DESIGN AND ANALYSIS OF SAVONIUS WIND TURBINE WITH MAGNETIC REPULSION

G.Thilak[1], S.Prabakaran[2], G.Sathi[3]
[1-2]*UG Student,* [3]*Faculty,*
[1-2-3]*Department Of Mechanical Engineering,*
[1-2-3]*Prince Shri Venkateshwara Padmavathy Engineering College, Mambakkam - Medavakkam Main Road, Ponmar, Chennai, Tamil Nadu 600127, India*

ABSTRACT

This project is to produce energy by using renewable energy resources, as the non renewable energy resources will get exhausted in a mere time if overuse today. This concern for the environment is the basis for the current attempt. The wind is eco-friendly and abundantly available resource. By using that energy in a useful manner a continuous power can be produced. With the help of MAGNETIC REPULSION PRINCIPLE we can able to generate more initial starting torque as the result of more efficiency.

Keywords—*Magnetic Repulsion, Wind Energy Using Neodymium Magnets, Power From Wind.*

---

1. INTRODUCTION

Wind energy conversion systems are an old concept in harnessing energy. Wind power was earlier used in small applications such as moving boats where sailing was employed, cooling houses, running machines in large farms, and even in small production facilities. The importance was redefined when conversion of the wind energy to electrical power highlighted a turning point for the wind power industries. Due to the impact in energy crisis and changes in the climates, wind turbines started to spread rapidly across the globe in the past decades. However, wind power is far from its full outcomes. Manufacturers have incrementally improved conventional wind turbines in the last few decades –but the greatest energy output has less starting torque. To overcome this we have used magnets to gain initial starting torque.

2. AIM OF PROJECT

The main aim of this project is to produce energy by using renewable energy resources, as the non-renewable energy resources will get exhausted in a mere time if overuse today. This concern for the environment is the basis for the current attempt. The wind is eco-friendly and abundantly available resource. By using that energy in a useful manner a continuous power can be produced. This method which overcomes the previous wind turbine problems, by adjusting the wind flows on blades which suit itself with efficient energy generation in all direction.

Ultimate design aims of the current attempt are,

1. To improve the self-starting.

2. To improve the speed of rotation of turbine.

3. To keep turbine in continuous rotation even in the less wind speed.

4. To get continuous rotation when there is less wind available.

5. To produce higher power.

3. PROBLEM IDENTIFICATION

This project is used for small scale generation of electricity. Savonius Wind Turbine is used for converting the force of the wind into torque on a rotating shaft. In existing wind turbines are used only for large electricity production and has low starting torque when there is no wind. With a Savonius wind turbine it does not matter from which direction the wind is blowing and starting torque, since there will always be more force exerted on whichever cup has its open face into the wind with availability of strong magnets, and this will push the rotor around. We can also used for generate electricity for small scale industry and houses. Standard HAWT (windmill) type wind turbines are unsuitable in locations with strong turbulent winds, so savonius wind turbines can sometimes be the best option.

4. COMPONENTS

4.1 Blades: Rotates when wind is blown over them.
4.2 Shaft: Blade to Alternator.
4.3 Dynamo: A device that makes direct current electric power using electromagnetism. It is also known as a generator, however the term generator normally refers to an "alternator" which creates alternating current power.
4.4 Magnets: Here we are using neodymium magnet for getting repulsive force to get initial starting torque.

5. LITERATURE REVIEW

5.1 Design And Development Of Vertical Axis Wind Turbine

Nilesh, N.Sorte & S.M.Shiekh dealt with the design and development of micro vertical axis wind turbine for rural application. This paper explains the various design parameters like swept area, number of blades, tip speed ratio, power coefficient and blade chord of micro vertical axis wind turbine along with their formulas. This paper also gives the idea about how to make the model of the prototype by using computer aided design software. Hence, this research paper helped in fulfilling few basic requirements of our project.

5.2 Design And Fabrication Of Vertical Axis Highway Windmill

S.V.Saravanan, M.Varatharaj, L.Ayyadurai, S.Palani & D.Prem worked together and published a research paper which deals with the design and fabrication of vertical axis highway windmill. This research paper gives the design methodology for blades so that the efficiency of the wind turbine is increased. This paper gives the idea of shape of blade, tower height and design of blade etc. Hence, this research paper suggested the various parameters required for the blades, which is the center of attention of our project. This also gave us the idea about the application of our project that is; if our turbine is mounted near to the dividers of the highways then it can generate electricity by using the wind which blows as the vehicle passes on the highways.

5.3 Wind Power Plant Using Magnetic Leviation

Dinesh N.Nagarkar & Dr Z.J.Khan told about the concept of magnetic levitation. It deals with the explanation of working of wind power plant using magnetic levitation wind turbine. In this paper the complete construction and working of wind power plant with magnetic levitation is given. But, in our project this magnetic levitation concept is not used. We have just use the concept of magnetic repulsion to reduce the self starting wind speed and to improve the speed of rotation of the turbine which in turn will keep the turbine continuously in rotation even with less speed.

6. SOFTWARE DESIGN

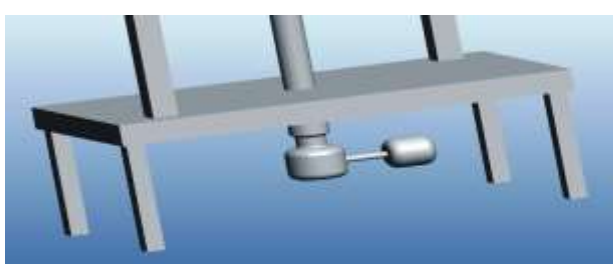

Fig-1: Base Sectional View

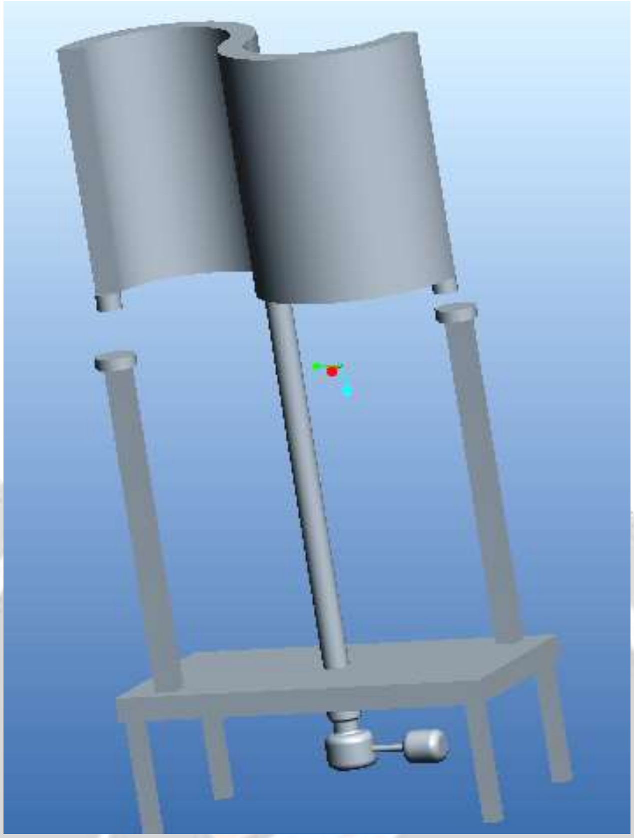

Fig-2: Front View

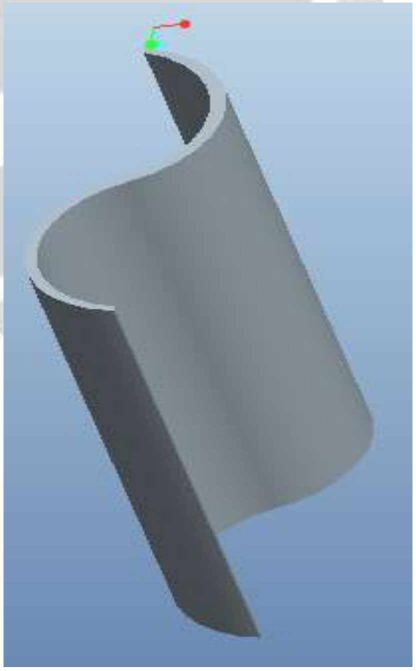

Fig-3: Blade Design

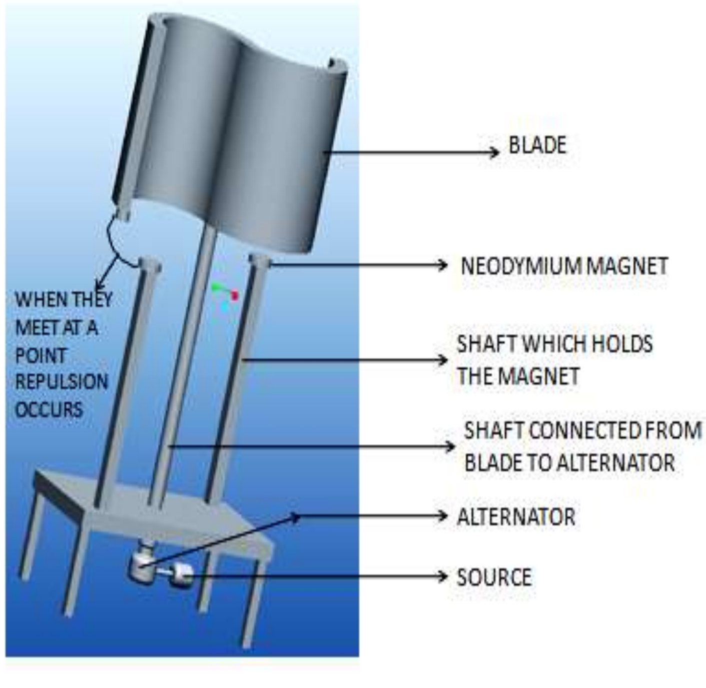

Fig-4: Final Assembly

7. CALCULATIONS

7.1 Area Required For Blade
The blade is bend to rectangular shape and then area is calculated.

Area = l x b

= 0.300 x 0.500

A = 0.15 m^2

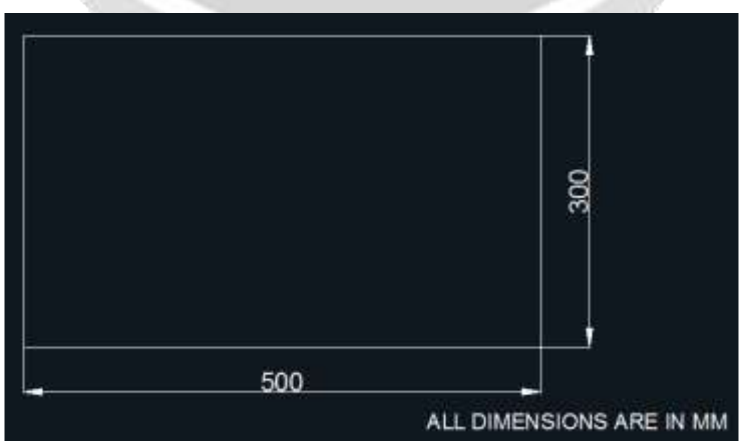

Fig-5: Blade Dimension

7.2 Power Extracted From The Wind

The total power available in wind at velocity 4 m/s,

Power = 0.5 x ρ x A x v^3

= 0.5 x 1.23 x 0.15 x 4^3

Power = 6 Watt

(Air has a density of approximately **1.225 kg/m^3**)

Also,

P = (2 x π x N) / (60)

6 = (2 x π x N) / (60)

No. of Rotations N = 58 Rotations/Min

For various wind speed, power developed are as follows:

- V = 4 m/s ; Power = 6 Watt
- V = 8 m/s ; Power = 47.2 Watt
- V = 12 m/s ; Power = 159.4 Watt
- V = 16 m/s ; Power = 377.85 Watt
- V = 20 m/s ; Power = 738 Watt

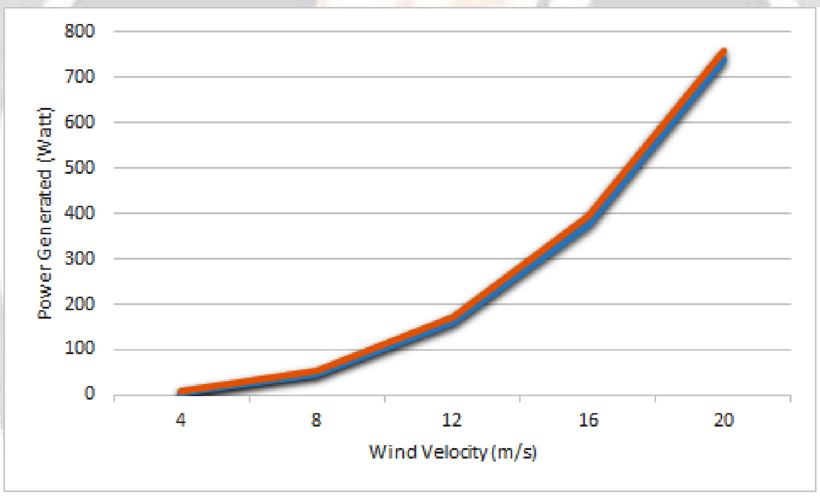

Chart-1: Power Vs. Wind Velocity

7.3 To Find Average Velocity

Practically, when the turbine is placed at 4 m/s inlet velocity and outlet is velocity 2 m/s the power that can be extracted from the wind is found by the following. The average wind speed,

Vavg = (V1+V2)/2

= (4+2)/2

Vavg = 3 m/s

Where V1,V2 are the inlet and outlet wind speed in m/s

7.4 The Mass Of The Airflow

m = ρ x A x ((V1+V2)/2)

= 1.23 x 0.15 x 3

m = 0.5535 kg/s

7.5 Kinetic Energy

$KE = m \times (v^2/2)$

$= 0.5535 \times (3^2/2)$

$KE = 2.49\ kg(m^2/s^2)$

7.6 Tip Speed Ratio For Maximum Power Output

λ (Tip Speed Ratio For Max Power) =4∏ /n

Here we are using 2 blades, n = 2, then,

λ (Tip Speed Ratio For Max Power) = 4∏ /2

λ (Tip Speed Ratio For Max Power) = 6.28

7.7 Material Specification

- Turbine blade material : Sheet Metal (2mm thickness)
- Shaft material : Mild Steel (dia – 30mm)
- Material : Mild Steel S45C
- Density (kg/m^3) : 7700-8030
- Young’s modulus (gpa) : 190-210
- Tensile strength (mpa) : 569
- Yield strength (mpa) : 343

8. PHOTOGRAPHIC VIEW

Fig-6: Blade Design

Fig-7: Base Sectional View

Fig-8: Gear Assembly

Fig-9: Bearings

Fig-10: Magnetic Arrangement

Fig-11: Final Assembly

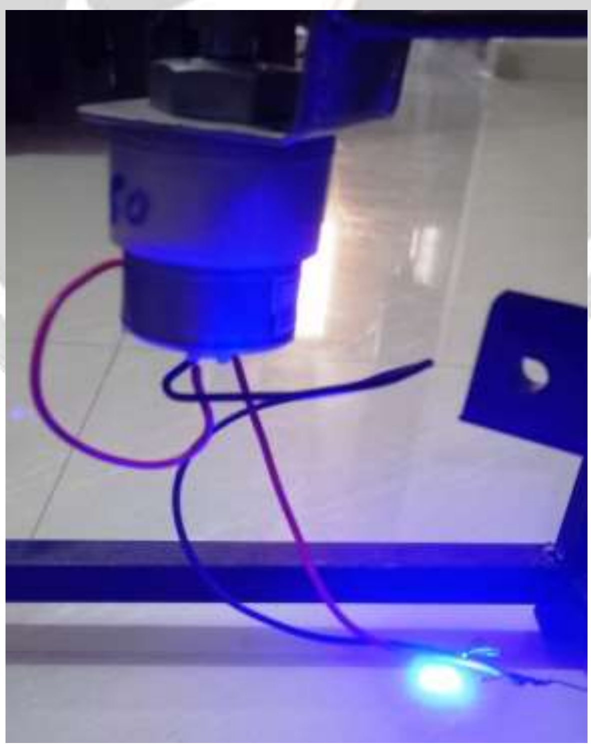

Fig-12: Power Generation

9. WORKING

Wind exerts force on the blade and this force will rotate the vertical turbine blade and this blade is coupled with the alternator through shaft and this alternator will produce electricity. Wind is an unconventional source of energy, by which the electricity can be obtained by converting kinetic energy of wind into electrical energy by using wind turbine. The magnetic repulsion arrangement will gives additional rotation to the wind turbine.

10. ADVANTAGES

- Ability to operate in a wide range of wind conditions.
- Low noise emission.
- Magnets give high starting torque.
- Compact size.
- Simple and cheap construction.

11. APPLICATIONS

- Agricultural and irrigation purpose.
- In house for small energy generation purpose.
- Street lights.

12. CONCLUSION

Over all, savonius wind turbine was a success. After testing the project as an overall system we found that it functioned properly savonius wind turbine would be in residential areas. Here it can be mounted to a roof and be very efficient and practical. Magnets gives high initial starting torque henceforth there won't any additional force required to start the turbine.

Table-1: Materials Used

SL NO	MATERIALS	QUANTITY
1	Sheet Metal	2
2	Centre Shaft	1
3	Base Shaft	8
4	Magnet Supporting Shaft	2
5	Dynamo	1
6	Magnets	12
7	Source(light)	1
8	Bearing Set	1

13. REFERENCES

[1] World Wind Energy Association - Home. 29 Apr. 2009

[2] "Installed Wind Capacity Surged 45% in 2007: AWEA Market Report." American Wind Energy Association. 29 Apr. 2009

[3] "Wind and Hydropower Technologies Program: How Wind Turbines Work." EERE: EERE Server Maintenance. 29 Apr. 2009

[4] "What is Magnetic Levitation?" The Tech FAQ. 29 Apr. 2009

[5] "Wind Turbine FAQ." Rainbow Power Company. 29 Apr. 2009

[6] Putnam, Palmer Cosslett. Putnam's Power from the wind. New York: Van Nostrand Reinhold, 1982

[7] Giancoli, Douglas C. Physics for scientists & engineers with modern physics. Upper Saddle River, N.J: Prentice Hall, 2000

[8] Gonen, Turan. Electric Power Distribution System Engineering. Boca

Raton: CRC P, 2008

[9] Hambley, Allan R. Electrical Engineering Principles and Applications

(4th Edition). Upper Saddle River: Prentice Hall, 2007

[10] Mohan, Ned. Electric Drives An Integrative Approach. Mnpere, 2003

[11] “Magnet Design”. 2000 Magnet Sales & Manufacturing Company,Inc.