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Study on Effect of Bucket Overlap on the Perfomance of Micro Savonius Wind Turbine

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Abstract: Power from wind or water current can be extracted using a horizontal or vertical axis turbine. Vertical axis turbines and solar panel are capable of extracting power from wind or water current regardless of the direction of flow. A hybrid turbine consists of two types of turbines on a same shaft. Such a design exploits good features of two turbines. This paper presents the design of a hybrid turbine based on a straight bladed Darrieus (lift type) turbine along with a double step Savonius (drag type) turbine. Four bladed Darrieus rotor is placed on top of a Savonius rotor. The hybrid vertical axis turbine has much better self-starting characteristics and better conversion efficiency at higher flow speeds. The hybrid turbine is built and tested in variable speed water currents. This turbine design can also be used as a wind turbine. This paper presents the system design and performance test results of the hybrid turbine. The designed hybrid vertical axis turbine will be used to generate power at the sea floor for an instrumentation system.

Keywords: **-**Design of shaft and Blades, Priniciple of working Micro Savonius Wind Turbine,Overlap Position of Blades**.**

I.INTRODUCTION

Wind is flow of gases on large scale. Wind is formed by help of suns solar radiation about 1to 2% of sun's radiation turns into wind energy so as the sun heats the ground surface of earth which heats up the air above it as the hot air rises, creating low pressure as hot air rises up cool air moves horizontally and eventually moves down creating high pressure at ground level thus movement of air from higher pressure to lower pressure makes the movement of air which is called as wind.

Wind energy is a domestic source of energy by which we can generate electricity which doesn't pollute the air like power plant rely on combustion of fossil fuels. Wind power is one of the lowest priced renewable energy technologies available today. Wind is sustainable source of energy.

Wind turbine is a power generating device that is driven by kinetic energy of the wind. Wind turbine general fall into two categories as Horizontal axis wind turbine (HAWT), Vertical axis wind turbine (VAWT). In HAWT the shaft is mounted horizontal direction.

The Savonius turbine is to be used for this vertical axis wind turbine. The Savonius wind turbine is rotated at the low speed wind turbine is rotated at the low speed wind, due to the minimization of friction between shaft and stator the total wind speed of turbine observed passes to the generator.

II.LITERATURE SURVEY

A. Experimental study to assess the performance of combined savonius & darrieus VAWT at different arrangements

B. -AliSiddiqui, Abdul memon et al

As both vertical axis wind turbine have, they own property as savonius works on drag force and darrieus work on lift force they thought of combining of both the turbines and calculated all parameters like efficiency and COP. So there where 3 combinations called as HYBRID VAWT.

1)Savonius turbine pleased at middle of darrieus turbine: COP=14.6%, effe=20%

2)Savonius turbine was placed at the bottom of darrieus turbine: COP=8.87%, effe=10%

3)Savonius turbine was placed at the top of darrieus turbine: COP=3.62%, effe=5%

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Fig1.1: Arrangements of combined Savonius & Darrieus wind turbine

C. Review of savonius wind turbine design and performance:

-M.Zemamou, A. Toumi et al

They concluded that the savonius rotor has proved its performance due to its simple design, low cost & low starting torque at low wind speed. And also carried experiment to know the parameters affecting the performance of turbine such as Effect of blades number, Effect of aspect ratio, Effect of overlap ratio, by this parameter they design a new savonius blades.

II. ABOUT SAVONIUS WIND TURBINE

The Savonius wind turbine was invented by the Finnish engineer Sigurd Johannes Savonius in 1922. Savonius wind turbines are a type of vertical-axis wind turbine (VAWT), used for converting the force of the wind into torque on a rotating shaft. Savonius turbines are one of the simplest turbines. Aerodynamically, they are drag-type devices, consisting of two or three scoops. Looking down on the rotor from above, a two-scoop machine would look like an "S" 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 Savonius turbine to spin. Because they are drag-type devices, Savonius turbines extract much less of the wind's power than other similarly-sized lift-type turbines. Much of the swept area of a Savonius rotor may be near the ground Principle of savonius rotor wind turbine is savonius wind turbine works due to the difference in forces exert on each blade. The lower blade caught the air wind and forces the blade to rotate around its central vertical shaft. The savonius wind turbine mainly consists of different parts such as Guide wire, Hub, Rotor, Blades, Shaft, Brake, Gear, Generator.

Fig:1.2 Savonius wind turbine

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III.METHODOLOGY

The vertical axis wind turbine is used to convert the kinetic energy into mechanical energy. The light weight blade materials (sheet) are used for making the vertical axis wind turbine. The height of blade is 50cm and width of blade is 15 cm. The whole turbine is assembling with collar and blades which is fitted by nut bolts. To achieve the unidirectional motion of the turbine the blades are bended by 200 angle curve shape and shaft of the turbine connected to the shaft of generator.

The method of conducting this project are having basically four steps. The steps include just changing the overlap ratio so the 4 steps are:

1)Without any overlap
2)With overlap of 10mm
3)With overlap of 20mm
4)With overlap of 40mm

1) Without any overlap: So in this step we will attach the blades of the turbine directly to the shaft with the help of Bolt and nut and let the blade rotate with help of wind or blower then we will check the output voltage and record It.

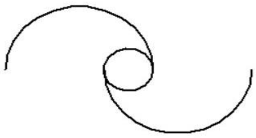

Fig:1.3 Without any overlap of blades

2) With overlap of 10mm: Next step is we will keep the blades in overlap position of 10mm which includes 5mm at each side of the blade and then we will fit the blade to shaft and check the output voltage.

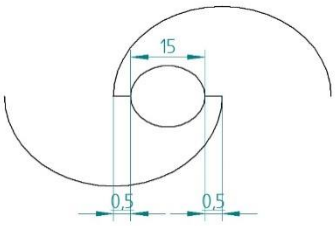

Fig:1.4 With overlap position of 10mm

3) With overlap of 20mm: Next step is we will keep the blades in overlap position of 20mm which includes 10mm at each side of the blade and then we will fit the blade to shaft and check the output voltage. And then we will record it.

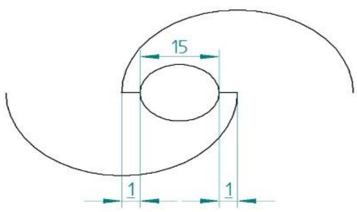

Fig:1.5 With overlap position of 20mm

5)With overlap of 30mm: Next step is we will keep the blades in overlap position of 30mm which includes 15mm at each side of the blade and then we will fit the blade to shaft and chuck the output voltage. And then we will record it.

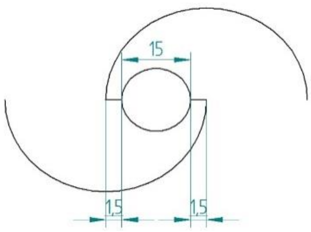

Fig:1.6 With overlap position of 30mm

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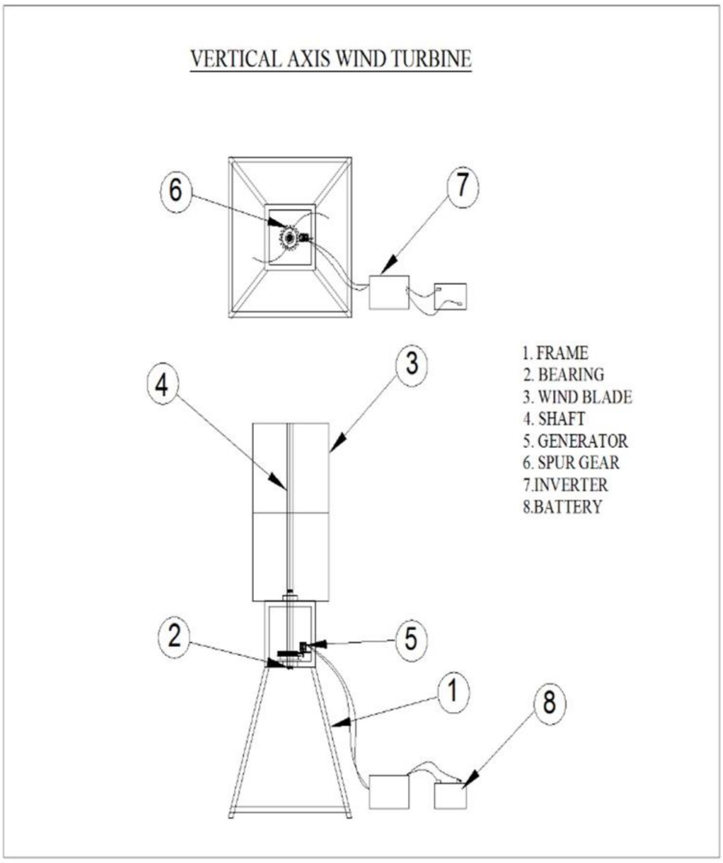

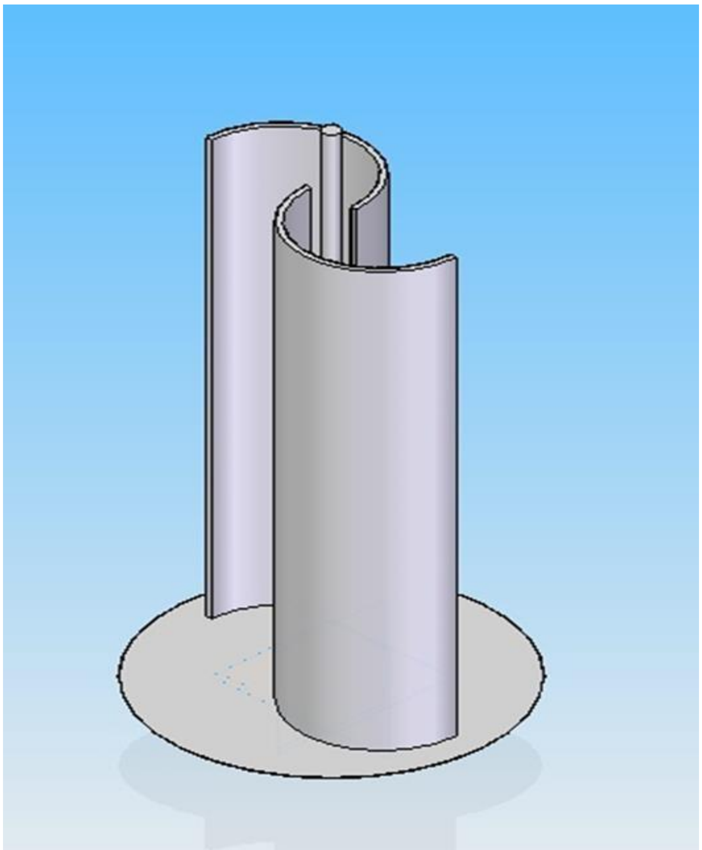

Fig.1.7 2D model of project

Fig.1.8 3D model of blades and shaft

V.DESIGN PARAMETERS

Design of blades

- Assume diameter of blade d = 15cm
- The velocity in Belagavi as per the google is = 3m/s
- Height of the blades = 50cm
- Overlap ratio:
  E= d/3
  E= 15/3= 5cm
- Diameter wind speed of rotor:
  D= 5*E
  D= 5*5
  D= 25cm
- Diameter of plates:
  F=1.2 * D
  F= 1.2* 25
  F= 30cm
- Area of the blade:
  A= h *D
  A= 50 * 0.25
  A= 0.125m^2

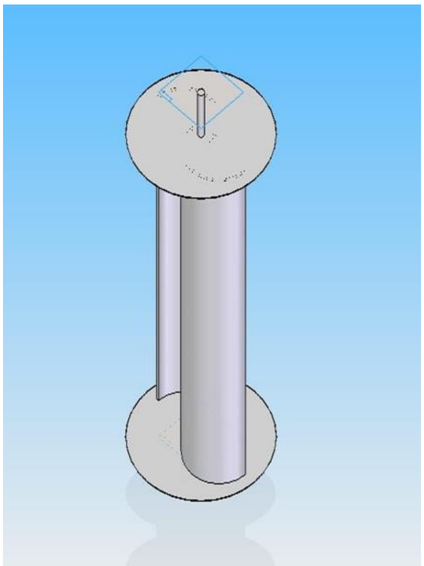

Fig.1.8 3D model of blades and shaft

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- Shaft power:
  $Ps = 1/2 * \rho * A * V^3 * Cp$
  Cp=0.593
  the Betz coefficient. density of the air (ρ) = 1.22 kg/m^3
  $Ps = ½ * 1.22 * 0.125 * 3^3 * 0.593$
  Ps = 12.3 W
  considering 50% mechanical and aerodynamic losses
  Pc = Ps/2
  Pc = 12.3 /2
  Pc= 6.15 W
- Angular velocity: $\omega = \lambda * v / r$ λ =1 (tip speed ratio of VAWT turbine)
  $\omega = (1*3) / 0.125$
  ω = 24 rad/sec

Design of shaft:

- Torque at the rotor shaft
  $T = Ps / \omega$
  T = 6.10/24
  T= 0.25 Nm

- Speed in rpm
  $Ps = (2 * \pi * N * T) / 60$
  $N = (Ps*60) / (2*\pi*T)$
  $N = (6.10*60)/(2* \pi *0.25)$
  N= 233 rpm

- Diameter of the blade (based on strength):
  Material: MS
  Shear strength of MS: 17.25MPa (from DHB)
  $d^3 = 16\ T / (\pi\ \tau_s)$
  $d^3 = (16 * 0.25) / (\pi * 17.25)$
  d= 4.5mm
- Diameter based on rigidity $d^4 = (584*T*L) / (G*\theta)$
  G: Modules of rigidity of MS = 80kn/mm^2
  $G = 80*10^3\ N/mm^2$
  θ= twisting force= 1°
  L= 100cm= 1000mm
  $d^4 = (584* (0.25*10^3) *1000) / (80*10^3) *1$
  d = 6.53mm

VI.ADVANTAGES AND DISADVANTAGES,APPLICATIONS

ADVANTAGES

1) They can produce electricity in any wind direction.
2) Strong supporting tower in not needed because generator, gearbox and other components are placed on the ground.
3) Low production cost as compared to horizontal axis wind turbine.
4) As there is no need of pointing turbine in wind direction to be efficient so yaw drive and pitch mechanism is not needed.
5) Easy installation as compared to other wind turbine.
6) Easy to transport from one place to other.
7) Low maintenance cost.
8) They can be installed in urban area.
9) Low risk for human and birds because blades moves at relatively low speed.
10) They are particularly suitable for areas with extreme weather conditions, like in the mountains where they can supply electricity to mountain huts.

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DISADVANTAGES

1) As only one blade of wind turbine work at a time so efficiency is very low
2) They need a initial push to start, this action use few of its own produce electricity
3) When compared to horizontal axis wind turbine they are very less efficient with respect to them. this is because they have an additional drag when their blades rotate.
4) They create noise pollution
5) Guy wires which hold up the machine, need some are to install

APPLICATIONS

Wind power generation is mainly including grid-connected and off-grid wind power generation. The large-scale wind turbine is often used for grid-connected power generation. The middle- and small-scale wind turbines are usually for off-grid power generation. This are also used in open places where there is high winds, Near tunnels.

VII.CONCLUSION

A strong multidiscipline team with a good engineering base is necessary for the Development and refinement of advanced computer programming, editing techniques, diagnostic Software, algorithms for the dynamic exchange of informational different levels of hierarchy.

This project work has provided us an excellent opportunity and experience, to use our limited knowledge. We gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this project work.

We are proud that we have completed the work with the limited time successfully. The "VERTICAL AXIS WIND TURBINE" is working with satisfactory conditions. We are able to understand the difficulties in maintaining the tolerances and also quality.

We have done to our ability and skill making maximum use of available facilities. In conclusion remarks of our project work. Thus, we have developed a "VERTICAL AXIS WIND TURBINE". By using more techniques, they can be modified and developed according to the applications.

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