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Small Scale Savonius Vertical Axis Wind Turbine

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ABSTRACT: Industrialization and urbanization is increasing leading to deficiency of the mineral resources. Due to this energy deficient condition, world would get handicapped for its energy resource requirement. Now we need to focus on alternative substitute for this problem. Light, wind, and biomass could be the substitute for this problem. Wind could the suitable option for it due to its high abundance. Wind turbine industry is fastly booming in the world due to urge for sustainable and renewable energy resources. This paper focuses on development of proto-type of small scale savonius vertical axis wind turbine.This wind turbine would work under different enviromental conditions, mostly urban environment consisting of tall skyscrapers, environment with low intensity of wind. This would the best option for large scale commercial wind turbine which could not work under urban conditions with low intensity of air. This approach would change our attitude for sustainable clean energy resources bringing evolution in wind turbine industry thus achieving the real goal of this technology. This small scale savonius vertical axis wind turbine would be light in weight to work under average wind velocity.

Keywords: Savonius wind turbine;Sustainable energy; Wind power

1 Introduction

WORLD is developing leading to exploitation of energy resources. Due to this exploitation there would be deficiency of the natural mineral resources in the future.Renewable energy resources could be the best option for the fossil fuel consumption. Fossil fuels leads to global warming which increases from the green house gases generated from the electric power station. Light, wind, water, biomass could the best alternative for these fossil fuel consumption. Wind could be one of cheapest and sustainable source as it is available in abundance. So looking at this perspective wind turbine generates sustainable and clean energy from wind Wind turbines can be classified as HAWT (Horizontal axis wind turbine) and VAWT (Vertival axis wind turbine). HAWT rotation is parallel to the ground. The following paper focuses on vertical axis wind turbine.VAWT could take the wind from any direction and rotate with the direction of wind flow [1]. VAWT has following advantages over HAWT [2]

1. Simple in construction and could be made form oil barrels cut in two halves.
2. Extremely low cost with easy installation.
3. Accepts wind from all directions as compared to horizontal axis wind turbine which requires positioning yaw control system.
4. Vertical axis wind turbine works under relatively low wind speed.
5. Requires less maintenance as it is close to the ground as compared to horizontal axis wind turbine.

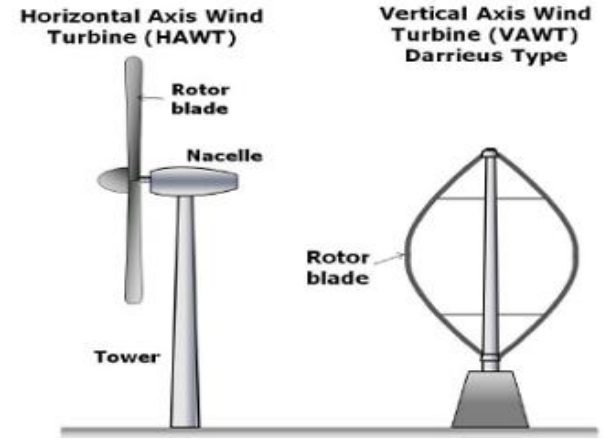

Fig. 1. *Wind turbine configuration of HAWT and VAWT.*

2 Working Priciple of Savonius Vertical Axis Wind Turbine

Savonius vertical axis wind turbines are the most compatible vertical axis wind turbine as it requires less space. Due to compact design rotor blades can easily rotate with intensity of wind speed [3].

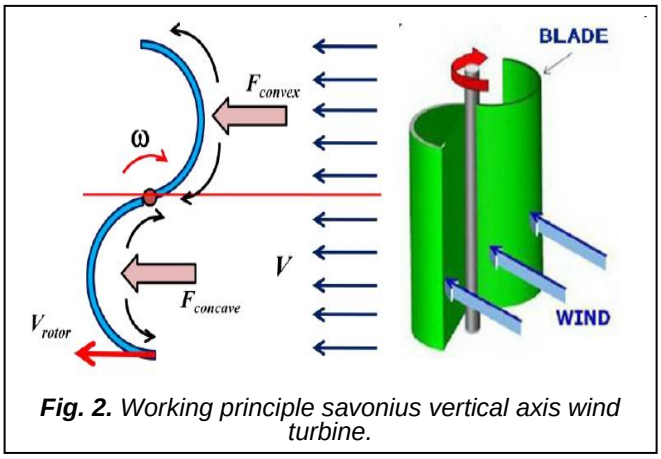

Fig. 2. *Working principle savonius vertical axis wind turbine.*

Savonius wind turbine works on the principle of differential force exerted on the blades. The curvature of this wind turbine is S shape in cross section. This cross section is divided into two shapes that are convex and concave blade aligned together in opposite direction on the rotatory shaft [3].

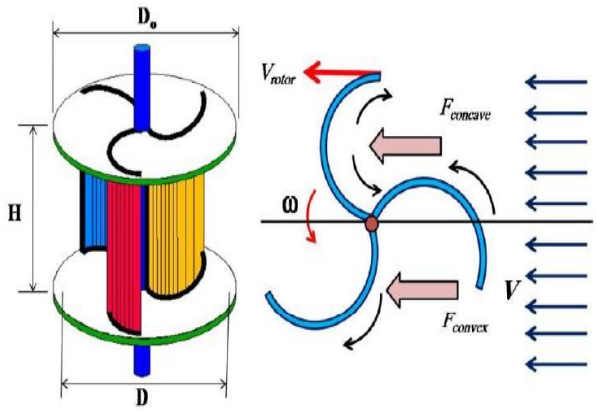

Fig. 3. *Schematic diagram showing the drag forces acting on three blade savonius vertical axis wind turbine.*

Savonius vertical axis wind turbine is divided into two halves that is convex curve and concave curve. Lower blade that is the concave half caughts the wind due inner curve shape and forces the blade to rotate. Thus rotatory motion of the shaft is obtained. While the other half that is the convex curve causes the wind to deflect to deflect sideway around. Blades facing the convex portion face the less drag for as compared to concave portion. While the concave portion experiences more drag force as compared to the convex portion. So due to these conditions, differential drag force is raised causing the savonios wind turbine to rotate. Thus savonius wind turbine act as a compatible and light weight assembly as compared to horizontal axis wind turbine.

3 Proto-Type of Small Scale Savonins Vertical Axis Wind Turbine

Fig. 4. *Proto-type of two blade savonius vertical axis wind turbine.*

The main parts of the proto-type of savonius vertical axis wind turbine

1. Blades
2. Centre shaft
3. Bearing
4. Bearing plate
5. DC motor
6. Base plate
7. Casing
8. Battery
9. Tripod

The small scale vertical axis portable wind turbine consists of two blades having curve shape and aligned in an opposite direction around the Centre shaft. These blades are given curve shape so as to capture maximum amount of wind and to develop high intensity pressure. Due to this high intensity of pressure created by this wind flow, the angle of attack acts in the direction of rotation of blade. This leads to rotation of turbine blades. With the rotation of blades the torque is generated leading to the rotation of centre shaft. The centre shaft is aligned with the dc motor provided at the bottom of assembly. The dc motor is press fitted in the base plate. The torque and speed extracted from the rotation of centre shaft is provided to the dc motor in the form of rotatory mechanical motion. This rotaory mechanical motion received by the dc motor leading to the generation of electromagnetic flux with induced electromotive force. This electromotive force leads to the generation of electric power. The obtained electric power is stored in the rechargeable batteries in required suitable form. Thus the stored electric power is used to charge our electronic cellular gadgets like mobile phones, tablets, cameras etc.

4 Experimentation on Components of the Proto-Type of Savonius Vertical Axis Wind Turbine

Components are used in the assembly of the wind turbine with optimum and reliable material satisfying the mechanical properties. Experimentation on the turbine components are discussed here.

4.1 Blades

Fig. 5. *Polypropylene sheet and aluminium sheet would be attached by riveting process.*

Here two blades are mounted on the shaft assembly to capture wind and develop high intensity of pressure. Moreover these blades need to be light in weight with high rigidity and toughness [4]. So understanding following hollow corrugated polypropylene is used for manufacturing of the turbine blades. Corrugated nature of the blades helps in developing the high of air pressure [5]. But while giving the curve shape to the blades while manufacturing, there is possibility of developing cracks high fatigue stress. So under this the blades might break from the centre leading to serious accidents and harmful injuries. Looking at this serious condition and failure rate of the blades and aluminium foil is riveted with the polypropylene sheet. This aluminium sheet increases the overall strength of blades and avoids the failure such as cracks, high fatigue stress, bending of the edges.

4.2 Centre Shaft

Shaft is an important component of a turbine assembly to transmit torque and speed extracted from the rotor blades to dc motor in the form of rotating mechanical motion. Here first we used polypropylene material for the shaft. The pp material proves to be unsuitable for the shaft as it is not flexible and develops instability in assembly.

Fig. 6. *Thin aluminium hollow centre shaft.*

Polypropylene is light in weight with high rigidity but it cannot recover bents produced in the shaft under avoided such as high velocity thunder storming , sudden lighting, sudden increase in temperature. These conditions prove to be unbearable for the solid polypropylene shaft material. So we scraped it. PVC material equivalently as better as polypropylene material posses excellent properties fire resistance abrasion resistance. But it is too flexible and does not remain straight causing deflection shaft leading to instability. So we scraped it. Mostly solid shaft is used in assembly for large scale commercial application here the prototype is small scale vertical axis portable wind turbine. The solid shaft would prove to be heavy and robust for this small scale vertical axis wind turbine. So to overcome this problem hollow aluminium shaft with light weight and high rigidity is used here. This hollow aluminium shaft would easily work with inertia forces created with wind flow [5]. This hollow aluminium shaft would rotate with the rotation of turbine blades leading to develop torque to be transmitted to the dc motor. Thus centre shaft is the essential component of turbine assembly to maintain alignment and stability in order to rotate freely.

4.3 Bearing

Bearing is an important component for transmission of torque in turbine assembly. Bearing plays an important role for the rotor to take self-starting action. So here a ball bearing made up mild steel is used. Hence bearing improves the friction reducing capacity and overall efficiency of the turbine.

Fig. 7. *Ball bearing of mild steel.*

4.4 Bearing plate

Bearing plate is used to support and hold the baring. This ensures smooth rotation of bearing with less vibration and maintains its stability [6]. Bearing plate is made up of mild steel has optimum and reliable mechanical properties with enough toughness and rigidity to work under extreme conditions.

Fig. 5. *Bearing plate for holding bearing.*

4.5 DC motor

Huge capacity alternators along with the generator and storage batteries are used in high purpose commercial turbines. But the disadvantage of using alternator is that it is quite stiff and heavy to be rotated by the mechanical motion transmitted by shaft. So overcome this problem DC motor is used as it takes less inertia and possess less stiffness. Thus Dc motors rotate freely from the speed and torque extracted by rotation of wind turbine blades.

Fig. 8. *DC motor as an alternator.*

4.6 Base plate

A base plate is provided in which DC motor is press fitted. Moreover two holes are provided to occupy the studs which help to hold back the assembly with stability.

4.7 Casing

A casing is provided to hold back the assembly. While the assembly is not in work or it needs to be taken from one place to another the blades are folded to occupy the shape of casing. Hence it acts as a small scale vertical axis portable wind turbine.

4.8 Battery

A rechargeable lead-acid battery for the storage of the electric energy produced from the alternator is provided. Battery maintains the flow of electric power supply to different applications.

4.9 Tripod

There might be low intensity of air at ground level or lower altitude so the required force for rotation of turbine blades is not developed. Intensity of wind increases with the increase in an altitude, So some height need to be provided to the assembly to develop the required force. So tripod in the form of stand to provide the required height is provided. Tripod material should be hard enough with rigidity to support the assembly and avoid any instability and vibrations. It would act as a vibration isolator.

5 RESULT

From the required considerations and perspective of obtaining reliable materials with optimum physical, chemical and mechanical properties, be selected the best of the material for our wind small scale two blade savonius vertical axis wind turbine. Thus small scale savonius vertical axis wind turbine would increase the overall efiiciency for different applications.

5 CONCLUSION

Small scale two blades savonius vertical axis wind turbine proto-type is manufactured which is compataible, light in weight and can work under various environmental conditions with most suitability for urban environment.

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