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FABRICATION AND TESTING OF CLOSE CASING VERTICAL AXIS WIND TURBINE WITH TUNNELLING EFFECT

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Abstract: This paper present a new concept of close casing vertical axis wind turbine (VAWT) with tunneling effect at different wind speed. Conventional existing wind mill are open to the surrounding and ambient air flows over it. Thus, considerable amount of wind energy is lost and utilization of the wind energy is not optimized. Here we are providing some suitable material sheet casing over the blades of the wind mill with suitable design and shape of the blades. These blades are enclosed in a suitable material casing from all the sides and only inlet and outlet ports are provided to the casing. Along with casing, the wind flow can be directed in the casing by passing it through the wind tunnel connected to the inlet port of the casing which will enhanced the wind velocity to some extent. The wind turbine exhaust then takes place through the exhaust port. We check the performance of close casing VAWT with conventional VAWT. Numeral results are used to analyze rotor speed, shaft torque, power and efficiency of close casing VAWT. This has been widely used in telecommunication companies, street lightning system in remote area and buildings application. This close casing VAWT with tunneling effect provide a means to predict overall performance and output of the turbine with varying free stream conditions.

Keywords: Innovations, Theoretical Analysis, Finite Element Analysis, Experimental

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INTRODUCTION

Vertical Axis Wind Turbines represent a reliable, practical and cost effective method for generating energy anywhere the wind blows. Vertical Axis Wind Turbines are Omni Directional. This means that they can capture wind power without having to be positioned in the direction that the wind is coming from. It also means that they have less Moving Parts than their horizontal counterparts. This makes them more reliable and much less costly to maintain. They produce a substantial amount of torque. This is due to the fact that the blades on the turbine have a much larger surface area than the blades found on a horizontal axis turbine. As a result, Vertical Axis Wind Turbines can be coupled directly to a water pump for example. The result is that the efficiency of converting the energy to directly power the application will be much greater. Finally, Vertical Axis Wind Turbines are designed to spin at a much slower speed than Horizontal Axis Turbines. Is this a disadvantage you ask? Not in the slightest! Spinning at a slower speed allows the turbines to function in much higher wind speeds. It also reduces noise and vibrations, is safer for birds and can be camouflaged into an urban or rural setting much more effectively, making Vertical Axis Wind Turbines a great option

PROJECT PROBLEM

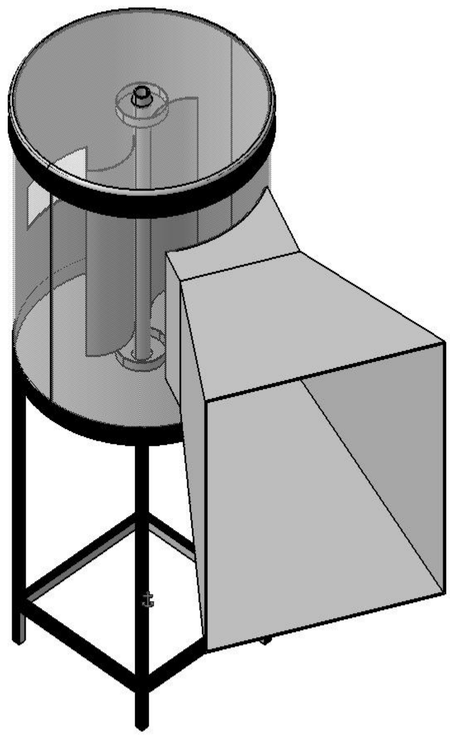
A wind turbine obtains its power input by converting the force of the wind into torque (turning force) acting on the rotor blades. The amount of energy which the wind transfers to the rotor depends on the density of the air, the rotor area, and the wind speed.

Conventional existing wind mill are open to the surrounding and ambient air flows over it. The unit does not have any casing over the wind mill blades. Atmospheric air when passes over the blades , the impact of the wind on the blades put it in rotation but the as the blades are not having any cover or casing over it , most of the wind mass escapes from the blades without transferring its energy to the blades. Thus, considerable amount of wind energy is lost with such escape of the wind from the blades and the utilizing of the wind energy is not optimized.

This wind energy can be taped by providing some suitable material sheet casing/ cover over the blades of the wind mill. With such a casing and suitable design and shape of the blades, maximum wind energy can be taped by making the wind to flow through the blades. The blades are enclosed in a suitable material casing from all the sides and only inlet and outlet ports are provided to the casing.

Along with casing, the wind flow can be directed in the casing by passing it through the wind tunnel connected to the inlet port of the casing which will enhanced the wind velocity to some extent. This will result in directed mass motion of the wind over the blades of the mill. The wind turbine exhaust then takes place through the bottom exhaust port.

FABRICATED MODEL OF VAWT WITH CLOSE CASING WITH TUNNELING EFFECT



MEASURING INSTRUMENTS

The measurement of wind speeds is usually done using a cup anemometer. The cup anemometer has a vertical axis and three cups which capture the wind. The number of revolutions per minute is registered electronically.

Tachometer

A tachometer is an instrument designed to measure the rotation speed of an object, such as a gauge in an automobile that measures the revolutions per minute (RPM) of the engine's crankshaft.

OBSERVATIONS

Without casing and with casing for the same sets of inlet wind velocities.

Where,

ρ - Density of air = 1.2kg/m^3

A - Swept area of rotor blade = D*H (m^2)

D - Diameter of rotor blade = 22cm

H - Height of rotor blade = 22cm

V - Velocity of wind air (m/s)

V_1 & V_2 - Velocity of inlet & Exhaust air (m/s)

N_1 & N_2 - Speed of shaft without & with casing (rpm)

Power of Wind

We know,

The mechanical power that can be obtained from the wind with an ideal turbine is given as:

$\text{Power}_{in} = \frac{1}{2} * m * V_1^2$

But, m = Mass flow rate = ρ*A*V

$P_{in} = \frac{1}{2} * \rho * A * V_1^3$

$P_{out} = ½ * \rho * A * V_1 * (V_1^2 - V_2^2)$

Torque of wind turbine

Torque with casing = $T_2 = \frac{Pin*60}{2\pi N2}$

Torque without casing = $T_1 = \frac{Pin*60}{2\pi N1}$

Efficiency of wind turbine

Efficiency = $\frac{Pout}{Pin}$

OSERVATION TABLES: (With Casing)

Wind Speed V_s(m/s)	Wind Speed Striking On BladeV_1	Rotor Speed N_2 (rpm)
4	3.2	171.9
5.6	4.5	196.6
7.5	6.7	236.3
10	8.9	256.7

(Without casing)

Wind Speed V_s(m/s)	Wind Speed Striking On BladeV_1'	Exhaust Wind Speed V_1"	Rotor Speed N_1 (rpm)
4	2.6	2.4	140.2
5.6	3.8	3.3	165.4
7.5	6	5	188.8
10	7.8	6.4	215.9

CALCULATIONS FOR PERFORMANCE

Sample calculations:-

Power of Inlet Wind Speed: Without casing

$P_{in} = ½ \rho*A*V_1'^3 = 0.51$ W

With casing

$P_{in} = ½ \rho*A*V_1^3 = 0.95$ W

Torque: Without Casing

$$\text{Torque} = \frac{0.51*60}{2*\pi*140.2} = 34.73 \text{ Nm}$$

With Casing

$$\text{Torque} = \frac{0.95*60}{2*\eta*171.9} = 52.77 \text{ Nm.}$$

Power of Exhaust Wind Speed (P_{out}):

Without casing

$P_{out} = ½*ρ*A*V_1'*(V_1'^2-V_1''^2) = 0.075W$

With casing

$P_{out} = ½*ρ*A*V_1*(V_1^2-V_2^2) = 0.115$ W

Power generated: Without casing

$Pg = T_1*N_1*η_g = 140.2*34.73*0.8 = 3.8$ W

With casing

$Pg = T_2*N_2*η_g = 171.9*52.77*0.8 = 7.2$ W

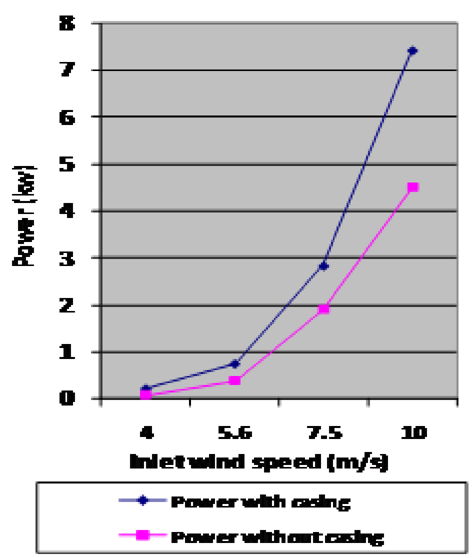
Efficiency of wind turbine: Without casing

$\eta = \frac{\text{Pout}}{\text{Pin}} = 14.17\ \%$

With casing

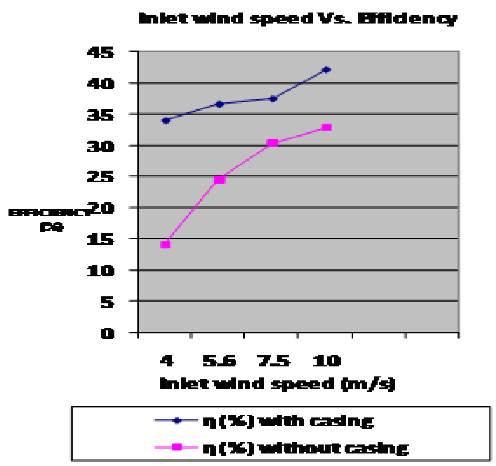
$\eta = \frac{\text{Pout}}{\text{Pin}} = 19.70\ \%$

GRAPHS



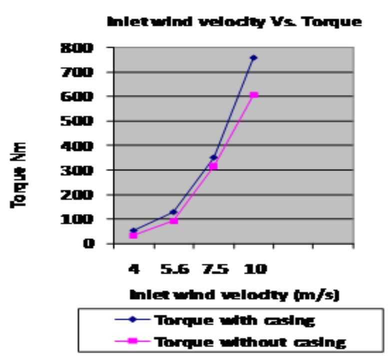
Graph of inlet wind speed Vs. Power

From graph we can say that power obtained at different wind speed with close casing wind mill is more as compare to power obtained at different wind speed in without casing wind mill.



Graph of inlet wind speed Vs. Efficiency

From graph we can say that efficiency obtained at different wind speed with close casing wind mill is more as compare to without casing wind mill.



Graph of inlet wind speed Vs. Torque

From graph we can say that torque obtained at different wind speed with close casing wind mill is more as compare to torque obtained at different wind speed in without casing wind mill.

PROJECT COST ESTIMATION

REQUIRED MATERIAL COST

Sr. No	Part Name	Specifications	Wt.	Cost (Rs)
1	Two Bearing	6202	-	400
2	Metal sheet	20 gauge	20 kg	2200
3	M.S. rod	10 mm	10 kg	500
4	Pipe	2.5ft	-	70
5	G.I. sheet	26 gauge	0.5 kg	60
6	M seal	-	0.25 kg	150
7	Metal plate	300 cm*4cm *.3cm	10 kg	550

Total material cost = **3930Rs.**

TABLE 2: LABOUR COST

1	Miscellaneous	40% of Total Cost	1572 Rs

Total labor charge = **1572 Rs.**

Total cost=material cost + labor cost =**5502 Rs**

This application has been widely used by telecommunication companies in remote area where self-sufficient power is needed to keep operation running. The street lighting system has become the most popular application adopted by our customers that can be installed either in the urban area or suburban area.

Street Lighting Systems lined up along the river in the urban area.

CONCLUSION

Vertical axis wind energy conversion systems are practicaly and potentially very contributive to the production of clean renewable electricity from the wind even under less than ideal sitting conditions. It is hoped that they may be constructed used high-strength, low- weight materials for deployment in more developed nations and settings or with very low tech local materials and local skills in less developed countries.

From the above calculations and graphs It is conclude that, In close casing VAWT with tunneling effect, The power of wind turbine, Torque available at the output of the shaft , Rotor Speed and Efficiency of the turbine increases with the increasing wind speed as compare to conventional VAWT. So The close casing wind mill with tunneling effect is more efficient as compare to without casing VAWT.

REFERENCES

1. Marco D'Amboise and Marco Medaglia, "Vertical Axis Wind Turbines: History, Technology and Applications" Master thesis in Energy Engineering – May 2010 PP 14-30.

2. John Olav Tande and Raymond Hunter, "Estimation of Cost of Energy From Wind Energy Conversion systems" Published in 1983 PP 8-10.

3. Terrence C. Sankar, "The Case for Vertical Axis Wind Turbines" Robert Morris University, Pittsburgh Pa PP 1-4.

4. Gene Abbascia, KojoAsenso and Adam White, "Magnetically Levitated Vertical-Axis Wind Turbine" Worcester Polytechnic Institute in 30 April 2009 PP 5-11.

5. M Ragheb, "Vertical Axis Wind Turbine" Published in 8/1/2011 PP 1-25, 38-39.

6. Cliff Kuang, "Farming in the sky, "popular Science, September 2008, Vol. 273, No. 3, PP.43-47.