MANUFACTURING OF DOUBLE STAGE SAVONIUS WIND TURBINE

Manufacturing Of Vertical Axis Wind Turbine

[1]Mr.Jaimin Patel,[2]Mr.Kartik Koshti
[1](BE Student –Department of Mechanical Engineering, AIT Campus),
[2](BE Student –Department of Mechanical Engineering, SOCET Campus)

Abstract— The materialism of modern world required huge amount of energy therefore, energy has increased dramatically. For solving the world energy problem and reduce the effect on environment of convectional energy sources all over world tends to renewable energy sources. Great attention is paid towards wind energy because of its competitively. Savonious rotor is one of the type of vertical axis wind turbine that specified as cheaper, easier in construction and low speed turbine. These qualities make savonius rotor comfortable for generating mechanical energy entire the world. At the different places of world Savonius wind turbine are experimentally studied in order to determine the effective parameters. From the research it concluded that two blade rotor is more efficient than three blades. The end plate joined with rotor gives more efficiency than without end plate. Double stage rotors have higher performance compared to single stage rotors. The research show also that the power coefficient increases with increasing the aspect ratio.

Index Terms—Wind energy, Renewable energy, Green energy, Rotor speed

I. INTRODUCTION:

Change in ambience is the major and most urgent environmental hazard in the world. The effect of green house produced by human activity, by plenty use of fuels like coal, oil and etc. that cause increases in worldwide temperatures, leading to more severe weather patterns such as floods, increasing sea levels and hazard to allover ecosystems.To avoid dangerous environmental condition increasing global emissions must decrease within the next years. This suggests us that we need to adopt renewable energy sources. Today the demands in fossil fuels has increased due to industries has increased also need of humans has increased. The effect of these fuels are hazardous for human and it is also dangerous for environment. To improve that effect there are lots of renewable scopes are available like wind energy, solar energy. In wind energy vertical axis wind turbine (Savonius wind turbine) one of the best solution for reduce the green house effect. It is more reliable and eco friendly energy source.

There mainly two types of wind tubine.

1) Horizontal Axis Wind Turbine (HAWT)
2) Vertical Axis Wind Turbine (VAWT)

1) Horizontal axis wind turbine :

The blades of a HAWT work to get energy from the wind by generating lift, resulting in a net torque about the axis of rotation. To work very effectively in large HAWT active pitch controllers are used to ensure that every blade is maintain an optimal angle that gives maximum power collection for given wind speed. However, in HAWT contains more complex parts like control system and it require more moving parts and effort to install than a VAWT assembly in which most of component plant on base.

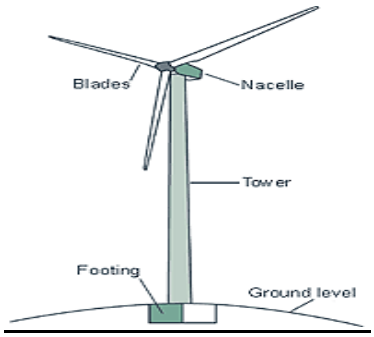

Fig 1. Layout of Horizontal axis wind turbine

2) Vertical Axis Wind Turbines:

Today VAWTs have been collecting more popularity because of interest in individual safe environment energy solutions. Small business companies from entire world have been marketing these new devices such as Helix Wind, Urban Green Energy, and Wind spire. The main targets of VAWT are individual homes, farms, or small residential areas for providing local and personal wind energy. This new era tends to opens up a whole new market in alternative energy technology.

VAWTs are small, quiet, easy to install, can take wind from any direction, and operate efficiently in turbulent wind conditions. Manufacturing of VAWT is much easier than a HAWT due to the constant cross section blades.

In VAWT two types of turbine available.

a. Derrious Wind Turbine
b. Savonius Wind Turbine

Fig 2.Derrious Wind Turbine

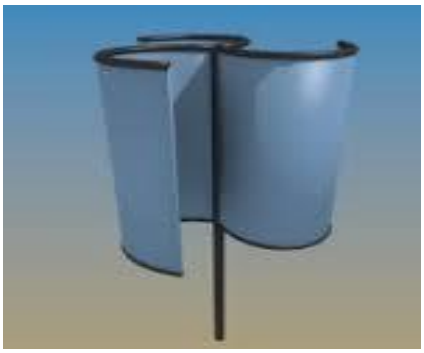

Fig 3.Savonius Wind Turbine

➢ **Double stage savonius wind turbine:**

Savonius wind rotor is one of the type of vertical axis wind turbines. Its structure is very simple. It has good starting characteristics, relatively low operating speeds, and a capability to collect wind from any direction. But its aerodynamic efficiency is very poor. The construction of savonius wind turbine is made by two vertical half cylinders. The two blade savonius rotor is very efficient for all stages where it is single-, two- or three-stages. Two-stages Savonius rotor has better power coefficient as compared to the single- and three-stage rotors.

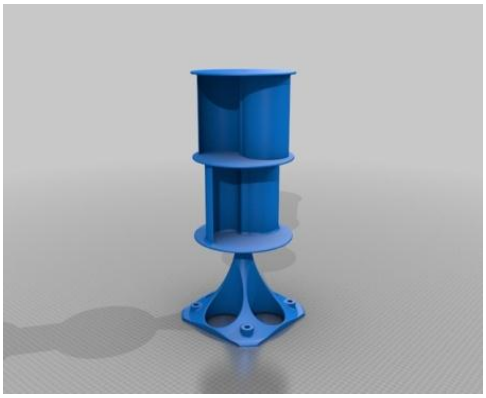

Figure 4.Double stage savonius wind turbine

II. LIST OF ABBREVIATIONS:

1. **VAWT**=vertical axis wind turbine
2. **HAWT**=horizontal axis wind turbine
3. **TSR**=tip speed ratio
4. **Cp** =power coefficient
5. **Ct** =torque coefficient
6. **Cts**=static torque coefficient
7. **T**=torque
8. **R**=radius
9. **A**=area
10. **Pm**= mechanical power
11. **Pw**=wind power
12. **α**=aspect angle
13. **CFD**=computational fluided design

III. DESIGN CALCULATION:

1. From the different measured values of mechanical torque and rotational speed, the mechanical power can be estimated at each wind speed as:

Pm=T.ω (W)

T =mechanical torque

w= angular speed

2. The angular speed:
$\omega = 2\pi n/60$ rad/s
n= shaft speed

3. The mechanical torque:
T= F.r
r= radius of pulley

4. The force on the rotor shaft:
F= (m-s)g
m= mass (kg)
g= gravitation acceleration
s= spring balance (kg)

5. The power coefficient Cp and static torque coefficient Cts:
Cp= Pm/Pw
Where,
$Pw=1/2(\rho AV^3)$

q= air density (kg/m3)
A= area (m2)
V= wind speed (m/s)

6. The power coefficient:
$Cp= g\pi rn(m-s)/15\rho AV^3$

7. The static torque coefficient:
$Cts=4T/\rho D^2V^2H$

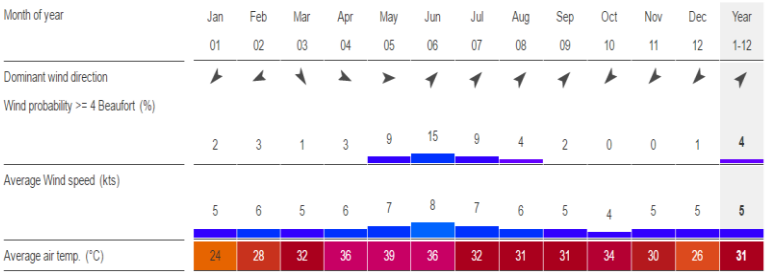

Figure 5. Wind speed during year

IV. ADVANTAGES:

1. VAWT can plant on the ground. It does not need the higher height.
2. It can be maintain easily. Construction cost is less.
3. It is more efficient and economical for residential energy mainly for villagers.
4. It can easily work at lower speed.
5. It is pollution free energy.

V. DISADVANTAGES:

1. Its efficiency is less compared to HAWT.
2. When the speed is higher it cannot take the benefits of it.
3. It cannot plant it at the high rise buildings.
4. It cannot plant more wind turbine at very closely.
5. It does not work behind the towers because tower breaks the wind speed.

VI. COMPONENTS:

1. **Turbine:**

Figure 6. Turbine

As per the figure we can explain the specification of turbine which we have made.
Height: Total (1000mm), each blade (500mm)
Width: total (300mm), each blade (150mm)
Circular plate: 350mm
Shaft length: 1500mm
Shaft diameter: 20mm

2. Base :

Figure 7. Base

As per figure we have made the base in form of base.
Specification:
Height: 400mm
Width: 400mm
Also we use the pedestal UCF 204 which has 22mm bearing.

3. Generator :

Figure 8. Generator

As a generator we used the induction IBF motor of washing machine.
Specifications:
Motor speed: 500 rpm
At this speed it gives 24v output.

4. Assembly :

Figure 9.Assembly

VII. LITERATURE SURVEY:

1) Ivan Dobrev July, 2012:

He has studied about flow through savonius vertical axis wind turbine type with aspect ratio having equal to almost 1. They studied simulation with both two dimensional and three dimensional models.CFD analysis was carried out to find the behavior of savonius wind turbine under flow field condition and performance evaluation , the flow analysis helps in determining the design was stable or not. The simulation was validated by the experimental investigation in wind tunnel carried out with PIV(Particle image velocimetry) with rotor azimuthal position.PIV was used to measure the instantaneous velocity field in the middle of the rotor normally to the axis of rotation.

2) K.K. Matrawy:

He has considered main design and performance parameters of a small scale vertical axis wind turbine (VAWT). They design two models (Two and Four cambered blades) and tested in an open wind tunnel. The studied parameters including: variation of rotational speed at different blade angles as well as variation of torque and power coefficients at different tip-speed ratios. They also carried out to investigation on the performance of (VAWT) with/without leading edge flap blades. The final experimental results showed that the blade angle of 45o increase the performance of (VAWT) comparing the other ones for both two and four bladedrotors. Using of flap blade which shows increase power coefficient by 2.4% compared with the same model without flap blade.

3) Bhojraj N. Kale:

People can use this system in agricultural area where there is no availability of power so that People can able to cover larger geographical area for power distribution. In the advent of this project if we will increase the generator capacity and large savonious unit with increased number of gener**: Bhojraj N. Kale** ators units so we can be able to create biggest power plan with optimized cost and suitable power.

4) S.M. Rassoulinejad-Mousavi:

Experimental study on aerodynamic performance of vertical axis wind turbines which is posed in two different situations is conducted in wind tunnel. In the first model savonius rotor is middle of H-rotor and in the second one H-rotor is top of savonius. Results show that combining both savonius and H-rotor with each other makes an efficient wind turbine which has better starting ability besides higher power coefficient.

5) N.H. Mahmoud:

N.H. Mahmoud has studied about Savonius wind rotors and identify the various performance parameters to increase its efficiency. In his experiments with various rotors with two, three and four blades; with single and double stages; with end plates and without end plates; with aspect ratios of 0.5, 1, 2, 4 and 5 and with different overlap ratios from 0 to 0.35 are investigated experimentally to determine the optimum values of Savonius turbine.The experimental results show that two blades rotor is more stable in operation than three or more rotor blades, the power coefficient increases with increasing the aspect ratio. The conclusions make the verification of the measurements from the static torque for each rotor at different wind speeds.A.AKadam has created different graph for his conclusion which showed below.

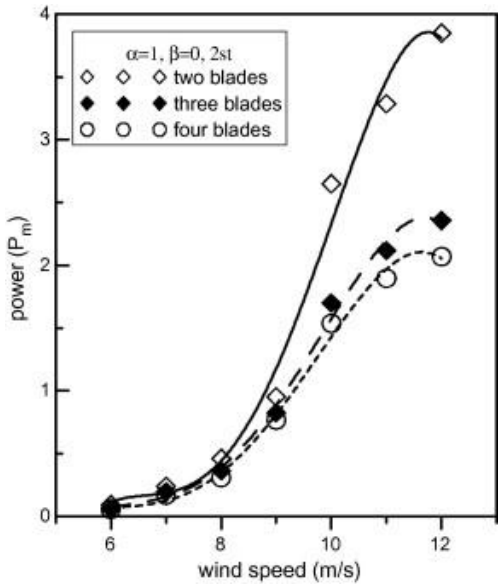

Figure 10. Mechanical power with wind speed for double stage rotor

VIII. CONCLUSION :

Analysis shows that VAWT (Savonius wind turbine) is easier to construct, low cost in manufacture, less maintenance, less space availability and most important free & green energy. The result also from literature shows that two blade rotor is more efficient than three blade. It is useful for reduce the pollution. Also, it can play important role in villages for free energy. It can reduce the pollution by fossil fuels. Hence, it is very useful for household application.

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[3] Bhojraj N. Kale Prof. Mechanical Engineering Department, Dr.BabasahebAmbedkar College of Engineering & Research, Nagpur.

[4] S.M. Rassoulinejad-Mousavi Department of Renewable Energy, Materials and Energy Research Center, Karaj, Iran.

[5] N.H. Mahmoud Mechanical Power Eng. Dept., Faculty of Engineering, Shebin El-Kom, Menufiya University, Egypt Received 15 July 2010; Accepted 21 November 2010.