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# Design, Analysis and Fabrication of Vertical Axis Wind Mill

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## Abstract:

With the recent surge in fossil fuels prices, demands for cleaner energy sources, and government funding incentives, wind mills have become a viable technology for power generation. Currently, horizontal axis wind mill (HAWM) dominates the wind energy market due to their large size and high power generation characteristics. However, vertical axis wind mills (VAWM) are capable of producing a lot of power, and offer many advantages. The mechanical power generation equipment can be located at ground level, which makes for easy maintenance. Also, VAWM are Omni-directional, meaning they do not need to be pointed in the direction of the wind to produce power.

Finally, there is potential for large power generation with VAWM because their size can be increased greatly.The main objective of the project is to design and analysis of vertical axis wind mill and also fabricates the VAWM prototype. This report outlines the efforts in the design of our full-scale VAWM. A model that carries out wind mill theory calculations was created to aid in the design of the full-scale windmill. The model inputs include design of blades and shaft, support structure done by using UNIGRAPHICS 8.0. And analysis is done by using Ansys 11.0.

**Keywords:** VAWM,DESIGN, ANSYS,STRESSES .

## 1.Introduction:

Wind turbines convert the wind's kinetic energy into electricity power through a Wind turbines produce rotational motion, wind energy is readily converted into electrical energy by connecting the turbine to an electric generator.

The combination of wind turbine and generator is sometimes referred as an aero generator. A step-up transmission is usually required to match the relatively slow speed of the wind rotor to the higher speed of an electric generator.India wind speed value lies between 5 kmph to 15-27kmph. These low and seasonal winds imply a high cost of exploitation of wind energy. Calculations based on the performance of a typical windmill have indicated that a unit of energy derived from a windmill will be at least several times more expensive than energy derivable from electric distribution lines at the standard rates, provided such electrical energy is at all available at the windmill site.The above argument is not fully applicable in rural areas for several reasons. First electric power is not available in many such areas due to the high cost of generation and distribution to small dispersed users. Secondly there is possibility of reducing the cost of the windmills by suitable design. Lastly, on small scales, the total first cost for serving a felt need and low maintenance costs are more important than the unit cost of energy. The last point is illustrated easily, dry cells provide energy at the astronomical cost of about Rs.300 per kWh and yet they are in common use in both rural and urban areas. Wind energy offers another source for pumping as well as electric power generation.

## 2.Basic Components of Wind Turbines

The main components of a WIND TRBINES are shown in Fig., in block diagram form. Summary of the system operation is as follows:

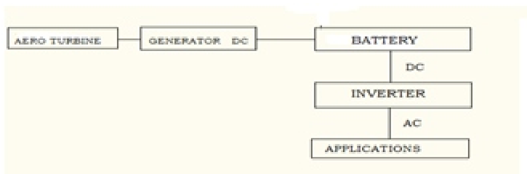


Fig: Block diagram of wind turbine

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Aero turbines convert energy in moving air to rotary mechanical energy. In general, they require pitch control and yaw control (only in the case of horizontal or wind axis machines) for proper operation. The output of this generator is stored to the battery. From battery the DC is converted in to AC by using the inverter. Yaw control. For localities with the prevailing wind in one direction, the design of the turbine can be greatly simplified. The rotor can be in a fixed orientation with the swept area perpendicular to the predominant wind direction.

## 2.1. Rotors::

Rotors are mainly of two types
(a) Horizontal axis rotor and
(b) Vertical axis rotor.
The rotor is only one of the important components.

## 2.2. Dynamo:

The dynamo uses rotating coils of wire and magnetic fields to convert mechanical rotation into a pulsing direct electric current through Faraday's law of induction.
The remaining components are supporting rod, fixture to the wind mill, bolts, bearing wing and shaft.

## 3.Modeling and Analysis of VAWM:

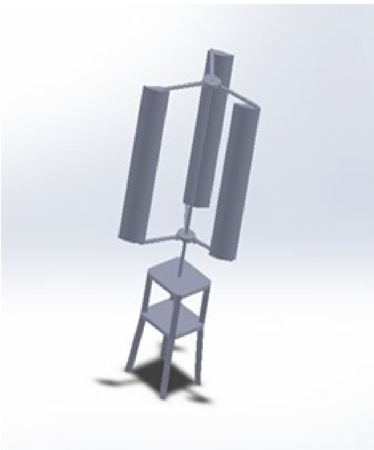

Fig: design of the VAWM

The design of the VAWM in UNIGRAPHICS Software.

**Blade Specifications:**

| Blade Material | Tin material |
|---|---|
| Length | 900 mm |
| Thickness | 3 mm |
| Bend Angle | 15° |
| Diameter | 330mm |

Wing Height - 870mm
Material used for Wing - Gi sheet
Base height -725mm
Material used for base -2X2inch L angular iron material
Base plate -2X2 fetes material iron
Top plate 1 and half square feet
Shaft - 2175mm, material is iron.

Fig: VAWM prototype

## 3.1 Process involved in VAWM:

The basic principle involved in VAWM is conversion of wind energy into electrical energy by using mechanical energy. The total available energy in wind for the swept volume by the blade is maximum energy that can be utilized but due to losses we get less energy as an output.

The wind energy available at wings is converted to rotations of main shaft and this main shaft rotates with support of roller bearings. This rotations of end wheel is connected to the dynamo with support of belt drive. The electrical energy is produced in dynamo is utilized with help of battery and from the battery energy is consumed by using step-up current.

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### 3.2. Power Calculation:

$K.E=1/2*m*V^2$
$m=\rho*A*V$
$K.E=1/2\ \rho*A*V*V^2$
m = mass of air transverse
A=Area swept by the rotating blades of wind mill type generator
$\rho$ = Density of air
V= Velocity of air
$K.E=1/2\ \rho*A*V^3$
$A=\pi/4*D^2$
$K.E=1/2*\rho*\pi/4*D^2*V^3$
Power Produced
$P=(\rho*\pi*D^2*V^3)/8$

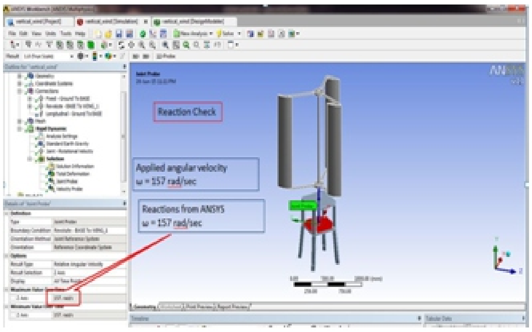


Fig: Boundary conditions for VAWM

### Boundary conditions:

Base is fixed, no translation in z- direction and the rotation applied in z- direction on blades.In this analysis we found that the minimum wind velocity obtained 1.4m/s then only the rotation is possible for the main shaft and the average wind velocity is 7.5m/s so from this value as an input we get the power of 302.2W as an output.

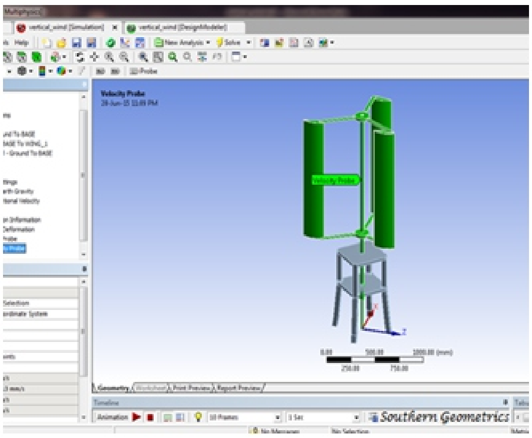


Fig: velocity profile of VAWM

### Analytical Result:

| Density of Air(Kg/m3) | Diameter of Wing(m) | constant value | velocity of air(m/s) | Power(w) |
|---|---|---|---|---|
| 1.225 | 1.22 | 0.716 | 1.4 | 2.0 |
| 1.225 | 1.22 | 0.716 | 2 | 5.7 |
| 1.225 | 1.22 | 0.716 | 2.5 | 11.2 |
| 1.225 | 1.22 | 0.716 | 3 | 19.3 |
| 1.225 | 1.22 | 0.716 | 3.5 | 30.7 |
| 1.225 | 1.22 | 0.716 | 4 | 45.8 |
| 1.225 | 1.22 | 0.716 | 4.5 | 65.2 |
| 1.225 | 1.22 | 0.716 | 5 | 89.5 |
| 1.225 | 1.22 | 0.716 | 5.5 | 119.1 |
| 1.225 | 1.22 | 0.716 | 6 | 154.7 |
| 1.225 | 1.22 | 0.716 | 6.5 | 196.6 |
| 1.225 | 1.22 | 0.716 | 7 | 245.6 |
| 1.225 | 1.22 | 0.716 | 7.5 | 302.1 |
| 1.225 | 1.22 | 0.716 | 8 | 366.6 |
| 1.225 | 1.22 | 0.716 | 8.5 | 439.7 |

### 4.Conclusion:

At this early stage of development there is a great deal of excitement and potential regarding domestic wind turbine, but until the installed costs start to approach the target prices, the turbines will remain as potential. The "VERTICAL AXIS WINDMILL POWER GENERATION" 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. Thus we have designed and developed a "Vertical axis windmill" which helps to know how to achieve non-conventional power generation. Compare to the horizontal axis windmill our model is easy to modeling and power generation. Vertical axis windmill achieves less cost and requires low wind for same power production from horizontal axis windmill. This will react to wind from any direction and they required less structural support. This configuration also eases installation and maintenance.

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