Development of Vertical Axis Wind Turbine

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***Abstract*: For project study installs vertical axis wind turbine system especially at roof top. The project is design with several types of blade for getting the efficiency and checking potential of design at ground level. The 2-blade model at 2.45 m/s rated wind efficiency of fabricated model around 18 percent with slight variation in velocities of the wind. The efficiency is quite low but it can be installed on individual houses for particular use. The energy produced makes the model a reliable source of continuous energy this is low-cost vertical axis wind turbine is basically a test keeping development in view and the paper aimed to refine the design features and fabrication techniques aims to make the device suitable for household use. Discussing its development and our project focus on harnessing this wind energy using a small axis wind turbine capable of working at low wind speed at low heights with less investment and maintenance cost. The project considered the major drawback of wind generated power that is inconsistent power production caused by variability in wind conditions and low conversion efficiency his problem reduce using additional flywheel device. The VAWT with vortex turbine is one such concept that uses the principle of generating an added vortex using a set of two vortex generators in order to improve the performance of the turbine.**

***Keywords*: vertical axis wind turbine, vortex generators, flywheel.**

1. Introduction

Wind power has become a legitimate source of energy over the past few decades as larger, more efficient turbine designs have produced ever-increasing amounts of power. But even though the industry saw a record 6,730 billion global investment in 2014, turbine growth may be reaching its limits.

Bladeless turbines will generate electricity for 40 percent lesser in cost compared with conventional wind turbines. In conventional wind power generation transportation is increasingly challenging because of the size of the components: individual blades and tower sections often require specialized trucks and straight, wide roads. Today's wind turbines are also incredibly top heavy. Generators and gearboxes sitting on support towers 100 meters off the ground can weigh more than 100 tons. As the weight and height of turbines increase, the materials costs of wider, stronger support towers, as well as the cost of maintaining components housed so far from the ground, are cutting into the efficiency benefits of larger turbines.

The alternative energy industry has repeatedly tried to solve these issues to no avail. But this latest entry promises a radically different type of wind turbine: a bladeless cylinder that oscillates or vibrates. The Bladeless Turbine harness vorticity, the spinning motion of air or other fluids. When wind passes one of the cylindrical turbines, it shears off the downwind side of the cylinder in a spinning whirlpool or vortex. That vortex then exerts force on the cylinder, causing it to vibrate.

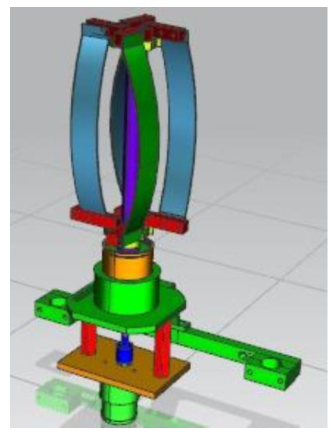

Fig. 1. Design of VAWT

The kinetic energy of the oscillating cylinder is converted to electricity through a linear generator similar to those used to harness wave energy. It consists of a conical cylinder fixed vertically with an elastic rod. The cylinder oscillates in the wind, which then generates electricity through a system of eccentric coupler to produce motion that will rotate a generator to produce electricity. The outer conical cylinder is designed to be substantially rigid and has the ability to vibrate, remaining anchored to the bottom rod. The top of the cylinder is unconstrained and has the maximum amplitude of the oscillation. The structure is built using resins reinforced with carbon and/or glass fiber, materials used in conventional wind turbine blades. The inner cylindrical rod, which will penetrate into the mast for 10% - 20% of its length (depending on the size of the mast) is anchored to it at its top and secured to the ground at its bottom part. It is built to provide highest resistance to the fatigue and allow its elasticity to absorb the vibrations generated by the cylinder. A semi-rigid coupling allows the upper section of the turbine to flutter in the wind while a linear alternator housed in the lower section converts the movements into electricity HISTORY OF BLADELESS POWER GENERATION The Vortex Street effect was first described and mathematically formalized by Theodore von Karman, the genius of aeronautics, in 1911.

This effect is produced by lateral forces of the wind on any fixed object immersed in a laminar flow. The wind flow bypasses the object, generating a cyclical pattern of vortices, which can become an engineering challenge for any vertical cylindrical structures, such as towers, masts and chimneys. The issue is that they may start vibrating, enter into resonance with the lateral forces of the wind, and ultimately, collapse. One of such Bladeless Wind Power Generation. The vortex design aims to eliminate or reduce many of the existing problems in conventional generators and represents a new paradigm of wind energy. It is morphologically simple and it is composed of a single structural component, so its manufacturing, transport, storage and installation have clear advantages. The new wind turbine design has no bearings, gears, etcetera, so the maintenance requirements could be drastically reduced and their lifespan is expected to be higher than traditional wind turbines.

A. Problem statement

We study the different research paper and we notice that, the many problems is in vertical axis wind turbine the major drawback of wind generated power that is inconsistent power production caused by variability in wind conditions and low conversion efficiency. So, our work is to development in VAWT.

B. Material selection

- *Vanes:* The vanes are made from light weight but high strength Polymer material by the name Nylon66. This material has good tensile properties and is also very smooth so surface friction is less. Secondly the material being flexible the twist can be applied without distorting the material of the vanes.
- *Central shaft:* This is the main shaft of the turbine made from aluminium for light weight. It is held in ball bearings at its one end. The ball bearings ensure simply supported structure with overhang on both sides but as two bearings are used side loads are evenly balanced and friction is less without sway.
- *Bearing housing:* Bearing housing is also made of aluminium which housed two ball bearings that support the main shaft.

C. Design and calculation

Design of vortex:

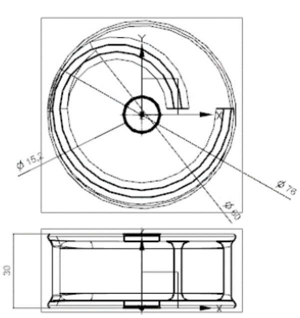

Fig. 2. Design of vortex

Table 1
ABS polymer

Designation	Ultimate Tensile Strength N/mm^2	Yield Strength N/mm^2
ABS Polymer	48	32

Fs allowable = 48/2 =24 N/mm^2
T design = 0.2 Nm
Check for torsional shear failure of shaft.

$$Td = \Pi/16 \times fs_{act} \times (D^4 - d^4)/D$$

$$\Rightarrow fs_{act} = \frac{16 \times Td}{\Pi \times (D^4 - d^4)/D}$$

$$= \frac{16 \times 0.2 \times 10^3 \times 32.4}{\Pi \times (80^4 - 76^4)}$$

$$\Rightarrow fs_{act} = 0.004\ N/mm^2$$

As $fs_{act} < fs_{all}$

2. 3-D CAD modelling

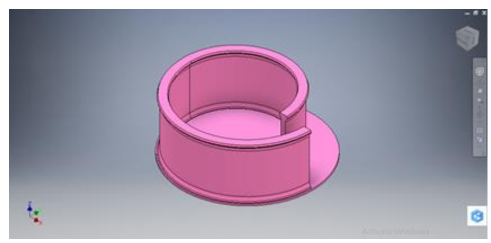

Fig. 3. Vortex chamber

3. Structural analysis

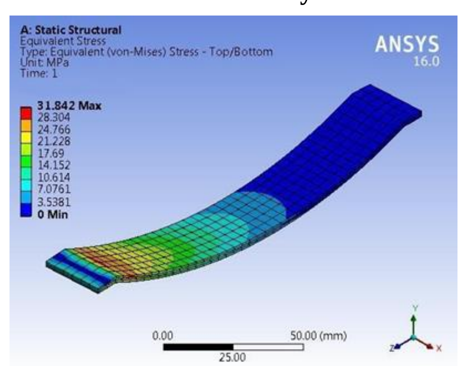

Fig. 4. Blade analysis

4. Result

A. Test and trial on VAWT with vortex

Table 2
Observation table

Air Vel.	Th. Power	Speed	Voltage	Current	Op power	Efficiency
2	0.6	200	1.5	0.1	0.15	25
2.5	0.75	275	2.89	0.1	0.289	38.53
3	0.9	390	3.5	0.13	0.455	50.55
3.5	1.05	540	4.6	0.14	0.644	61.33
4	1.2	690	6.1	0.14	0.854	71.16

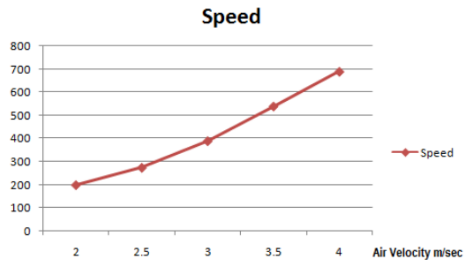

Fig. 5. Graph of Turbine Speed vs. Air Velocity

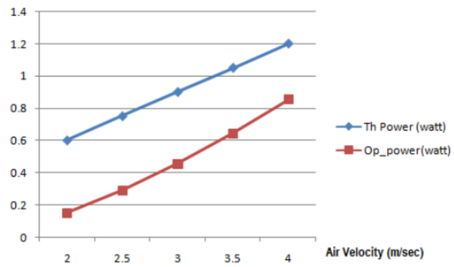

Fig. 6. Comparative Graph of Th. Power, Actual Power vs. air velocity

5. Conclusion

In this analysis on VAWT The design and analysis of vane shows that vane is safe under given system of forces. The design and analysis of vortex shows that it is safe under given system of forces. Output speed increases with the increase in velocity to the turbine. Efficiency increases with the increase in velocity to turbine.

References

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