Spherical Shaped Vertical Axis Wind Turbine

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Abstract - *We know that there is enough wind globally to satisfy much, or even most of humanity's energy requirements – if it could be harvested effectively and or on a large scale. If the efficiency of a wind turbine is increase, then more power can be generated thus decreasing the need for expensive power generators that cause pollution. In this paper an experimental setup is developed of Vertical axis wind turbines (VAWT's), which may be as efficient as current horizontal axis systems, might be practical, simpler and significantly cheaper to build maintain than horizontal axis wind turbines.(HAWT's) and its main advantage is it can rotate in wind coming from all directions.*

***Key Words*: VAWT, HAWT, Spherical Blades, Neodymium Magnets, 360Degree Wind, Axial Generator etc.**

1. INTRODUCTION

This project introduces structure and principle of the proposed Spherical Shaped Vertical Axis wind turbine for better utilization of wind energy. The wind speeds in most of Asian zone is much lower than 7 m/s, especially in the cities, but the mechanical frictional resistance of existing wind turbines is too big, usually it can't start up when the wind speed is not big enough. Spherical Shaped Wind turbine has the features of no mechanical contact, no friction etc. minimizing the damping in the SVAWT, which enables the wind turbine start up with low speed wind and work with breeze. VAWT wind turbine also have other inherent advantages, such as they are always facing the wind, which can rotate in winds coming from 360 Degrees. Which might make them a significant player in our quest for cleaner renewable sources of electricity.

Major drawbacks for the early designs (Savonius, Darrieus, and cycloturbine) included the pulsatory torque that can be produced during each revolution and the huge bending moments on the blades. Some geographic features such as mountains also have in influence upon wind. Mountains can create mountain breezes at night, because of the cooler air flowing down the mountain and being heated by the warmer valley air causing convection current. Conventional horizontal axis wind turbines (HAWT) has several disadvantages such as vibrations, sounds, need of gears and support structure, one directional accessibility etc. Eliminates these all.

In this project we attempt to design and fabricate a Spherical Shaped vertical axis wind turbine.it has advantages such as they are always facing the wind, which can rotate in winds coming from 360 Degrees. Which might make them a significant player in our quest for, cleaner renewable sources of electricity.

The main objective of this Project work is to harvest and recapture the maximum amount of wind energy from atmosphere. The unused and considerable amount of wind is used to drive the spherical shaped vertical axis wind turbine, which will use the kinetic energy of the wind to produce the electrical energy. Our aim is to design the turbine which will capture the maximum of wind in any direction by placing it at optimum place and height by considering both the cost and safety of the system. This system can be used in huge number to generate the huge amount of useful electrical energy. This energy can be stored and transferred to nearest rural places where we can fulfill the demand of electricity. The thought of design directs us to look into the various aspects such as manufacturing, noise, cost which leads us to our additional aim of analyzing the system to overcome the usual technical glitches. The project brief involves the design of a small scale wind turbine that can be easily mass produced and fitted on every roof top to aid electricity consumption.

2. OPERATING PRINCIPAL

Aerodynamically, it is a drag type device, consisting of five or six scoops. Looking down on the rotor from above, this scoops of the machine would look like as "sphere" 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 SVAWT turbine to spin. Because they are drag type devices. SVAWT turbines extract much less of the wind's power than other similarly sized lift type turbines. Much of the swept area of a Spherical rotor may be near the ground, if it has small mount without an extended post , making the overall energy extraction less effective due to the lower wind speeds found at lower heights.

It can consume wind from all directions around 360 degrees because of the spherical scoops design. Its area of capturing is more due to spherical scoops therefore its efficiency is more than any of the wind turbines present now a days.

2.1 Magnet Selection:

Some factors need to be assessed in choosing the permanent magnet selection that would be best to implement the maglev portion of the design. Understanding the characteristics of magnet materials and the different assortment of sizes, shapes and materials is critical. There are four classes of commercialized magnets used today which are based on their material composition each having their own magnetic properties. The four different classes are Alnico, Ceramic, Samarium Cobalt and Neodymium Iron Boron also known NdFe-B. Nd-Fe-B is the most recent addition to this commercial list of materials and at room temperature exhibits the highest properties of all of the magnetic materials. It can be seen in the B-H graph shown in Figure 3.10 that Nd-Fe-B has a very attractive magnetic characteristic which offers high flux density operation and the ability to resist demagnetization. This attribute will be very important because the load that will be levitated will be heavy and rotating a high speeds which will exhibit a large downward force on the axis.

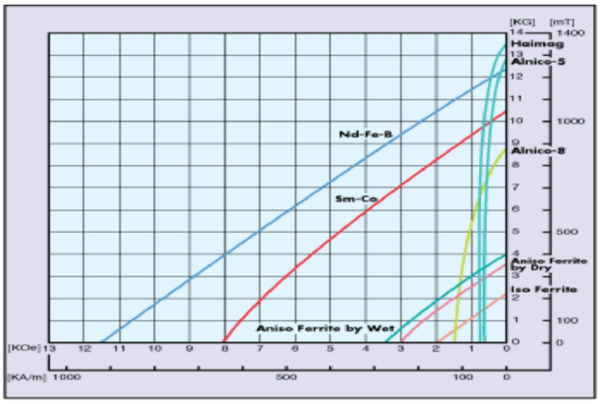


Figure1. B-H Curve of Various Magnetic Materials

The next factor that needs to be considered is the shape and size of the magnet which is directly related to the placement of the magnets. It seems that levitation would be most effective directly on the central axis line where, under an evenly distributed load, the wind turbine center of mass. The basic rendition of how the maglev will be integrated into the design. If the magnets where ring shaped then they could easily be slid tandem down the shaft with the like poles facing toward each other. This would enable the repelling force required to support the weight and force of the wind turbine and minimize the amount of magnets needed to complete the concept.

Figure2. Magnets placement

2.2 Winding Design:

The number of windings per coil produces a design challenge. The more windings will increase the voltage produced by each coil but in turn it will also increase the size of each coil. In order to reduce the size of each coil a wire with a greater size gage can be utilized. Again another challenge is presented, the smaller the wire becomes the less current will flow before the wire begins to heat up due to the increased resistance of a small wire. We are using 8 coils connected in series.

When designing a generator the application, which it will be used for, must be kept in mind. The question must be answered, which property, the current or the voltage, is of greater importance? The problem that is produced by a larger coil is the field density is decreased over the thickness of the coil. The thickness of the coil is what reduces the flux magnitude.

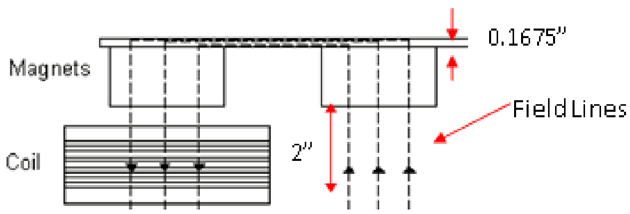


Figure3. Coils and Magnets

This design will increase the field density greatly improving the voltage output. The increased thickness of a coil would therefore increase the distance between the two magnets reducing the flux. A balance must be found between the amount of voltage required and the amount of current required. We have chosen to use a very high gage wire to increase the amount of voltage the generator can provide. If the generator is required to produce more current the coils can be replaced with those of a smaller gage wire. The permanent magnets we have chosen to use provide a very strong magnetic field.

Figure4. Winding Design

Figure5. Actual Setup

2.3 THE POWER IN THE WIND

The power in the wind can be computed by using the concept of kinetics. The wind mill works on the principle of converting kinetic energy of wind to mechanical energy. The kinetic energy of any particle is equal to one half its mass times the square of its velocity.

Kinetic energy = $\frac{1}{2} mv^2$

Amount of Air passing is given by

$m = \rho AV$ ……………………(1)

Where

m = mass of air Trans versing

A = area swept by rotating blades of wind mill type generator

ρ = density of air

V = velocity of air

Substituting this value of mass in expression of K.E.

$= \frac{1}{2} \rho AV.V^2$ watts

$= \frac{1}{2} \rho AV^3$ watts……… (2)

Second equation tells that the power available equals to air density ($1.255 kg/m^3$) & is proportional to the intercept area. Since the area is normally circular of diameter D in horizontal axis of turbine, then,

$A = (\pi D^2)/4$ (sq.m.)

Put this quantity in equation second then

Available wind power

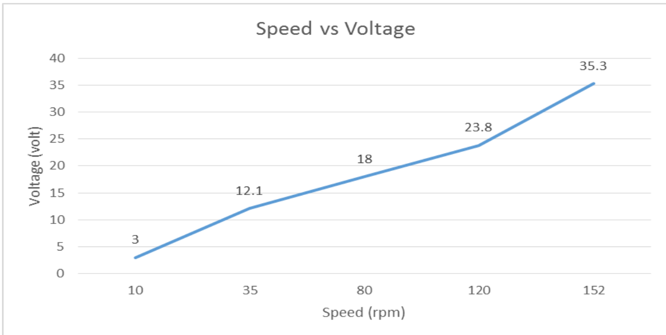
$P_a = (\rho \pi D^2 V^2)/8$

Table -1 Material Descriptions

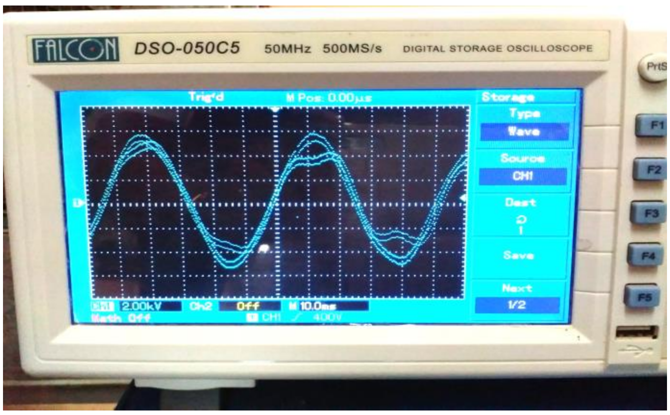
S.NO.	DESCRIPTION	MATERIAL USED	DIMENSIONS IN 'inch'
1.	Stator	Ply wood	Diameter 20
2.	Rotor Disc	Mild Steel	Diameter 10
3.	Blades and Wings	Mild Steel	Height of the blade 30
4.	Central Shaft	Stainless Steel Sheet	Diameter 1 , Height 31
5.	Base Assembly	Iron	Size 24 x 24

3. Power Output:

Sr. No.	Speed (rpm)	Voltage (volt)
1	10	3
2	35	12.1
3	80	18
4	120	23.8
5	152	35.3



Graph 1. Speed vs Voltage Generation



CRO Waveforms

4. CONCLUSIONS

Our work and the results obtained so far are very encouraging and reinforce the conviction that Spherical shaped vertical axis wind energy conversion systems are practical 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 using high-strength, low-weight materials for deployment in more developed nations and settings or with recyclable materials and local skills in less developed countries. A modified design of savonius model wind turbine blade was used in the construction of the model. An aluminum shaft was used to avoid the wob-bling movement of the rotor.

At the end of the project, the spherical shaped vertical axis wind turbine was a success. The rotors that were designed harnessed enough air to rotate at low and high wind speed while keeping the center of mass closer to the base yielding stability. The wind turbine rotor levitated properly using permanent magnets, which allowed for a smooth rotation with negligible friction. Generator satisfied the specifications needed to supply the LED load. An output ranging from 40V to 45V was obtained from the spherical shaped vertical axis wind turbine prototype. Overall, the spherical shaped vertical axis wind turbine was a successful model.

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