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Prototype of Vertical Axis Savonius type Wind Turbine with 2.3kWh Power Generation

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Abstract: ***In recent scenario the energy utilization is most impacted topic in research and development section. Research work on wind and solar section has been considerably increased due to its availability and effectiveness. In wind section, windmill is one of the way, through which we can use maximum percentage of wind energy. The Horizontal Axis Wind turbine can be said tradition equipment for wind energy utilization. Due to its characteristics it is not used for household purpose. In case of Vertical Axis Windmill, due its type of blade, it is compactable for household purpose. For the main aim to choose this type of design, it is suitable for varying condition of weather.***

Keywords: Energy Utilization, Magnetic Levitation, Savonius Blade, Vertical Axis.

I. INTRODUCTION

The main advantage of vertical axis wind turbine is its levitation between rotors and the base with help of two magnets, which eliminate the mechanical friction completely. In conventional windmill there is a loss of work due to mechanical friction. In this vertical axis windmill the blades we have to use are must be low weight and shape of the blades must be in optimum shape so it can utilize maximum wind and generate optimum output. The output we obtain is depends on the velocity of the wind which strikes on the blades and also size of the windmill.

II. DESIGN

A. Savonius Blade

The Savonius turbine is one of the simplest turbines. Aerodynamically, it is a drag-type device, 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, if it has a small mount without an extended post, making the overall energy extraction less effective due to the lower wind speeds found at lower heights. [8]

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Design Parameters (from fig a&b):

d = Diameter of the Blade

D_o= Diameter of the Rotor

a = Distance between two blades at the center

H= Height of the blade

Assumptions:

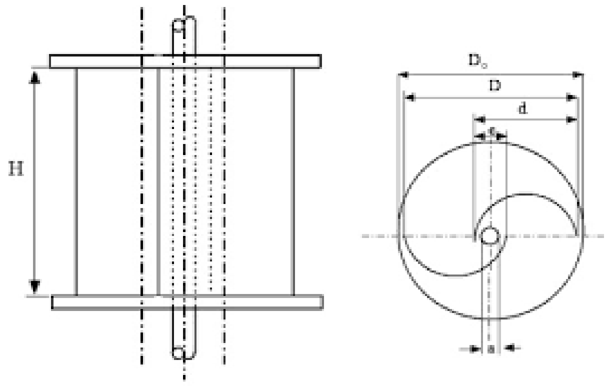
d=0.6m

H= 2m

V = 6 m/s (assuming this is the wind speed)

ρ= 1.225 kg/m3 density of air at sea level and 15°C

From Calculations:



(a) (b)

Area(A) = Height * Diameter [1]

= 2 * 0.6

$=1.2m^2$

a = d/3 = D/5 [2]

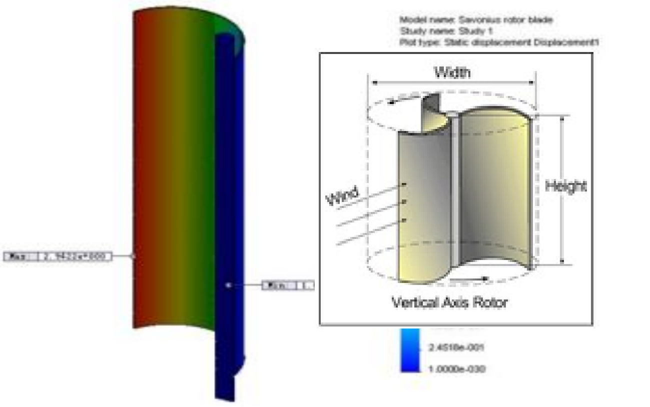
a = 0.2m, D = 1m

Force calculation:

Lift force = $F_L= ½ \rho V^2 AC_L$ [3]

Drag force=$F_D = ½ \rho V^2 AC_D$ [3]

C_L =0.385, C_D =1.50



Material used for Blade is E Glass Fiber [4,5]. According to analysis it is seen that at 5m/s wind speed maximum deformation of the blade is 2.9422mm. This shows the design is safe.

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The other properties of the material are given below.

Blade Thickness	10mm
End plate Thickness	50mm
Density	$1.7e^3 – 2e^3$ kg/m^3
Young's Modulus	27.2 – 39.4
Poisson's ratio	0.07-0.11
Tensile strength	217-520 Mpa
Compressive strength	276 – 460 Mpa
Maximum deformation	2.9422mm

B. Magnet

Neodymium magnets: A neodymium magnet (also known as NdFeB, NIB or Neo magnet), the most widely used type of rare-earth magnet, is a permanent magnet made from an alloy of neodymium, iron and boron to form the Nd2Fe14B tetragonal crystalline structure.

Neodymium magnets are the strongest type of permanent magnet commercially available. They have replaced other types of magnets in the many applications in modern products that require strong permanent magnets, such magnetic fasteners

Magnet uses for levitation [6]:

Type of Magnet	N52
No. of magnets	2
Distance	30mm
Weight capacity	5.71lb = 2.6kg

RPM calculation

Ma * Va = Mr * Vr

Where: Ma = Mass flow rate of air

Va = Velocity of air

Mr = Mass of rotor

Vr = Linear Velocity of rotor

Vr = 3.675m/s

C. Components and Materials

- Inner fixed shaft- Mild steel
- 2 Ball Bearing: Bearing no. 6010
- Rotor blade: E Glass Fiber (No. of blade=2)
- Magnets: Magnet used in electrical circuit: Permanent Neodymium Magnet (N52) (No of Magnets -4, Magnetic field of each magnet: 0.4T)
- Coils- Copper coil 1500 turns (No. of Coils: 4)

III. POWER GENERATION

Lenz law states that when an emf is generated by a change in Magnetic flux according to Faraday's Law, the polarity of the induced emf is such, that it produces a current that's magnetic field opposes the change which produce it [7]. So as the rotor will rotate the magnetic flux of the magnet which is located at bottom side of the rotor is changed due to the presence of coil at the base. And according to Electromagnetic induction the power is generated.

According to Lenz law

Induced emf = $\pi n a^2 B \omega \sin(\omega t)$

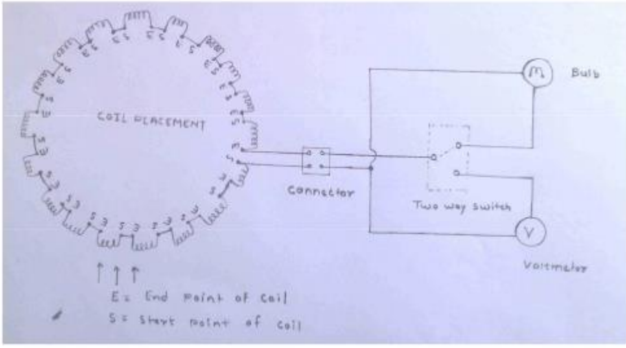
Where a = radius of the coil

ω = angular velocity

n = no. of turns

B = Magnetic Field of Magnet

IV. BENEFITS



- This model is capable to run in wide range of the wind condition.
- It is not dependent on the wind direction.
- Its size is compactable.
- Electrical circuit arrange at ground level.
- There is no requirement of addition mechanism to supervise the system.
- The noise emission is very less compare to the horizontal axis wind turbine. It is suitable for residential use, street lights etc.

V. CONCLUSIONS

This is prototype of the Vertical Axis Savonius type Wind turbine. This model is small in size though it generates 2.3kWh power. If this concept uses at large scale, then it will very useful power generation. However, there are many drawbacks of this system but it can be eliminated by suitable change.

REFERENCES

1. Antonio Gagliano, Francesco Nocera.International journal of Energy and Environmental Engineering(IJEEE) 2013. Assessment of micro-wind turbines performance in the urban environments: an aided methodology through geographical information system
2. F. Sigernes, University Centre in Svalbard (UNIS), Norway." DRAFT: Savonius wind rotor basics"
3. Ashwin Dhote1, Prof. Vaibhav Bankar2 "DESIGN, ANALYSIS AND FABRICATION OF SAVONIUS VERTICAL AXIS WIND TURBINE", International Research Journal of Engineering and Technology (IRJET), Volume: 02 Issue: 03 | Jun-2015
4. WIDODO1, W.S., CHIN2, A.C., HAERYIP SIHOMBING3, and YUHAZRI4, M.Y., "DESIGN AND ANALYSIS OF 5 KW SAVONIUS ROTOR BLADE", GLOBAL ENGINEERS & TECHNOLOGISTS REVIEW,
5. http://www.hibid.co.uk/metcalc/metcalc.html
6. https://www.kjmagnetics.com/fieldcalculator.asp
7. https://www.electrical4u.com/lenz-law-of-electromagnetic-induction/
8. https://en.wikipedia.org/wiki/Savonius_wind_turbine

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