Design and Development of Novel Vertical Axis Wind Turbine

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***Abstract* -The new technology alternative energy is considered as renewable energy and used to reduce cost of fuel of non-renewable energy sources generation this intern reduces the environmental effect. Wind power has a key role in reducing GH (green house) gas emissions. Today Horizontal Axis Wind Turbine (HAWT) is commonly used where the axis of rotation is parallel to the ground and the Vertical Axis Wind Turbine (VAWT). The is focused on primarily on VAWT, These devices operate on any direction wind flow and require much less space than a traditional HAWT ,in future VAWT beats the other sources of energy. VAWTs dominate over HAWTs, such as:**

1) Simple construction.
2) Reduces cost of construction,
3) They can accept flow from any direction,

Relatively low and constant wind strength VAWT work well. VAWTs include both a drag-type and lift type configurations.

In this work we attempt to design and fabricate a Vertical Axis Wind Turbine.

Keywords: **GH, Turbine, HAWT, VAWT etc.**

I. INTRODUCTION

Wind power means, power in the wind extracted into other form intern converted into electricity. Vertical axis wind turbine rotors are leading to more popular than horizontal axis wind turbine because of its easy manufacturing, working and its economics. Wind energy is a simple and renewable green source.Variable pattern of wind distribution makes wind energy viable alternating. The variable wind condition and the low electrical conversion efficiency because of inconsistent power produce. The increased capital investment in energy storage solutions requires combating these conditions. Wind energy is favored and it is alternative to fossil fuels such as plentiful, renewable, widely distributed, and produces lower greenhouse gas emissions.Also the construction of wind farms is not harmful, so that visual impact is negative and the effect on wildlife. Hence, today's the largest forms of green energy used in remains it.

A. Vertical Axis Wind Turbines (VAWT)

The principle of windmill is converts the kinetic energy of wind into mechanical energy, it can be converted into electricity. The main rotor shaft is arranged vertically which give the advantage to it. This advantage is on sites where wind direction is variable as VAWTs can use wind from different direction. In VAWTs the gearbox and generator are placed at the ground level, which reduce the need of supported by tower. And make accessible maintenance**.** The power conversion is less efficient, a pulsating torque created by some models and drag forces experienced as the blades rotate into the wind is the major part of VAWTs. The negative effect of pulsating torque on wildlife and we tried reducing the pulsating torque and making more wildlife-friendly designs.

B. Horizontal Axis Wind Turbines (HAWT)

The main rotor shaft of Horizontal axis wind turbines are arranged horizontally. The blades of the wind turbines installed perpendicularly to the rotating axis, and form a certain angle. The wind turbines with more blades are called low speed turbines. The main disadvantages of Horizontal axis are that, the maintenance is quite difficult as rotor is placed much above from the ground. The wind turbine is a rotating machine. The kinetic energy available in the wind is converted into the mechanical energy .The turbines shaft is connected to the permanent magnet dc generator through gears. The dc generator converts provided mechanical energy into the electrical energy. The charge controller Prevents overcharging and may protect against overvoltage. The batteries are used to store the generated energy. After conversion from dc into ac the produced electricity is supplied to the appliances.

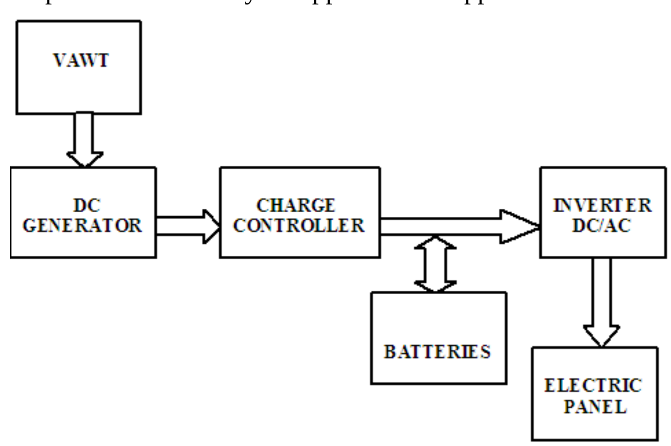

Fig.1. Block diagram of Prototype Model

C. The twisted blade

Darrieus turbines have relatively good efficiency but poor reliability. Blades of darrieus turbine canted into helix will allow wind pull each blade on both windward and leeward sides. Which spreads the even torque over the complete revolution, it protect from destructive pulsations. Savonius turbines have dominated being self starting with as reliable. Fig 1 shows the twisted blade design, proposed design catch the wind from all directions and convert the maximum power of the wind by torque on a rotating shaft, while the skewed leading edges reduce resistance to rotation.

A proposed design was selected that had not been tested previously. Design model exhibited a enclosed enter chamber while most twisted blade structured turbines are open in center to pass air to move between the twisted chambers on each side of the turbine axis as shown in fig.2. 360^0 angle blade twist makes largest static torque and makes different from traditional twisted wind turbines where a 90° angle of twist is standard.

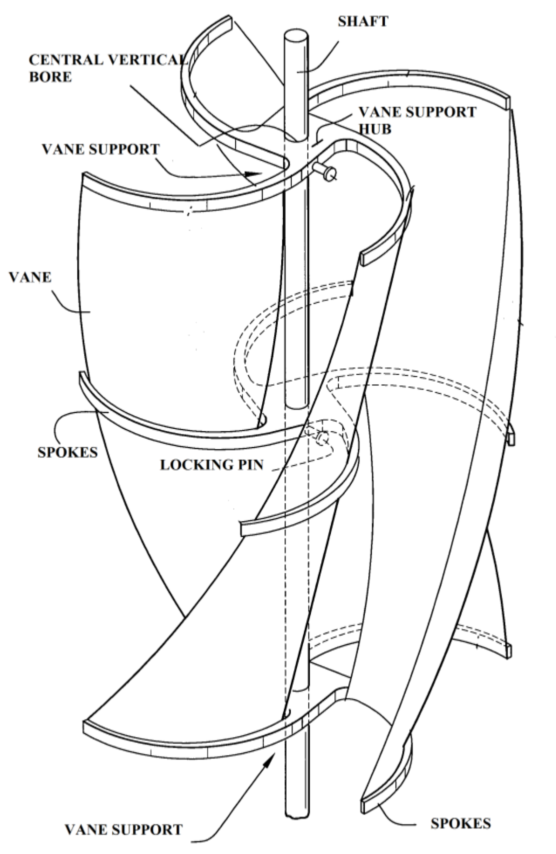

Fig.2. Twisted Blade Design

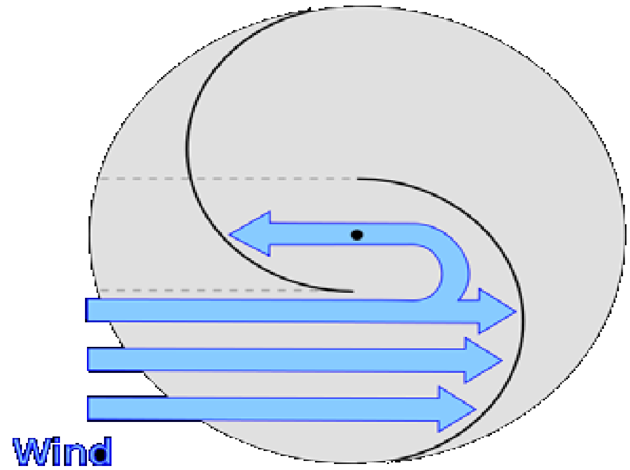

Fig.3. Typical Savonius Wind Turbine Cross-Section

D. Advantages of VAWT over HAWT

1. Less supporting structure.
2. Maintenance of the wind turbine quite easy.
3. Cost effective.
4. Work in All direction flow.

E. The power in the Wind:

The principle of windmill is converting kinetic energy of wind into mechanical energy and hence in power calculated by kinetics. The kinetic energy of any particle is equal to one half its mass times the square of its velocity,

Kinetic Energy = ½ mv2.

Amount of Air passing is given by

$m = \rho AV$ --------------------------------------(1)

Where,

m = mass of air transversing

A=area swept by the rotating blades of wind mill

Type generator, ρ = Density of air, V= velocity of air

Substituting above value of the mass in expression of

$K.E = \frac{1}{2} \rho AV^3$ watts ----------------------(2)

From Second equation shows that the air density (1.225 kg/m3) and intercept area is proportional to available power. Since the horizontal axis aero turbines of the area of circular diameter D is,

$$A = h \times d$$

F. Wind turbine design parameters

a. *Wind Speed*

The windmill is very important part of the productivity by using wind, wind turbine generate power. The rotation of wind the axis (horizontal or vertical) and causes the shaft on the generator to sweep past the magnetic coils creating an electric current.

b. Swept Area

The swept area is the section of air that encircles the turbine in its movement.
The swept area is given by,

$$A = h \times d$$

i.e Bigger area, Bigger power output for same wind conditions.

c. Power and Power Coefficient

Power available,

$$Pw = \frac{1}{2}\rho A V^3$$

Where, ρ = Air Density Kg/m^3, V=Velocity (m/s), A=Swept Area

$$C_p = \frac{\text{Captured Mechaical Power by Blades}}{\text{Available Power in the Wind}}$$

d. Tip Speed Ratio

Cp dependant on TSR

$$TSR = \frac{\text{Tangential Speed at the Blade Tip}(R\omega)}{\text{Actual Wind Speed}(V)}$$

Where,

ω=angular speed (rad/sec)

e. Blade chord

The chord is the length between leading edge and tralling edge of the blade profile. The blade thickness and shape is determine by type of airfoil is used

f. Number of blades

The number of blades has direct effect in the smoothness of rotor operation as they can compensate cycled aerodynamics loads. For easiness four or three blades have been contemplated

g. Solidity Ratio

$$\delta = \frac{NC}{R}$$

Where, N=number of blades, C=blade chord, R=blade length

When,

$$\delta > 0.4 \textit{ Then turbine is self starting}$$

H . Prototype model specifications

a. Base dimensions

Height 0.152m, Width 0.190m

b. Theoretical Calculations

Table.I

For wind velocity 4m/s

Diameter (meter)	Height (meter)	Power (Watt)	Speed (RPM)	Torque (N-m)
0.5	0.385	7.546	152.86	0.47
0.7	0.539	14.790	109.19	1.29
1	0.77	30.184	76.43	3.77
1.2	0.924	43.46	63.69	6.51
1.5	1.155	67.91	50.95	12.73

Table.II

For wind velocity 5m/s

Diameter (meter)	Height (meter)	Power (Watt)	Speed (RPM)	Torque (N-m)
0.5	0.385	14.738	191.06	0.73
0.7	0.539	28.88	136.48	2.02
1	0.77	58.95	95.54	5.89
1.2	0.924	84.89	79.61	10.18
1.5	1.155	132.64	63.69	19.89

I. Results:

Speed=230.6 rpm
Voltage=264mV
Current=18.16mA

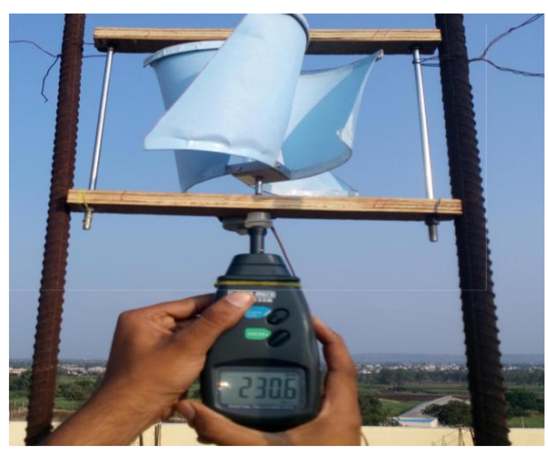

Fig 4.Speed Measurement Prototype Model

Fig.5 Voltage and Current measurement from Prototype Model

A. Results obtained from prototype:

The readings are taken from 10am to 5pm,at interval of 7 minutes.

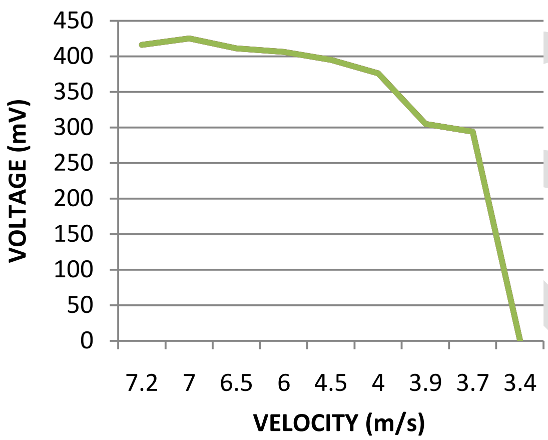

Fig.6. Voltage (mV) Vs Velocity (m/s)

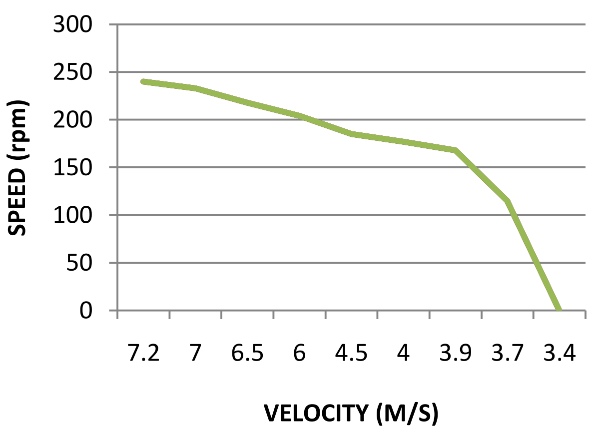

Fig.7. Speed (rpm) Vs Velocity (m/s)

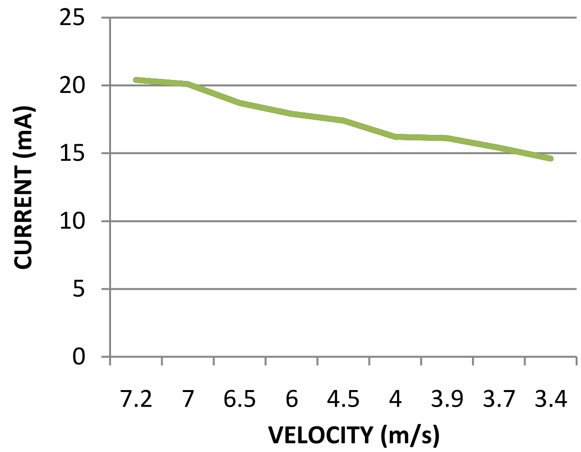

Fig.8. Current (mA) Vs Velocity (m/s)

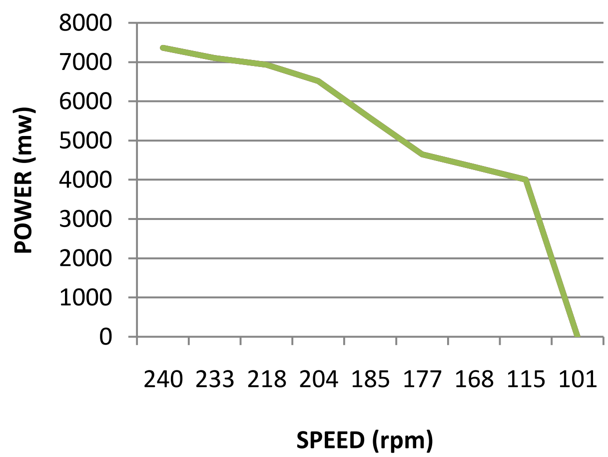

Fig.9. Power (mW) Vs Speed (rpm)

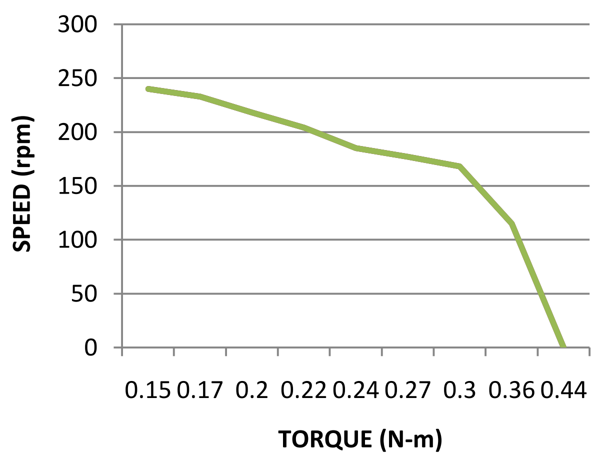

Fig.10. Speed (rpm) Vs Torque (N-m)

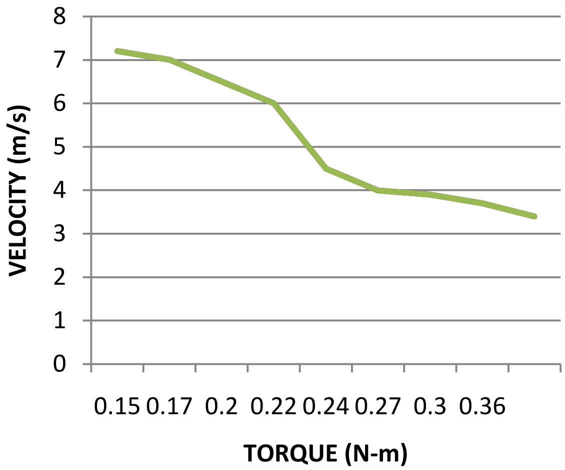

Fig.11. Velocity (m/s) Vs Torque (N-m)

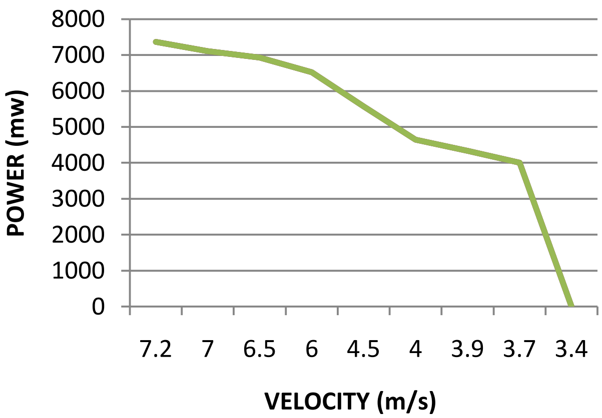

Fig.12. Power (mW) Vs Velocity (m/s)

j. Average of Readings:

Wind Velocity = 3.476 m/s

Speed = 141.4 rpm

Voltage = 322.46 mV

Current = 14.01 mA

II. CONCLUSION

The results of this analysis met all established performance goals. A new variation of the standard twisted savonius wind turbine was analyzed, designed and tested under various wind conditions. The turbine also proved to be self-starting under low wind speeds. Additional testing would be required to make a definitive conclusion. However, the general curvature supports the general engineering theory behind VAWTs.

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