Vertical Axis Wind Turbine

Jadhav Akshay[1] Mule Vaibhav[2] Mali Milind[3] Mungashe Krushna[4] Prof. M. K. Shaikh[5]
[1,2,3,4]Student [5]Assistant Professor
[1,2,3,4,5]Department of Mechanical Engineering
[1,2,3,4,5]Pravara Rural Engineering College, Loni, SPPU, Pune, India

Abstract— "Vertical Axis Wind Turbine" expecting to developing robust large scale VAWT technology based of an electrical control system with direct driven energy converter. This approach allows for a simplification where most or all of the control of turbines can be managed by electrical converter system, reducing investment cost and need of maintenance. In highways the vehicle suffers a lot to travel in might time because of lightning problem. This problem can be overcome by using the Vertical Axis Highway Windmill (VAHW). The main aim of this project paper is to produce energy by using renewable energy resources in that manner the wind is very much ecofriendly and very compactable one. By using that energy in useful manner we can produce a continuous power.

Keywords: Blade Shape, Power Consumption

I. Introduction

A windmill is a mill that converts the energy of wind into rotational energy (mechanical energy) by means of vanes called sailsor blades. Centuries ago, windmills usually were used to mill grain, pump water, or both. Thus they often were gristmills, wind pumps, or both. The majority of modern windmills take the form of wind turbines used to generate electricity, or wind pumps used to pump water, either for land drainage or to extract groundwater. A wind turbine is a device that converts kinetic energy from the wind into electrical power. The term appears to have migrated from parallel hydroelectric technology (rotary propeller). The technical description for this type of machine is an airfoil powered generator.

Ever since the Seventh Century people have been utilizing the wind to make their lives easier. The whole concept of windmills originated in Persia. The Persians originally used the wind to irrigate farm land, crush grain and milling. This is probably where the term windmill came from. Since the widespread use of windmills in Europe, during the Twelfth Century, some areas such as the Netherlands have prospered from creating vast wind farms. The towers without guy wires are called freestanding towers. Something to take into consideration about a tower is that it must support the weight of the windmill along with the weight of the tower. [3]

The first windmills, however, were not very reliable or energy efficient. Only half the sail rotation was utilized. They were usually slow and had a low tip speed ratio but were useful for torque. Since its creation, man has constantly tried to improve the windmill. As a result, over the years, the number of blades on windmills has decreased. Most modern windmills have 5-6 blades while past windmills have had 4-8 blades. Past windmill also had to be manually directed

Into the wind, while modern windmills can be automatically turned into the wind. The sail design and materials used to create them have also changed over the years. In most cases the altitude of the rotor is directly proportional to its efficiency. As a matter of fact, a modern wind turbine should be at least twenty feet above and three hundred feet away from an obstruction, though it is even more ideal for it to be thirty feet above and five hundred feet away from any obstruction. Different locations have various wind speeds.

II. Working of the Vertical Axis Wind Turbine

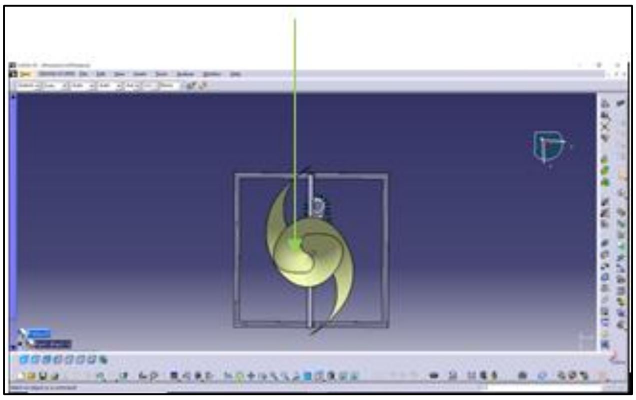


Fig. 1: CAD Model of Vertical Axis Wind Turbine

Before discussing the finer details of the system .In the system we have taken helical shape of blade, these blade mounted on vertical shaft. Output of this shaft is given to generator shaft to produce power. To avoid deflection of rotor shaft we use ball bearing. We arrange the chain drive to increase the speed generator shaft and for improving the efficiency.

A. *Working Steps of System*

- A vertical axis wind turbine is type of wind turbine where the main rotor shaft is set transverse to the wind while the main component are located at the of the turbine. This arrangement allows the generator to be located close to the ground, facilitating service and repair.
- VAWTs do not need to be pointed into the wind which removes the need for wind sensing and orientation mechanism.
- When air strikes on the blades at very low speed also(upto 2 m/s) the rotor rotates and when rotor rotate it rotates the generator shaft at very high velocity because of the a small gear is mounted on the generator shaft so when one rotation of rotor shaft completed there is 2.5 rotation of generator shaft takes place.
- At the speed of 60 RPM of generator shaft it produces 10 Watt power.

III. CASE STUDY

Fig. 2: Case study of VAWT

Street light on highway. Case study consideration is system design to produce power of 20 Watt... Capacity of turbine is 50 W, height of blade is 2.14 meter. Number of blades 2.

IV. DESIGN CALCULATIONS

A. Selection of Blade

- Average temp=24^0C
- Average wind velocity=8m/s
- Consider power to be generated=30watt

1) Wind power: Pw = ½ ρ AV3
2) Swept area: A=DH
3) Aspect ratio: α = Rotor Height (H)/Rotor Diameter (D)

Density of air,
ρ =1.173kg/m^3
P=0.5ρ AV^3
A=0.1m^2
Swept area=0.1m^2
Consider turbine efficiency 25% & generator efficiency 80%
P = 150watt
P= 0.5ρ A V^3
150 = 1/2×A×1.173×512
A=0.5m^2
Taking diameter as 500mm,
H=A/D
=0.5/0.5
=1m
From above information we have selected savonious blade of NACA0018

B. Design of Shaft

T=W×r
=W×0.25
W=W1+W2
W1=W2=1kg
W=2×9.81
=19.62N
T=19.62×0.25
=4.905N.m
FOS=3

$$\tau_{all} = \frac{0.5 \times Sut}{3} = 26.67$$

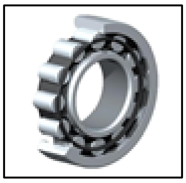
$$\frac{T}{J} = \frac{\tau}{K}$$

$$d^3 = \frac{538.28 \times 1000}{\Pi \times 26.67}$$

d = 18.59mm
Select std. diameter of shaft as 20mm

C. Selection of Bearings

1) Shaft Bearing (Cylindrical Roller Bearing)



Bearing number NU-2305
n= 150rpm
Ln = 45000
d= 25mm
L05 =
= 405
L05 = 4.48 L10 [ln( )]^(1/1.5)
L10 = 654.84 MR
Fa = 200N
Fr = 175N
Fa/Fr = 1.14
X= 0.56, Y=1.5
Pe = (Fr*X+Fa*Y)*1.5
Pe = 597
Pe = $(C/L10)^3$
C = 4455.81 N
4455.81 <32000
Bearing is safe.

2) Bearing Mounted on Generator Shaft (Deep Groove Ball Bearing)

Bearing number 6300
d = 10mm
n= 300rpm
LH = 45000

$$L05 = \frac{60 * 300 * 45000}{106}$$

=720

L10 =1164.16MR
Fa =40N
Fr =45N
Fa/Fr = 0.89
X= 1, Y=0.6
Pe = (Fr*X+Fa*Y)*1.5
Pe = 100.5
Pe = $(C/L10)^3$
C = 5412.54N
5412.54<6300

Bearing is safe.

V. ADVANTAGES

- Reduces or even eliminates the cost of electricity.
- It is good for the environment because windmills produce no polluting exhaust
- The cost to operate a windmill is very low
- It helps our country reduce its dependence on foreign oil

VI. CONCLUSION

The vertical turbine has the advantage of being deployable in urban or other crowded zones, whereas horizontal-axis turbines require a large footprint due to the space needed for safe spinning of the blades. Further, a vertical axis turbine does not need to be facing any particular wind direction, which is important in a region where wind direction changes day to day.

Change in blade shape allows more rotation of the rotor even at low speed. The helical shape of the blade has a tendency to rotate the rotor even when the wind flows from the different direction. Low cost power generation.

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