Prof. S.R.Jadhav, et. al. International Journal of Engineering Research and Applications
www.ijera.com
ISSN: 2248-9622, Vol. 11, Issue 7, (Series-VI) July 2021, pp. 23-34

RESEARCH ARTICLE OPEN ACCESS

‘Vertical Axis Wind Turbine as Emergency Power Source at High Altitude’

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ABSTRACT
Wind energy is one of the most promising renewable energy resources for power generation, and rapid growth has been seen in its acceptance since 2000. The most acceptable classification for wind turbines is by its axis of orientation: Horizontal Axis Wind Turbines (HAWT) and Vertical Axis Wind Turbines (VAWT). HAWTs are used in many countries for medium-to-large scale power projects, and most commercial installations around the globe are solely based on these turbines. On the other hand, HAWTs are not recognized as a viable option to harness the energy of the wind in urban areas, where the wind is less intense, much more chaotic and turbulent. VAWTs are suggested as a better choice for cities, high altitudes isolated semi-urban areas. Several attributes have been suggested for the large-scale deployment of VAWTs, e.g., good performance under the weak and unstable wind, no noise and safety concerns, and aesthetically sound for integration in urban areas. Significant research has been published on wind turbine technology and resources assessment methodologies, and this review paper is a modest attempt to highlight some of the major developments of VAWTs.

Date of Submission: 17-07-2021 Date of Acceptance: 02-08-2021

I. INTRODUCTION

Problem Definition

In the trek of Sinhgad Fort we faced non availability of power source due to which many problem arised such as 1) Mobile charging 2) light problem 3) Cooking of food etc. A thought was given to develop an emergency power source likely portable wind Turbine, as on hill stations air can be efficient source for power generation and because of limit of transmission of power from power plants.

Objective

- To design portable and foldable VAWT
- To design a compact and light weight VAWT.
- To have ability to generate electricity at slow wind speeds.
- To be silent and without vibration.
- To have an emergency power source on the go.
- Self-starting solution.

Wind Energy

Wind Energy is the use of air flow through wind turbines to provide the mechanical power to electric generators. Wind power, as an alternative to burning of fossil fuels, is plentiful, renewable, widely distributed, clean, produce no greenhouse gas emissions during operation, consume no water, and use little land. The net effect on land is far less problematic than those of non-renewable (conventional) energy sources.

Wind farms consist of many individual wind turbines, which are connected to the electric power transmission network. Onshore wind is an inexpensive source of electric power, competitive with or in many places cheaper than coal or gas plants. Offshore wind is steadier and stronger than on land and offshore farms have less visual impact, but construction and maintenance costs are considerably higher. Small onshore wind farms can feed some energy into the grid or provide electric power to isolated off-grid locations.

Wind power gives variable power, which is very consistent from year to year but has significant variation over shorter time scales. It is therefore used in conjunction with other electric power sources to give a reliable supply. As the proportion of wind power in a region increases, a need to upgrade the grid and a lowered ability to supplant conventional production can occur. Power-management techniques such as having a excess capacity, geographically distributed turbines, dis-patchable sources, sufficient hydroelectric power, exporting and importing power to neighbouring areas, or reducing demand when wind production is low, can in many cases overcome these problems. Weather forecasting permits the electric-power network to be readied for the predictable variations in production that occur.

Wind energy is the world`s fastest growing renewable source. According to targets for wind energy presented by International Energy Agency, the global contribution of wind energy should reach from 15 to 18% by 2050. During the last decade, global cumulative wind capacity increased from 59 GW in 2005 to 433 GW in 2015 supplying 3.7% of global electricity. Wind installations have represented more capacity than any other renewable energy technologies. At the end of 2015, the cumulative installed and grid-connected wind power in the European Union reached 143 GW with 8.9 GW in Italy, placing this country at the fifth position among the EU wind energy producer countries. It is reported that, in 2015, a considerable number of small wind turbines (under 200 kW) have been installed. In Italy, a cumulative installed capacity of small wind systems has reached approximately 50 MW with 2,000 new wind turbines.

Wind energy has become one of the fastest growing segments of all renewable energy sources as a sustainable and eco-friendly alternative to fossil fuels which can irreparably harm the environment. With the negative environmental effects of long-term fossil fuel use, alongside the depletion of previously abundant oil and gas reserves, there is a global demand for a sustainable and clean alternative energy resource . Wind energy has become one of the most viable alternative energy resources, with recent technological advances leading to more efficient turbine designs. Global warming, energy scarcity, rapid depletion of fossil fuels and exponential growth in the energy demand in several developing countries has created an excellent opportunity for large-scale acceptance of renewable energy technologies.

Savonius Wind Turbine

Savonius wind turbines are type of vertical-axis wind turbine (VAWT), used for converting the force of the wind into torque on a rotating shaft. The turbine consists of a number of aerofoils, usually but not always vertically mounted on a rotating shaft or framework, either ground stationed or tethered in airborne systems.

The Savonius wind turbine was invented by the Finnish engineer Sigurd Johannes Savonius in 1922. However, Europeans had been experimenting with curved blades on vertical wind turbines for many decades before this. The earliest mention is by the Italian Bishop of Czanad, Fausto Veranzio, who was also an engineer. He wrote in his 1616 book ‘Machinae novae’ about several vertical axis wind turbines with curved or V-shaped blades.

The Savonius turbine is one of the simplest turbines. Aerodynamically, it is a drag-type device, consisting of two or three scoops. Looking down on the rotor from above, a two-scoop machine would look like an "S" shape in cross section. Because of the curvature, the scoops experience less drag when moving against the wind than when moving with the wind. The differential drag causes the Savonius turbine to spin. Because they are drag-type devices, Savonius turbines extract much less of the wind's power than other similarly-sized lift-type turbines. Much of the swept area of a Savonius rotor may be near the ground, if it has a small mount without an extended post, making the overall energy extraction less effective due to the lower wind speeds found at lower heights.

Fig 5.(Savonius Wind Turbine)

According to Betz's law, the maximum power that is possible to extract from a rotor is $P_{max}=(16/27).\rho.r.h.v^3$ where ρ is the density of air, h and r are the height and radius of the rotor and v is the wind speed. However, in practice the extractable power is about half that (one can argue that only one half of the rotor the scoop co-moving with the wind works at each instant of time). Thus, one gets $P_{max} \approx 0.36 kg\text{-}m^{-3}.h.r.v^3$

The angular frequency of a rotor is given by $\omega=\lambda.v/r$, where λ is a dimensionless factor called the tip-speed ratio. λ is a characteristic of each specific windmill, and for a Savonius rotor λ is typically around unity.

For example, an oil-barrel sized Savonius rotor with h=1 m and r=0.5 m under a wind of v=10 m/s, will generate a maximum power of 180 W and an angular speed of 20 rad/s (190 revolutions per minute).

These turbines have achieved some level of acceptance due to their low cut-in wind speedsand self-starting capability but suffer from a low rotational performance and overall efficiency.Akwa et al.performed a detailed study on Savonius turbines and concluded that a diversity of rotor configurations is a useful characteristic of this type machine. The aerodynamic performance is affected by the geometry of the rotor, air flow characteristics, and operational conditions. The power coefficient of different designs of Savonius varied and evaluated in the range of 0.05–0.30.

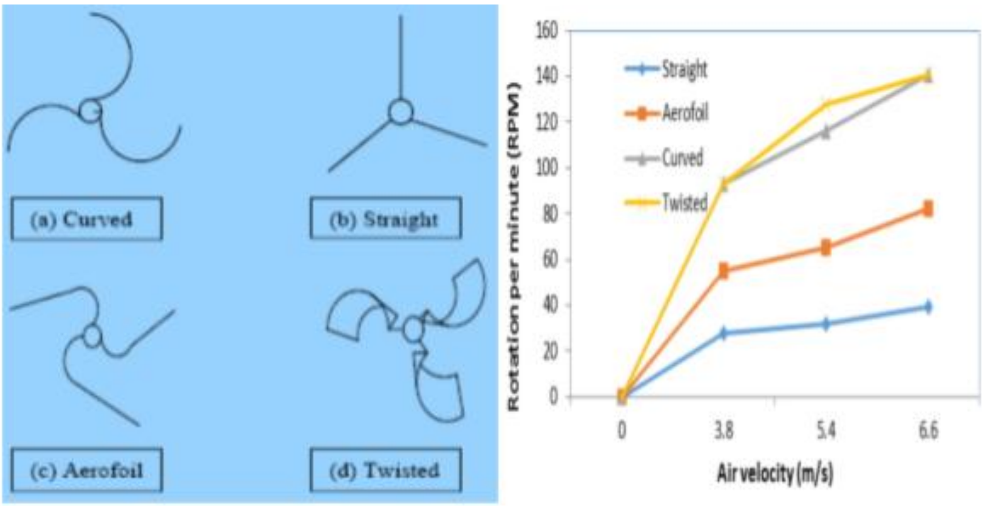


Fig 6.(A sectional view of tested blade designs of Savonius Turbine and variations of RPM in blade design with wind speed)

Recently Savonius was tested with four blade configurations for the rotational performances. The experiments were conducted for the curved, straight, aerofoil, and twisted blade.The straight blade design was found to have the least rotational performance (RPM) while the best performance was recorded for the twisted blade type.

1.6. Advantages of VAWT over HAWT

VAWTs commonly function nearer to the ground, and has the benefit of enabling placement of heavy equipment, such as the gearbox and generator, close to the ground level and not in the nacelle.

Another benefit of a VAWT over the HAWT is that it does not need a yaw mechanism, because it can harness the wind from all directions. This benefit is outweighed by numerous other limitations, such as: time varying power output because of change of power in a single blade rotation, the requirement for guy wires to support the main tower and the fact that the Darrieus VAWTS are do not self-start like HAWTS.

VAWTs give many advantages when compared traditional horizontal-axis wind turbines (HAWTs). They may be packed very closer together inside the wind farms, and this allows more in any space. They are also quiet, they are omni-directional, and they also generate lower forces on the support structure. They also do not need as much wind in order to produce power, therefore permitting them to be nearer to the ground where the speed of the wind is lower. Because they are closer to the ground, this means they are easily controlled and can be implemented on tall structures. cautiously designing the wind farms using VAWTs may result in the generation of power output that is ten times greater than a HAWT wind farm that is the same size.

VAWTs are also more quieter than the HAWTs, with the dB levels at a ground level that is ten meters from the tower measured about 95 dB for a HAWT this is about the sound of a highway with cars passing by – as compared to about 38dB for a VAWT which is about the sound of whispered conversation. This is because of multiple reasons, starting with a lower tip speed of VAWTs.

1.7. Disadvantages of VAWT

- VAWTs sometimes do not function properly under winds that are gusty.
- They generate extremely low starting torque, and also have dynamic stability issues.
- Due to broad variation in applied forces in every rotation the blades may lead to fatigue failure.
- The vertical types of blades implemented in early models became bent with every spin, and this caused them to have cracks.
- This makes VAWTs less reliable.

1.8. Uses of VAWT

- Battery charging of gadgets.
- Auxillary power for boats or caravans.
- It can be mounted on road dividers.
- It can be used to light street lights.

1.9. Methodology

- Problem Definition
- Literature review and Market survey
- Design 2D sketch of model in Auto-CAD.
- Selection of standard components.
- Calculations of remaining parts.
- Purchasing of standard components from market.
- Designing of rough 3D model
- Analysis
- Manufacturing
- Assembly
- Testing of Model

II. LITERATURE REVIEW

Craig Stout , Sheikh Islam ,Alasdair White , Scott Arnott , Erald Kollovozi ,Morven Shaw , Ghazi Droubi , Yashwant Singha , Benjamin Bird did a study on efficiency improvement of vertical axis wind turbine with an upstream deflector.Thepurpose was to investigate the fluid flow around a three-bladed VAWT and analyse the effect an upstream deflector has on the turbine efficiency .The major advantage of VAWT is that they are omni-directional and can extract wind energy in all direction. However there is a problem of negative torque induced on the returning blades. Hence deflectors are used to overcome this problem by redirecting the airflow away from returning blades, decreasing the negative torque.

A numerical analysis was conducted using CFD to ratify the chosen airfoil geometry , then design and analysis of the VAWT was done for both open rotor and deflector configurations. All CFD simulations were performed in 2-D using ANSYS Fluent 14.0. The geometry and mesh of the open rotor models were created using ANSYS Fluent 14.0 Design Modeller. The governing equations were based on continuity and momentum equations and are solved using k-epsilon (RNG) turbulence model. The open rotor was optimized first and then the Augmented rotor (deflector).

The Darrieus-turbine consisting three NACA 7715 airfoil blades of 1m chord length was designed. Three domains were used for numerical analysis a) the outer fluid domain b) the rotating rotor domain and c) inner fluid domain. The rotor domain was defined as a moving reference frame , with angular velocity input parameter used to vary the tip speed ratio of turbine. An output parameter of torque (T) was used in many calculation to measure turbine efficiency..

The augmented rotor was identically modelled to open rotor , with addition of a deflector plate. To determine turbine performance the top quadrant and bottom quadrant were simulated.

Testing of four bottom quadrant deflector was done with deflector angles of 90^0 , 63^0 , 45^0 and 36^0. The results show that the performance of turbine was decreased by 9.006% and 9.034% respectively. With smaller deflector angles of 45^0 and 36^0 the efficiency was seen to be increased by 1.741% and 2.212% respectively.

The variation in efficiency was seen because the way in which the deflectors direct the flow. Deflector with larger angles (90^0 and 63^0) were seen to alter the flow to blades 1 and 3, reducing the forces of lift. The desired result of pressure distribution reduction on blades was achieved but the wind flew over the returning blade 2. However the size of the deflectors leads to the redirection of flow to blade 1, reducing the induced force of lift on the blade. For the smaller deflector widths (45° and 36°) the flow onto blade 1 is not altered significantly.This allows for the generation of torque as if the turbine was in its ‘open-rotor’ condition, while reducing the flow to the returning blade (blade 2). This allows for the improvement of the systems efficiency, while reducing the rotational speed of the system required to reach optimal efficiencies.

For comparison, an identical set of simulations were conducted with the use of a series of top-quadrant deflectors, with widths of 90°, 63°, 45° and 36° implemented. However, significant decreases in the turbine efficiency were obtained when all top-quadrant deflector variations were used. Smaller angles ($63^{0,}$ 36^0,45^0) reduced the efficiency of rotor by 11.078%, 3.736% and 2.256% respectively. For a larger angle the maximum efficiency was seen to be increased by 1.266%.

The results were concluded that the use of small curved upstream deflectors improved the optimal performance of turbine by 1.266%. Thus the use of deflectors had a positive effect on turbines performance.

M.M.S.R.S. Bhargava , Velamati Ratna Kishorea, Vaitla Laxmanb did a study on influence of fluctuating wind conditions on vertical axis wind turbine using a three dimensional CFD model. The paper presents investigation on the effect of fluctuating wind conditions on the performance of 1.1kW commercial Darrueus type 3 straight bladed VAWT. , Darrieus type having NACA 0015 airfoil profile. Turbulence was modelled using Transition SST K-ω model. Free stream velocity $U\infty$ was varied in sinusoidal manner with respect to flow time for U_{mean}=10 m/s. In this study, the effect of variation of fluctuation amplitude U_{amp}, fluctuation frequency f_c and tip speed ratio λ on the performance of VAWT was investigated. The vortex structures are studied for U_{amp} =10% and 50%.

From the results, it is observed that the uniform and fluctuating wind CP curves do not trace each other. Cycle averaged CP increases with U_{amp}. A maximum CP of 0.33 is obtained corresponding to U_{amp} =50%. Cycle averaged CP increases to a maximum value and then decreases with λ_{mean}. Maximum CP of 0.31 is obtained corresponding to λ_{mean}=2. Cycle averaged CP increases to a maximum value and then marginally decreases with f_c. Maximum CP of 0.31 is obtained corresponding to f_c =1 Hz. Hence the overall performance under fluctuating wind conditions improved when VAWT is operated at higher U_{amp}, $\lambda_{mean}\geq 2$ and f_c close to 1Hz.

Bavin Loganathan, Israt Mustary, Harun Chowdhury, Firoz Alam have presented a study on effect of turbulence on a savonius type micro wind turbine. The objective of the study was to investigate effect of turbulence of a multi-bladed micro vertical axis wind turbine with semi-circular shaped blades in a wind tunnel environment under a range of wind speeds. Power inputs of a 24, 32 and 40 bladed rotor distance between two blades of 35mm, 17.5mm and 9mm was measured.

A VAWT having semi circle shaped blade made of PVC material mounted in between two circular discs providing equal space were used. Three rotors with 24, 32 and 40 blades with blade diameter of 40 mm and blade height of 160 mm were constructed. The rotor radius is 150 mm. The RMIT Industrial Wind Tunnel was used to measure the torque and rpm of the wind turbine for different configuration of the grid. Generation of turbulence was done with the help of wooden grids. Three different grids were used to maintain a blockage ratio of50%.The small, medium and large grid sizes were (70 mm u 70 mm), (250 mm u 250 mm) and (720 mm u 720 mm) respectively. The turbulence intensity was measured by keeping the inlet velocity constant at 8.5 m/s and varying distance of the turbine from the grid position from 0 to 7.5 m. The setup was positioned and fixed properly on top of the movable test rig table. The test rig table was placed at different position in the wind tunnel. After performing the experiments it was observed that turbulence intensity increases with the increase of grid size. Smaller grids had larger impacts on turbulence intensity comparing to large and medium grids.The variation of power with intensity for 24-, 32- and 48-bladed rotors using small, medium and large grids. It can be observed that the turbulence had a significant impact on the power output of the turbines. The result shows that the power output of a multi-bladed Savonius type rotor decreases with the increase of turbulence intensity. The result also shows that the turbulence intensity increases with the increase of grid size with the same blockage ratio. The larger grid dimensions had higher flow rate thus the turbine power was larger. The inlet velocity had higher impact on power output compared to intensity. The result also indicated that the optimal number of blades for the Savonius type micro vertical axis wind turbine is 32 blades. Further increase or decrease of the number of blades can decrease the power output of the turbine.

Sahishnu R. Shah , Rakesh Kumar b, Kaamran Raahemifar , Alan S. Fung have done a research on small scale vertical axis wind turbine. The primary objective of this research was designing and modelling of vertical axis wind turbine. Two new shapes of rotor blade were examined against straight and curved blades in terms of rotational performances. MATLAB simulation was used to develop a mathematical model comprising of various parameters which were used for validation of model. The aims were to analyze turbine blade shape, develop a mathematical algorithm and to establish the techno economic performance to the new curved shape design. The design intended that the turbine should have low cut-in wind speed, lightweight, and can be easily moveable. The drag based machine should be capable of harnessing energy from the non-directional wind at low cut-in speed, which makes it a better choice for many urban applications. A

Savonius turbine was selected as it requires very low cut-in wind speeds. Savonius rotors with four shapes wre tested and their rotational performance were analyzed. Curved, straight, aerofoil and twisted blades were used for conducting the experiments. The rotations per minute (RPM) for each blade types were recorded with respect to wind speed . The straight blade was found to have lowest RPM in all four shapes while the best RPM has been posted for the twisted blade. In respect to the wind speed, the straight blade has been seen to have less efficiency in comparison to other three blades shapes. The reason for this is there is a more drag force acting on the straight blades, separated by 120◦ , relative to the other three configurations. The same speed of wind produces the lesser amount of torque for straight blade shape. The rotational performance for the curved blade type was closer to the twisted type, whereas, the aerofoil blade has lower RPM than the twisted and curved blades.

To advance the proposed design a mathematical model was made using MATLAB . The software was used to analyze the performance of the model. The output voltage and currents were analyzed and the simulated values of voltage, current, and power were estimated and compared with experimental results. The calculation for electrical power output and annual energy generated at various predictable wind speeds were also made. The results were concluded as the simulation results were in a reasonable agreement to experimental values. This difference was due to uncontrolled test conditions and measurement errors. The annual energy output estimated that the design could generate annual energy of 7838kWh and corresponding annual revenue was estimated $846.51.

III. DESIGN AND CALCULATION

TURBINE DIMENSIONS

Due to starting torque problems in Darrieus type turbine we have selected savonius type of turbine for our designing and manufacturing. Energy carried out by wind is given by kinetic energy

Hence,

$KE=1/2*m*V^2$

$KE=1/2*\rho*A*V^3$

Where

A= Swept Area

ρ= Air Density

V= Wind Speed

A physical limit is exists known as Betz limit.

It is the hypothetical maximum energy which can be extracted from a volume of moving air. It was independently discovered by three different scientists between 1915 and 1920, but as per Stiglers Law it wasn’t named after the person who discovered it first but after Alfred Betz who discovered it in 1920.

The limit is 16/27, typically represented as the approximation 59.3%.

It is based on a hypothetical disk with an infinite number of blades with no drag and no hub. This is obviously different than any real world device.

The principle is simple. At a certain point, the back pressure of air makes the air move around the device instead of through it. Obviously, if all of the energy was taken from the moving volume of air, the air would be still behind the device. In that case, all the rest of the air would simply move around it for no generation. Note that this has been the fatal flaw with every concentrator / Venturi effect / funnel wind turbine since the 1920’s, up to and including the Sheerwind Invelox.

Commercial utility-scale wind turbines with horizontal axes and three blades don’t achieve 59.3% of course but they approach 90% of that and have been proven globally as the best set of compromises for economically harvesting energy from the wind. That’s why utility scale wind generation is the cheapest form of new generation out there.

That last bit is important. Efficiency of harvesting of a free resource doesn’t matter when the free resource is so abundant that there are multiples of the energy flowing through it at any given time. What does matter is the economics of harvesting the energy.

As savonius type of turbine is considered the betz limit is considered as 0.26

Power to be generated is 125 watts

$125=0.26*1/2*1.225*A*10^3$

$A=0.784m^2$

H=0.784m

D=0.9m

SHAFT

Initial Driveshaft Design

The design of the turbine driveshaft was initially governed by the torque generated from the rotating blades.

The yield strength of AISI1018 is

σ_y =370 MPa

$=370*10^6$ Pa

Maximum principal stress theory is σ_y and the minimum principal sheer stress is zero from the maximum shear stress theory

τ_{max}= $TD_o/2J$

Polar moment of inertia

$J=\pi/2[(D_o/2)^4-(D_i/2)^4]$

Wind Force
When moving air wind is stopped by a surface the dynamic energy in the wind is transformed to pressure. The pressure acting the surface transforms to force

$F_w=p_d*A$

$=1/2*\rho*V^2*A$
F_w=wind force (N)
A=surface area(m^2)
p_d=dynamic pressure(Pa)
ρ=density of air (kg/m^3)
V=wind speed(m/s)

$F_w=0.5*1.225*10^2*0.78492$

$F_w=48N$

$T=F_w*r$

T =48*0.45

T =21.6Nm

Assume
$D_o=0.025m$
$D_i=0.019m$
$J=\pi/2[(D_o/2)^4-(D_i/2)^4]$

$J=\pi/2[(0.025/2)^4-(0.019/2)^4]$

$J=2.555*10^{-8}$

$\tau_{max}=T*D_o/2*J$
$\tau_{max}=21.6*0.025/2*2.555*10^{-8}$

$\tau_{max}=10.56*10^6$ Pa

185MPa>τ_{max}

Therefore design is safe.

BEARING

A **bearing** is a machine element that constrains relative motion to only the desired motion, and reduces friction between moving parts. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis or, it may *prevent* a motion by controlling the vectors of normal forces that bear on the moving parts. Most bearings facilitate the desired motion by minimizing friction. Bearings are classified broadly according to the type of operation, the motions allowed, or to the directions of the loads (forces) applied to the parts.

Rotary bearings hold rotating components such as shafts or axles within mechanical systems, and transfer axial and radial loads from the source of the load to the structure supporting it. The simplest form of bearing, the *plain bearing*, consists of a shaft rotating in a hole. Lubrication is often used to reduce friction. In the *ball bearing* and *roller bearing*, to prevent sliding friction, rolling elements such as rollers or balls with a circular cross-section are located between the races or journals of the bearing assembly. A wide variety of bearing designs exists to allow the demands of the application to be correctly met for maximum efficiency, reliability, durability and performance.

The term "bearing" is derived from the verb "to bear" a bearing being a machine element that allows one part to bear (i.e., to support) another. The simplest bearings are bearing surfaces, cut or formed into a part, with varying degrees of control over the form, size, roughness and location of the surface. Other bearings are separate devices installed into a machine or machine part. The most sophisticated bearings for the most demanding applications are very precise devices; their manufacture requires some of the highest standards of current technology.

The radial load acting on bearing is because of the weigtht of blades and wind force.

W_b= weight of blade

W_b=58.86N (Approx weight of three blades in newton)

F_w= Wind force

$F_r=F_w+W_b$

$F_r=48+58.86$

F_r=106.86s

F_r=107N

$P=XVF_r+YF_a$

P=Equivalent dynamic load (N)

X=Radial Load Constant

Y=Axial Load Constant

F_r=Radial load

F_a=Axial Load

V=race rotation factor

$P_e=VF_r*K_a$

As calculated above F_r =107N and F_a=0
V=1 when the inner race rotates while outer race is held stationary in housing
K_a=1.2 (load factor)
X=1 and Y=0 from table

$P_e=1*107*1.2$

P_e=128.4N

Now bearing life is calculated as

Tip speed ratio for savonius type of turbine is 0.7-0.8
Tip speed ratio= Tip speed/Wind speed
0.8=Tip speed/10

Tip speed= 8m/s

RPM=8*60/π*D

RPM=152.78rpm

RPM=160rpm

L_{h10}=6000hrs (for short period application with no seriousconsequences)
$L_{10}=L_{h10}*60*160/10^6$

Where,
n= number of revolutions per minutes= 160rpm
L_{10h}=Rated life of bearing (6000hrs. in our case)

L_{10}=57.6 million revolution

Using load life relationship

$L_{10}=(C/Pe)^3$

$C=(L_{10})^{1/3}*P_e$

C=495.875N

From table (V.B.Bhandari)

32005X

D_o=47mm

D_i=25mm

B=15mm

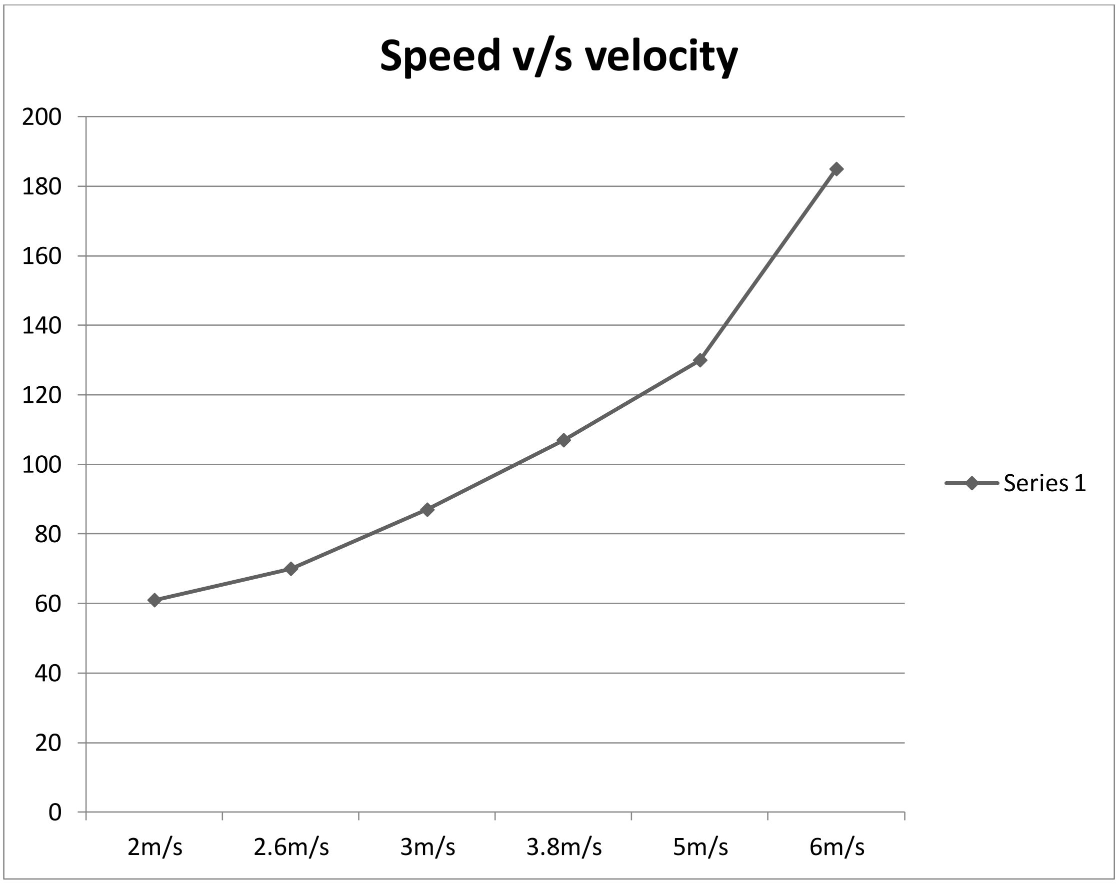
C=25500N

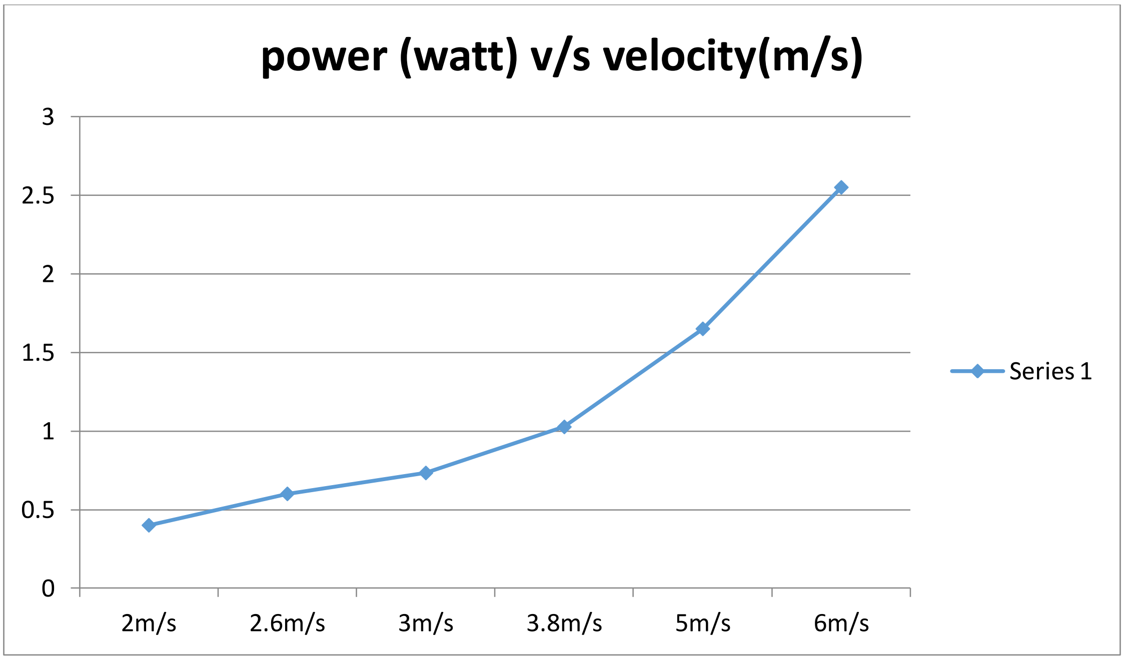
C_o=5600

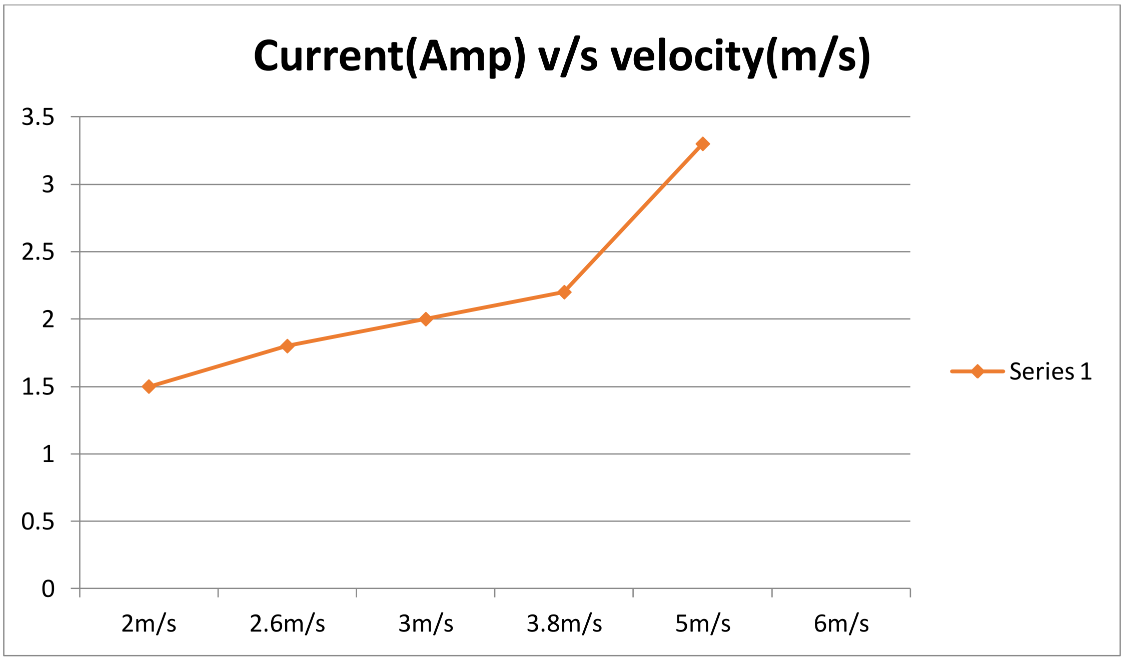
Bearing designation 32005X is selected as dynamic load carrying capacity calculated is less than standard dynamic load carrying capacity of bearing.

IV. RESULT

Sr. No.	Velocity(m/s)	RPM	Current(Amp)	Voltage	Power(watt)
1.	2	61	1.5	0.8	0.4
2.	2.6	70	1.8	1.0	0.6
3.	3	87	2	1.1	0.733
4.	3.8	107	2.2	1.4	1.026
5.	5	130	3.3	1.5	1.65
6.	6	185	4.5	1.7	2.55


Speed v/s velocity
200
180
160
140
120
100
80
60
40
20
0
2m/s
2.6m/s
3m/s
3.8m/s
5m/s
6m/s
Series 1


power (watt) v/s velocity(m/s)
3
2.5
2
1.5
1
0.5
0
2m/s
2.6m/s
3m/s
3.8m/s
5m/s
6m/s
Series 1



V. CONCLUSION

If any conclusion can be drawn is that the VAWT technology undoubtedly will be with us in the future, and can be seen all around us, as has happened with other renewable technologies for electricity production, such as HAWT , thus becoming part of the future renewable energy range and the business network, contributing to the reduction of CO2 production and economic growth.

Hence we decided to design a portable vertical axis wind turbine for our project. The designed turbine should be for use in emergency situation or else while trekking where power source is unavailable. Hence such turbines should operate even at slow wind speeds and this can be made possible by using various attachments like wind boosters , wind flaps or designing blades giving maximum power output or use of permanent magnet bearing to reduce frictional losses and indirectly increase power output. Considering the power output the portability of turbine can be done by using foldable blades and designing the height as low as possible so that it can be packed easily in a bag. These all parameters are decided keeping in mind the cost and market availability of the components.

VI. FUTURE SCOPE

Although predicting the future based on data is not always fully conclusive, we can deduce that: The VAWT technology is sliding into the use in small generating installations, especially in urban environments that currently have winds that are not exploited. There are studies about the omnidirectional-guide-vane which make power, speed and torque increase markedly in these sorts of environments .

Employing Wind VAWT in hybrid power generation system can be the solution at many locations since the cost of this system is considered to be lower than the use of both individual technologies .

About the studies devoted to the types of optimal generators for producing electricity from wind energy in urban environments it can be drawn that the desired features are: -

1) Low cogging torque.
2) Very high electrical and mechanical efficiency (including the operation of main charge).
3) Compact size and high specific torque / power.
4) Lower noise and vibration. –
5) Cheap and easy to manufacture and install.

Due to the high cost and risk involved in the physical realization of a model to be submitted to the testing necessary to meet the various operating parameters as well as how changes in the environment and morphology evidence bearing on this, numerous studies have been devoted, through computer programs and various calculation methodologies, to try to improve the performance and efficiency of VAWT, and this will continue until noticeable results are achieved and someone bets by the use of technology.

For high volume productions using the technology HAWT large wind turbines will remain the most common used technology, as yields and production are higher when compared with the VAWT. But the use of VAWT small wind farms is not excluded, as it has been concluded that, contrary to what happens to the HAWT – The closer they are between them, the lower power coefficient they get, under certain provisions of proximity, VAWT increases it. This does not exclude the situation of small VAWT wind farms on the roofs of buildings or in high places either urban or rural environments.

VII. ACTUAL PHOTOS


Assembly of VAWT


Stand and Generator Gear Arrangement


Blades with frame


Frame

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