inconsistent power production caused by variable wind speed. [1]

Windmills have been in practical use since the 7th century. They have been used for generation of power in both mechanical and electrical ways as those needs have evolved. Modern day windmills are almost all used to generate electrical power, bringing about the modernized name of wind turbines. These were generating approximately 160,000 Mega-Watts (MW) as of 2009; according to the World Wind Energy Association and the numbers are ever growing with an expected 200,000+ MW in 2010 and approaching 2,000,000MW in 2020. [1]

There are many different types of wind turbine. The overwhelming majority are Horizontal Axis Wind turbines (HAWT), which follow the same basic design as the original windmills from the 12th century. They consist of a vertical tower, with the axle and the gears are present on top, oriented horizontally. Usually there are three blades attached to this horizontal axle in modern turbines. The other major type of wind turbine is Vertical Axis Wind Turbines (VAWT). These always have a tower that also acts as the axle. The moving axle can be at top of a longer tower or supported by frame that goes around and above the blades. In this design the generator, gearbox and other electronics are near the ground.

There are two major subtypes of VAWT namely the Lift-based Darrieus designs which utilize airfoils, and the Drag-based Savonius turbines which use large cups for blades. Both designs were first developed in the early 20th century.

The diagram below depicts the basic operation of the three primary types of modern wind turbines.

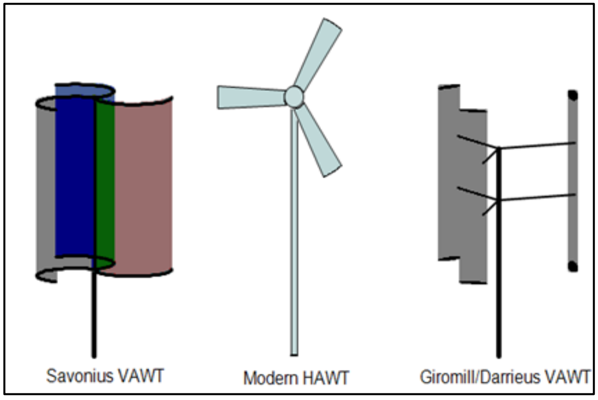

Fig. 1: Principal Types of wind turbine [1]

Savonius VAWTs are known for their reliability but also generally low power output. The main idea of this turbine is that the differential of the winds force being deflected off the back of one blade and the force being deflected into and captured by the front of the other blade causes the turbine to spin. For this reason they operate Savonius wind turbines are potentially ideal for operation in turbulent environments where HAWTs are extremely ineffective. One of these turbulent places is around buildings. This would be the ideal place for wind turbines because the power would be generated near the location of its use reducing losses in transporting the energy. Higher wind speeds are also found at higher altitudes, so placing wind turbines on the roofs of buildings would have many benefits if those turbines could capitalize on the turbulent wind environment. It is also be essential for the turbines to not create vibrations or pulsations, which could easily be channeled into the building, not only damaging the building but also potentially the people inside. [2][3]

A helical twist (about the axle) of a simple Savonius turbine greatly increases performance and efficiency are shown by many studies. This is prominent because the wind is pushing on the blade for more of each rotation, so it can extract more of the power from the wind. This twist also continues to increase the performance in turbulent winds. Possibly the most important benefit is that twisting the turbine enough for constant pushing of the wind can remove the potential for pulsations. This would allow these twisted Savonius wind turbines to be placed on buildings, therefore capturing more energy and virtually eliminating transmission costs and losses. The only drawback is that the shape of a twisted Savonius wind turbine is extremely complex and therefore very expensive to manufacture. In this project we will a pseudo-three-dimensional angular side view, both in Geometry Expressions. model the shape of the helix wind turbine from a two dimensional top view .

II. LITERATURE SURVEY

The fist accepted establishment of the use of windmills was in the tenth century in Persia. Today, there are several hundred thousand windmills in operation around the world. Modern windmills known as wind turbines partly because of their functional similarity to the steam and gas turbines and partly to distinguish them from their traditional forbears. Windmills were used in Persia (present-day Iran) as early as 200 B.C. The "Panemone" were vertical axle windmills, which had long vertical drive shafts with rectangular blades. Made of six to twelve sails covered in reed matting or cloth material, these windmills were used to grind grain or draw up water, and were used in the grist milling and sugarcane industries. During the middle ages windmills first appeared in Europe. The first historical records of their use in England date to the 11th or 12th centuries and these are reports of German crusaders taking their windmill-making skills to Syria around 1190. By the 14th century, Dutch windmills were in use to drain areas of the Rhine delta. [4]

In July 1887, Scottish academic James Blyth installed the first electricity-generating wind turbine which was a battery charging machine to light his holiday home in Marykirk, Scotland. Some month’s later American inventor Charles F Brush built the first automatically operated wind turbine for electricity production in Cleveland, Ohio. In the United Kingdom Blyth's turbine was considered uneconomical yet in countries with widely scattered populations, electricity generation by wind turbines was more cost effective.

The first automatically operated wind turbine, built in Cleveland in 1887 by Charles F. Brush. It was 60 feet (18 m) tall, weighed 4 tons (3.6 metric tons) and powered a 12 kW generator. [4]

In 1908 there were 72 wind-driven electric generators operating in the US from 5 kW to 25 kW. American windmill makers were producing 100,000 farm windmills each year, mostly for water-pumping around the time of World War I. By the 1930s, wind generators for electricity were common on farms, mostly in the United States where distribution systems had not yet been installed. In this period, high-tensile steel was cheap, and the generators were placed atop prefabricated open steel lattice towers. [4]

In the autumn of 1941, the first megawatt-class wind turbine was synchronized to a utility grid in Vermont. The first utility grid-connected wind turbine to operate in the UK was built by John Brown & Company in 1951 in the Orkney Islands. [5]

Despite these diverse developments, developments in fossil fuel systems almost entirely eliminated any wind turbine systems larger than super micro size. Anti-nuclear protests in Denmark spurred artisan mechanics to develop micro-turbines of 22 kW in the early 1970s. The organization of owners into associations and co-operatives lead to the lobbying of the government and utilities, which incentivized larger turbines throughout the 1980s and afterwards. Local activists in Germany, nascent turbine manufacturers in Spain, and large investors in the U.S. in the early 1990s then lobbied for policies which stimulated the industry in those countries. Later companies formed in India and China. As of 2012, Danish company Vestas is the world's biggest wind-turbine manufacturer. [5]

Wind energy was the fastest growing energy technology in the 1990s, in terms of percentage of yearly growth of installed capacity per technology source. The growth of wind energy, however, is not evenly distributed around the world. By the end of 1999, around 69% of the worldwide wind energy capacity was installed in Europe, a further 19% in North America and 10% in Asia and the Pacific. It is expected that wind energy would play an increasingly important role in the future national energy scene. Greenpeace states that about 10% of electricity can be supplied by the wind by the year 2020. [5]

III. METHODOLOGY, DESIGN AND ANALYSIS OF BLADE

In design of VAWT some important parameters are necessary to understand the design of VAWT and these parameters are:

1) free stream velocity : the incoming flow velocity without any restriction are known as free stream velocity.
2) Blade profile: the two-dimensional cross sectional area of the aerofoil which makeup the geometry each blade section.
3) chord length : length of the airfoil profile.
4) solidity: the percentage of the frontal area of turbine that is taken up by the turbine blade.
5) Number of the blade: number of the blade also affect the performance of turbine.
6) Angle of sweep: the angle around the circumference that each blade sweep.
7) Rate of twist : the rate at which the blade twists about the centre axis of the turbine with respect to height of the turbine.
8) Fluid density: density of fluid which flows around the blade.
9) Turbine height: the length of the centre axis of turbine is known as height of turbine.
10) Turbine diameter: it is the diameter of circumference of the turbine.

Design of blade is done on the solid work 2015 and for design of the blade, we used different NACA profile and Analysis is done by ansys 15 and obtain result of effect of air velocity on the blade

Some common result are obtain which are shown below for different NACA profile.

A. NACA 0018(3 BLADES):

Chord length: 1m
Blade length: 4m
Rotor diameter: 3m
Inner shaft diameter: .25m
Plate thickness: .15m
Turbine height: 4.3m
Solidity: 56.58%
Rate of twist: 120degree

- First graph is drawn between coefficient of drag and wind velocity.
- Second graph is drawn between coefficient of lift and wind velocity.

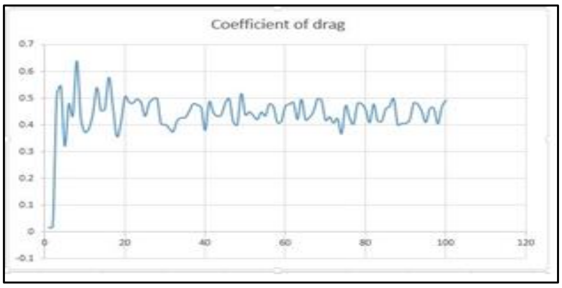

Fig. 2:

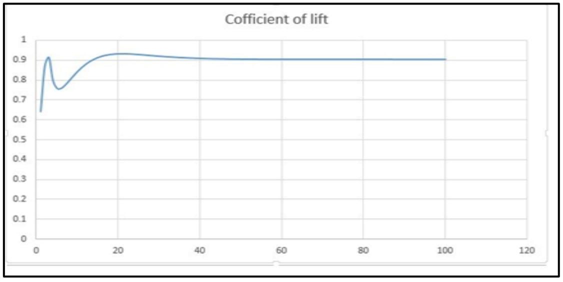

Fig. 3:

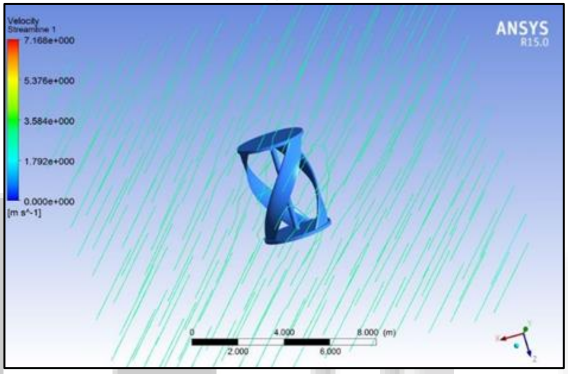

Fig. 4: Velocity streamline

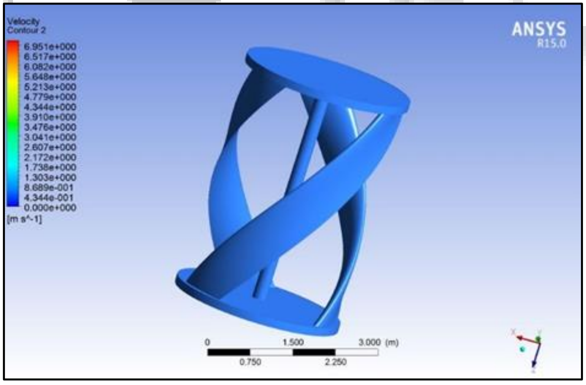

Fig. 5: Velocity contour

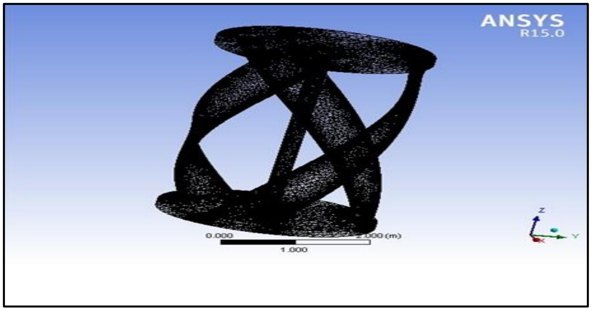

Fig. 6: Mesh

B. NACA 0018(2blades):

Chord length: 0.8m
Blade length: 3.7m
Rotor diameter: 3m
Inner shaft diameter: .25m
Plate thickness: .15m
Turbine height: 3.9m
Solidity: 41.87%
Rate of twist: 120degree

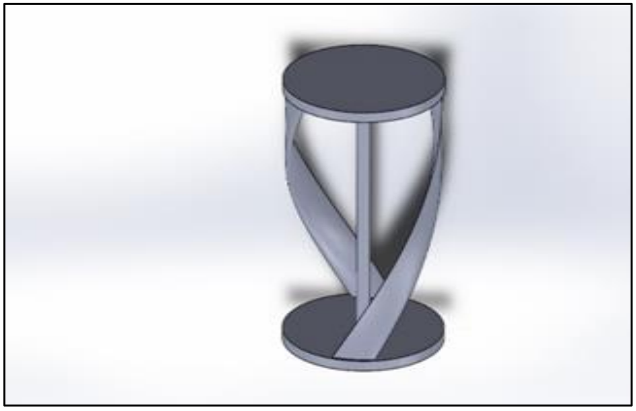

Fig. 7:

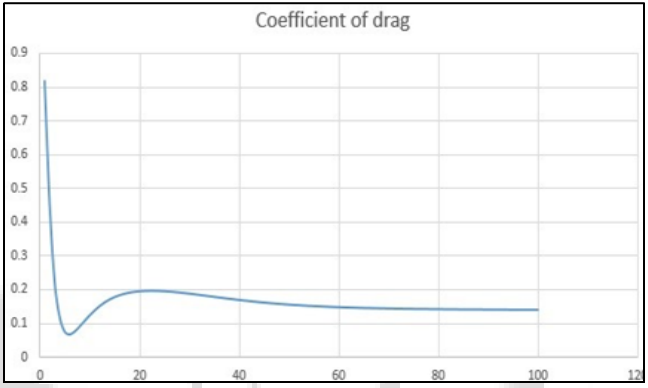

Fig. 8:

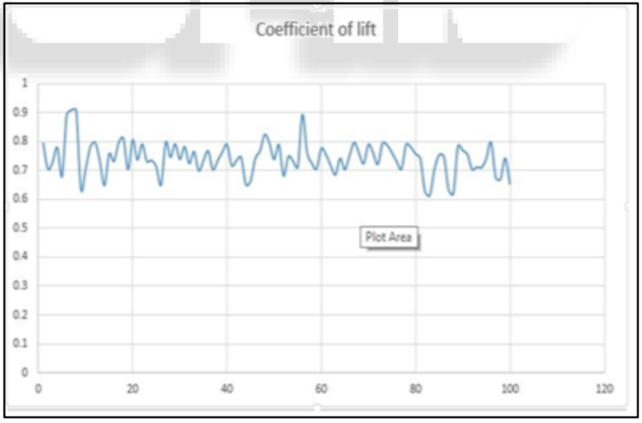

Fig. 9:

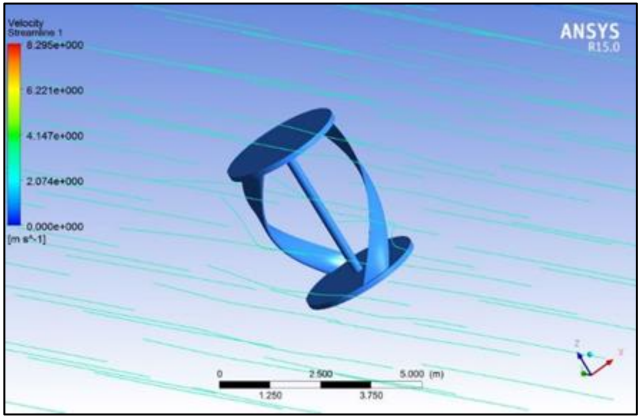

Fig. 10:

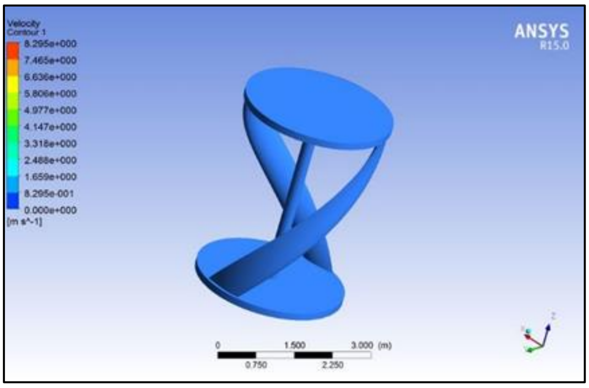

Fig. 11: Velocity streamline

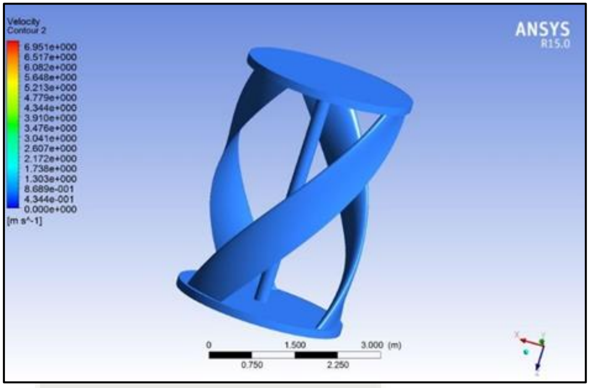

Fig. 12: Velocity contour

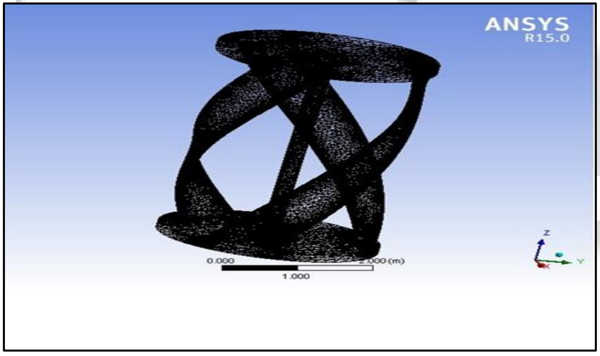

Fig. 13: Mesh

IV. CONCLUSIONS

Several conclusions can be made from the computational work of this project. These conclusions are listed below.

1) The modelling and analysis of a wind turbine with swept blades is both a very unique and complicated problem. Multiple input parameters greatly affect the performance of a turbine design. Furthermore each of these input parameters, such as incoming velocity, turbine size, cord length and number of blades influence other key parameters such as turbine frontal area and solidity. This greatly complicated the analysis process and compounded the number of test cases needed to fully understand the effects on performance of each input parameter.
2) The torque generated by the turbine is not solely a function of the tangential force acting on each of the blades. It is also a function of the angular momentum flux around the turbine circumference. For a complete understanding of torque generation and energy transfer through the system, the conservation of momentum equation must be satisfied. Understanding of the downstream momentum loss is crucial in evaluating the energy produced by a turbine.
3) Peak performance of a discrete airfoil section for a given turbine configuration occurs when an airfoil profile exhibits a high coefficient of lift value at high angles of attack. This provides for a large lifting force at an angle of attack large enough to produce a significant force in the tangential direction. Current analysis indicates that a NACA0018 would optimize performance.
4) For rotational speeds close to, and equal to zero, the discrete sections at large angles of attack produce a large drag force. Much of this force is in the tangential direction and results in positive torque. This phenomenon increases the ability of the turbine to be self-starting.
5) Power increases as blade number decreases. This is thought to be due to flow interference. The fewer the number of blades, the more time the flow has to converge back to its original uniform condition for the next blade. The more that this flow represents the ideal, uniform case, the better the turbine will perform.

REFERENCES

[1] Park, Jack. The Wind Power Book. Cheshire Books, 1981.
[2] [Putnam, Palmer Cosslett. Power from the Wind. Van Nostrand Company.
[3] Kovarik, Tom, Charles Pupher, and John Hurst. Wind Energy. Domus Books, 1979.
[4] Hunt, Daniel V. Wind power: A Handbook on Wind Energy Conversion Systems.Van Nostrand Reinhold, 1981.
[5] Eggleston, David M. Wind Turbine Engineering Design. Van Nostrand Reinhold, 1987.
[6] Global Wind Energy Systems. (2007). Turbine Information. Retrieved from:http://www.tmawind.com/turbine.php