

Design and Estimation of Wind Machine for standalone Application

Nitin Jadhav¹, Mahendra Sable²

¹ Mechanical Engineering Department, JSPM'S, R.S.C.O.E, Pune-411033, India
jadhavnitin888@gmail.com

² Mechanical Engineering Department, JSPM'S, R.S.C.O.E, Pune-411033, India
Mahendramjs9@rediffmail.com

Abstract –

The depletion of conventional sources of energy like fossil fuel has compelled man for search for the alternative sources of energy. Owing to acute energy crisis that most developing countries including India are facing today, the interest in alternative energy sources has increased manifolds in recent past. And the potential of wind energy as a source of alternative energy perhaps cannot be underestimated. Growth in wind power is tremendous, with capacity more than doubling every three years. In this seminar I am focusing on selection of wind turbine according to our requirement and which factors are considered while selecting wind turbine. By using appropriate wind turbine we can provide a good alternative source of energy thus providing a solution to the acute energy crisis.

Keywords: Wing, turbines, Design Calculation, Rural Area etc.

1. Introduction

This project envisions the design and appropriate implementation of a 0.50 kW electricity producing wind turbine. The turbine will ideally be designed for implementation in remote communities to power individual house's electrical needs or to be fed directly into a local energy grid. The aim of the project is to design a wind energy converter comprising of a rotor system, a gearbox and a generator that will successfully produce the specified electrical power. As wind turbines are not new technology the project will be aimed at proving and optimizing a system based on existing technology to achieve the desired power output. Considerations are taken in designing the turbine with an effective post life recycling scheme in mind so that there will be minimum wastage of resources once the turbine is made redundant. Ultimately the aim of this project is to make.

Use of a natural resource to supply mankind's energy requirements in a sustainable manner. If a wind turbine can be designed and constructed so that it can produce more power over its life time than it takes to be produced and maintained over its useful life, then it is a sustainable answer

to our global energy requirements. It is obvious now that we are facing an oncoming global energy shortage. Fossil fuel prices are rising in conjunction with the decrease in their stockpiles and it is vital that alternative methods of energy production be investigated and introduced on a global scale to maintain our standard of life. Wind energy has the potential to meet our requirements and several nations have already begun effectively producing and harvesting this form of green energy.

2. CONCEPTUAL DESIGN

Design and build a 500 W, Wind turbine that is capable of producing the power in the real world situations. The design of the turbine will includes exploration of various new techniques of power control as well as construction of the both model and full scale turbine. The full scale turbine is design such way that, it can be connected to generator and facility to connect it with, external examination unit and data collection unit to measures the power output, torque and speed of the turbine. The design is also include the facility of power optimization by pitching and yawing.

A SWT is a device that enables the extraction of the power in a moving mass of air, and converts this power to a usable form, namely, electricity. The objective of this chapter is to formulate a conceptual design for a SWT, and then by using typical engineering methods create a refined and viable final design. To achieve this objective a conceptual design will initially be devised, with a general operational description and a list of the required components. The fundamental principles that govern the operation of a HWT will be investigated to develop further understanding of the system requirements.

These principles will assist in identifying the requirements of the design. Once the design requirements have been ascertained, the major part of the SWT design can commence. This firstly requires an investigation of the wind as a resource, and selection of a target location for the designed device. The second step is the development of the turbine design itself. A breakdown of the components will identify those that are to be designed, and those that are to be obtained through commercial sources. Each of the major components in the wind energy conversion system will be designed or specified according to normal engineering

methods. This chapter will conclude with an overview of the final design and its expected outputs and specifications.

- **2D and 3 D Conceptual Model**



Fig.1.1 Blade Arrangement for Straight Blade Vertical Axis Wind Turbine.

3. AERODYNAMICS AND POWER CALCULATIONS:-

Analytical design of wind turbine is basically a part of aerodynamic and power optimization. While designing an aero-generator we will have to optimize the aerodynamic shape of the blade for optimum power extraction as well as manufacturing feasibility.

In this project work we specifically observed,

- NACA-0018
- NACA-4415
- NACA-7622

0018-is previously used for vertical axis H-shape windmills and most optimum performance in this range. While 7622-63 is specifically design for horizontal axis turbine and easy to fabricate.

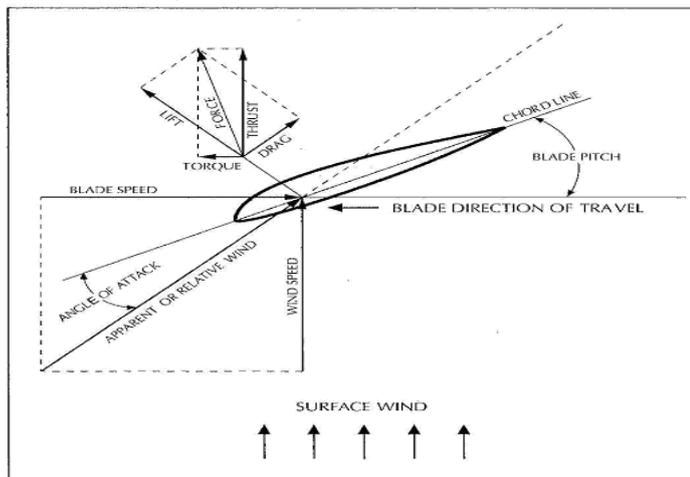


Fig.1.3 Lifts generation in wind turbine blade

We are going to use the newly developed profile as 4415. As per the graph generated by the design-foil, the lift characteristic of this profile is better for self starting capability of the vertical axis wind turbine.

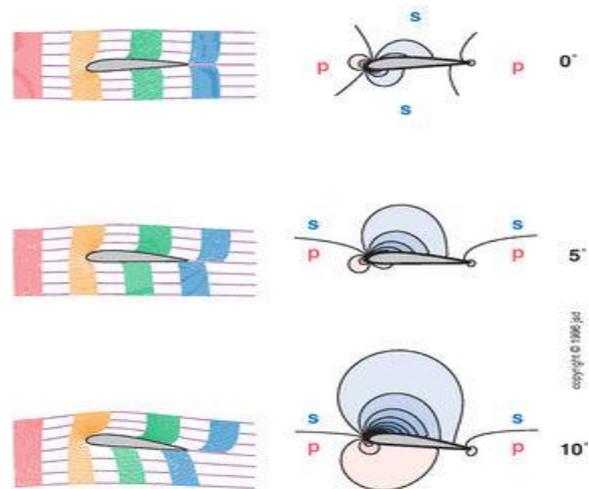


Fig.2.1 Lifts generation in wind turbine blade in different angle of attack

TURBINE SOLIDITY AS A FUNCTION OF TSR

The operating tip-speed ratio (TSR) for a Darrieus rotor lies between 4 and 6. This design TSR then determines the solidity, gear ratios, generator speeds, and structural design of the rotor. Using this TSR and the graph in figure 1.4, a value of the solidity is selected. As with the prop-type rotor, the solidity allows for the calculation of blade area.

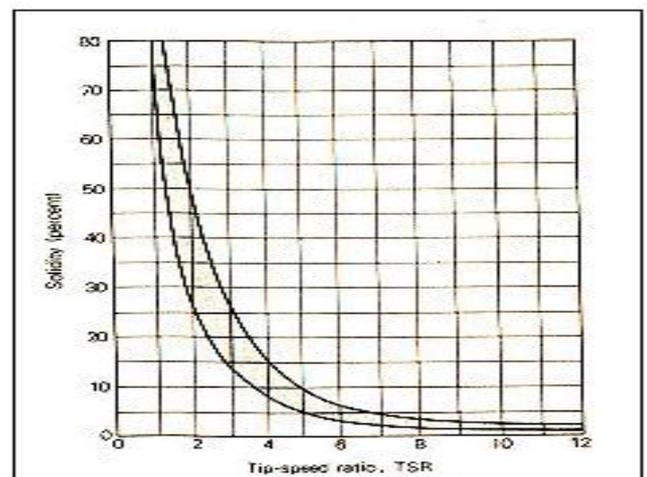


Fig.2.2 tip speed ratio and blade solidity relation

Turbine size as a function of power required. The power of the wind is proportional to air density, area of the segment of wind being considered, and the natural wind speed.

The relationships between the above variables are provided in equation

$$P_w = \frac{1}{2} \rho A V^3 C_p \eta_o$$

Where

P_w = Power of the wind turbine (W)

ρ = air density (kg/m³)

A = area of wind turbine rotor (m²)

$V = u$ = wind speed (m/s)

C_p = coefficient of performance

η_o = combine efficiency of electric generator + mechanical coupling

At standard temperature and pressure (STP = 273K and 101.3 KPa), equation reduces

$$P_m = \frac{1}{2} \rho A V^3 C_p \eta_o \tag{2}$$

A turbine cannot extract 100% of the winds energy because some of the winds energy is used in pressure changes occurring across the turbine blades. This pressure change causes a decrease in velocity and therefore usable energy.

- The mechanical power that can be obtained from the wind with an ideal turbine is given as:

$$P_m = \frac{1}{2} \rho (16/27 A u^3) \tag{3}$$

Where

P_m : mechanical power (W)

In equation [3], the area, A , is referred to as the swept area of a turbine. For a VAWT, this area depends on both the turbine diameter and turbine blade length.

- For an HAWT the equation for swept area is:

$$A_s = \pi R^2 \tag{4}$$

Where

A_s : swept area (m²)

D = diameter of the turbine (m)

The constant $16/27 = 0.593$ from equation [3] is referred to as the Betz coefficient. The Betz coefficient tells us that 59.3% of the power in the wind can be extracted in the case of an ideal turbine. However, an ideal turbine is a theoretical case. Turbine efficiencies in the range of 35-40% are very good, and this is the case for most large-scale turbines.

It should also be noted that the pressure drop across the turbine blades is very small, around 0.02% of the ambient air pressure. Equation [3] can be re-written as

$$P_m = C_p P_w \tag{5}$$

Where

C_p : coefficient of performance.

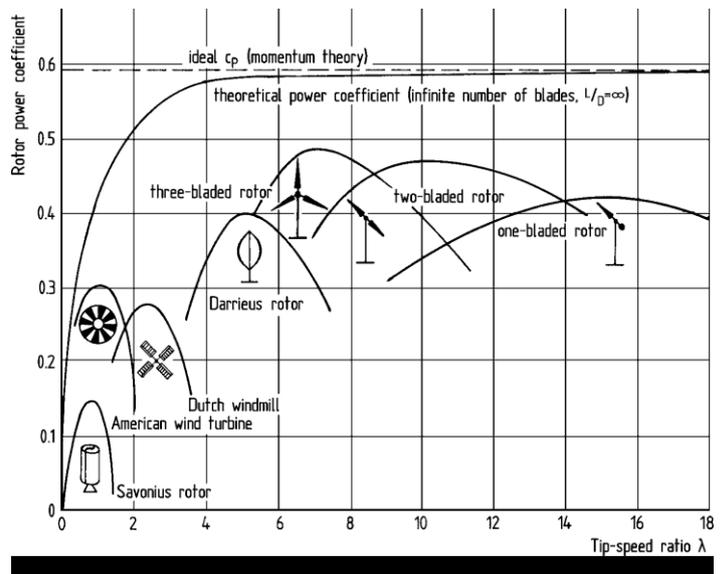


Fig.2.3 Rotor Power Coefficient Vs Tip Speed Ratio

The coefficient of performance depends on wind speed, rotational speed of the turbine and blade parameters such as pitch angle and angle of attack. The pitch angle for a HAWT is the angle between the blades motion and the chord line of the blade, where as for a VAWT the pitch angle is between the line perpendicular to the blades motion and the chord line of the blade. The angle of attack is the angle between the relative wind velocity and the centerline of the blade. For fixed pitch turbines, these angles do not change and the C_p is directly related to the Tip Speed Ratio. See graph 1 for typical C_p values for various types of wind turbines.

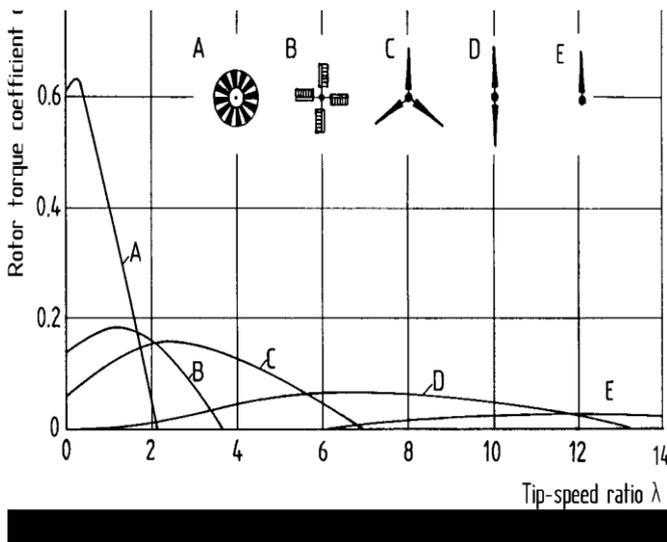


Fig.2.4 Rotor Power Coefficient Vs Tip Speed Ratio

4. BASIC AERODYNAMICS

The 3-D turbine can be modeled as a 2-D cross section, as shown below

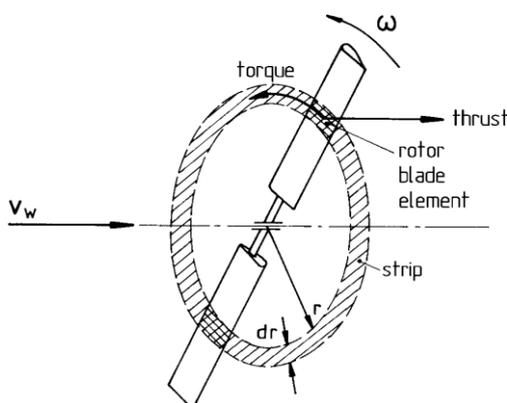
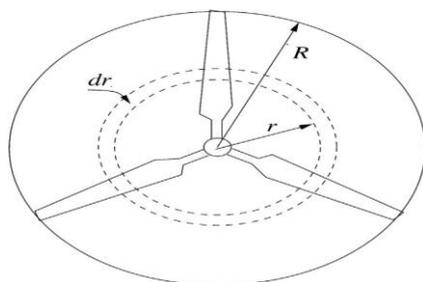


Fig.3.1 HAWT model.

The forces felt by each blade of turbine depend on wind speed, rotational speed, and the angle of attack (angle between oncoming wind and the chord line). A positive angle attack is when the nose of the airfoil points upwards with

respect to the oncoming wind. To calculate torque, angle of attack α was determined for each point in the cycle.

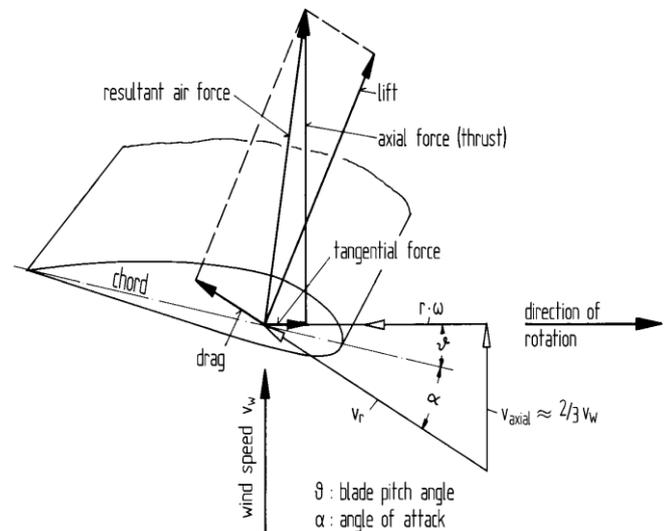


Fig.3.2 Air foils Force acting

- The equation for angle of attack is given as:

$$\alpha = \tan^{-1} \{ V_w \cos \theta \div V_w \sin \theta + V_t \} \quad (6)$$

Where,

V_w is the wind speed.

V_t tangential speed of the airfoils.

θ position of the airfoil in the rotation cycle.

- The tip speed ratio (TSR) is defined as:

$$\lambda = \text{TSR} = V_w / V_t$$

V_w =tangential speed of wind turbine blade tips.

V_w = wind speed or Wind velocity rated

The torque is dependent on the lift and drag coefficients. Plots of lift and drag coefficients verses angle of attack are shown below. These were calculated using the Design Foil software with a Reynolds number of 230,000 (the average Reynolds number expected with a TSR of 6 at higher angles of attack, it is apparent that drag increases significantly and lift drops off. High angles of attack also cause separation further up along the airfoil, increasing drag. At very high angles of attack, this drag takes over. It is thus important to maintain lower angles of attack throughout the rotation cycle to improve efficiency.

- Forces

The forces on the airfoil can be calculated using Figure below. It is difficult to do simple analysis of the airfoils due to the large variation in airspeeds and angles of attack that the airfoils encounter as they move around the cycle. The airfoils are traveling with the chord line perpendicular to the turbine radius (they are not pitched). The rotational force from lift and drag for each blade is thus:

$$F \text{ motion} = \{L \sin \alpha - D \cos \alpha \}$$

(7)

Where

L is the lift,

D is the drag,

α is the angle of attack.

- The power produced by the turbine from each blade is

$$P = \{L \sin \alpha - D \cos \alpha \} * V \tag{8}$$

Where

V is the speed of the turbine blades.

- Available Power

The power available in the wind is proportional to the cube of the wind speed and the area of the turbine,

$$A = D h A_s \tag{9}$$

Where

D and h are the diameter and height, respectively.

- The total power available is given as

$$P = 0.5 \cdot 0A V^3 \rho \tag{10}$$

Where

ρ is the density of the air ,

V_w is the undisturbed

This is the power that would be produced if 100% of the wind energy were harnessed. However, this would require making the wind velocity go to zero, which is not possible. On the other extreme, if the turbine did not slow the wind down at all, the turbine would not capture any energy. Between these two extremes lies a velocity change that yields the maximum amount of power. The physicist Albert Betz proved that the maximum amount of power that can be captured is 59% of the power in the wind.

5. AIRFOILS GEOMETRY

The first step in designing a Darrieus turbine is to choose the optimal number of blades. Blades in rotational motion leave turbulent flow in their paths. As the number of blades is increased, airfoils run into more turbulent flow and work less efficiently. However, a turbine with fewer blades has more wind passing through the turbine that does not contribute to power. An even number of blades is more likely to cause vibration problems. For these reasons, a three bladed design will yield the flattest power coefficient curve over 360 degrees of rotation. For these reasons, the three-bladed design was chosen. The blades will be symmetrical airfoils type NACA 0018-63. This airfoil profile was found to have the most optimal performance for use with Darrieus wind turbines [Source: Migliore]. The NACA 6-series airfoils are designed to increase the amount of laminar flow and reduce drag. A profile of the airfoil chosen is shown in the figure below. The tip speed ratio is an important design

aspect. Most Darrieus wind turbines are designed to have a TSR between 4 and 6. Power curves show that optimal TSRs for a Darrieus design with wind speeds of 6 m/s are between 4 and 8, depending on solidity (see Appendix). Lower TSRs have been shown to reduce noise generation, an important issue in urban settings. With this as a consideration, a TSR of 6 was chosen. TSR varies with wind speed. To achieve a TSR of 4.0 at a wind speed of 6 m/s with the 63-018 airfoil, the solidity (ratio of total blade area to total frontal area) should be 0.20 as shown in Figure.

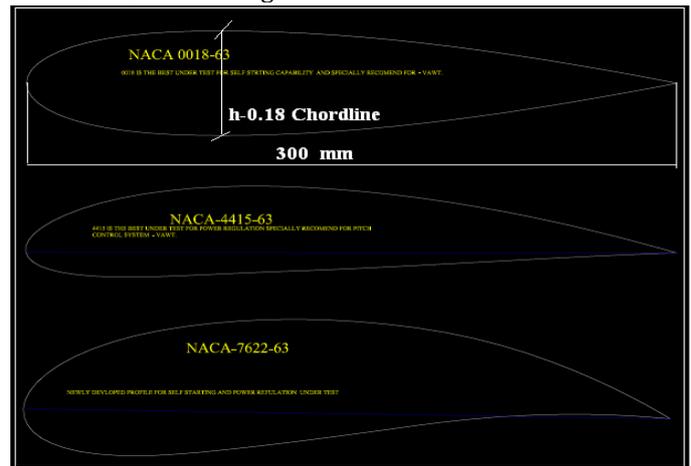


Fig. 3.3 Blade profile studied in design foil.

6. AEROFOIL PERFORMANCE:-

The performance of aerofoil is depend on various factors . we are using Design -foil software to analyses the performance of the of the various blade profile in virtual wind tunnel. This software gives the freedom to make the profile as per our choice and find out the result at the various wind conditions and other parametric changes. This software provides the graphs and co-ordinate points in excel format to analyze the data as per requirement.

Table No.4.1 Input needed for design foil software for aerofoil analysis.

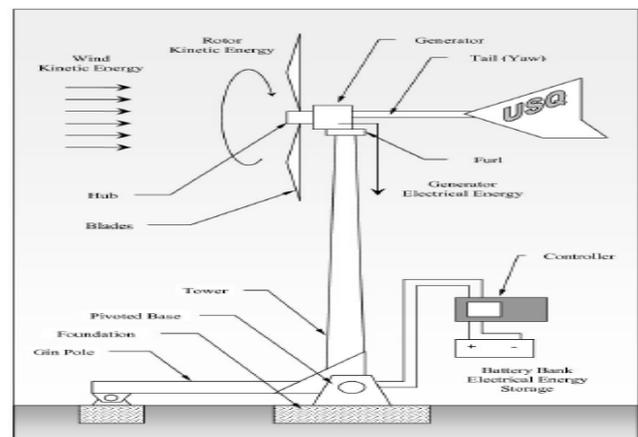


Fig 3.4 Expected conceptual model before manufacturing.

7. CONCEPTUAL MODELING

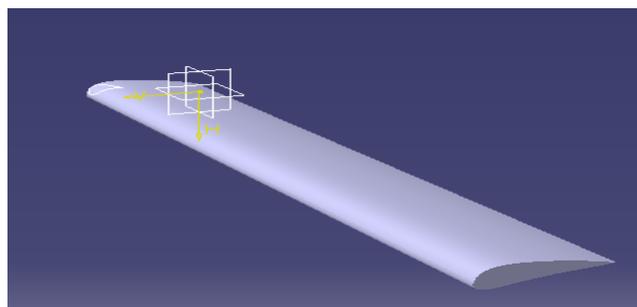
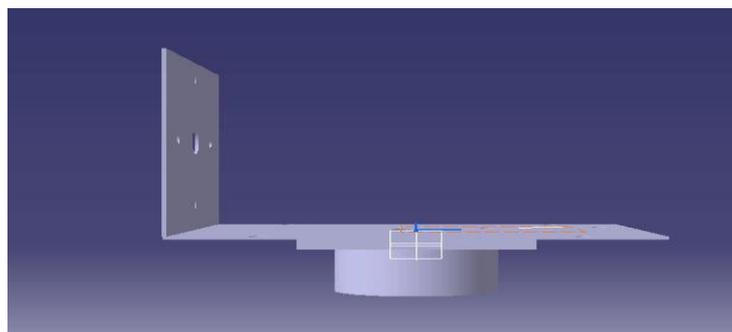
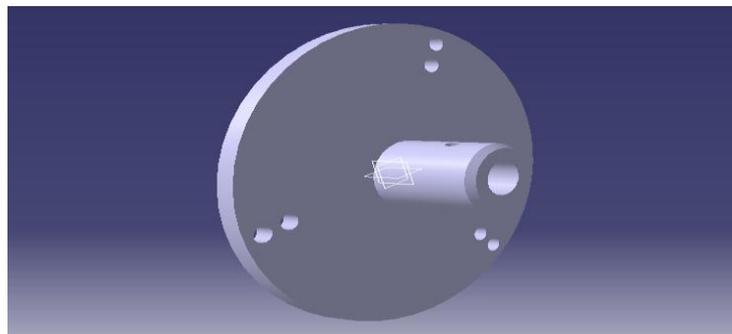


Fig.4.1 CAD Model

8. Calculations:

Wind turbine is the device which extracts energy from blowing wind. Horizontal axis wind turbine are lift base machine. The air velocity and density strongly affect the wind turbine energy generation. We are interested to design a small turbine producing 50 watts power and highly economical cost. The as per market survey we have Generator specification 28 volt, 500 w, 3 phase A.C.

Now as per generation available we will design wind turbine which suites generator to produce optimum power.

- P= power generated by turbine in watts.
- ρ =fluid density wind =1.22 kg/m³
- A=swept area of wind turbine =m²
- v= rated wind speed =m\s
- Cp= coefficient of performance =0.54 [standard]

η_{ov} = over all efficiency of drive train & electrical generator =0.90

$$P = \frac{1}{2} \rho A V^3 C_p \eta_{ov}$$

$$50 = \frac{1}{2} \times 1.225 \times A [7^3] 0.54 \times 0.9$$

$$50 = 102.10 \times A$$

$$A = 0.489 \text{ m}^2$$

Now,

$$A = \frac{\pi}{4} d^2$$

$$0.489 = \frac{\pi}{4} d^2$$

$$d^2 = 0.622$$

$$d = 0.789 \text{ m}$$

Now, radius of rotor= $d/2 = 0.394 \text{ m} = 394 \text{ mm}$.

Now, rotor radius is nothing but blade length i.e. 394 mm. Rotor radius is only the Blade length.

Now wind Turbine rotor Diameter = $1.25 \times d = 0.986 \text{ m}$

$$D = 986 \text{ mm}.$$

The 1.25 is correction factor, which helps to compensate loss in area of wind turbine blade due to change in chord length; along the length.

As well as it provide excess area to blade and hub assembly with main shaft.

Theoretical torque of Generator-

Specification:

Voltage = 28v

Current in amp = 2 Amp. (1.7 Amp. rated)

Power = 50 watls.

Phase = 3 Phase

Insulation = F

Type = Radial

Rpm = 500 rpm

$$P = \frac{2\pi N \tau}{60}$$

$$50 = \frac{2\pi \times 500 \times \tau}{60}$$

$$T = 0.954 \text{ Nm}$$

This is the theoretical torques of generator we need that to produce more torque from wind blade.

Now from reference no 1, if tip speed ratio selected 4.5

$$\lambda = \omega r / v$$

Where ω = angular speed of rotor,

r = Blade length

v = rated velocity we can use 6 blade m/c

Now, $\omega = 2\pi N/60$ rad/sec

Now generator rpm = 500 rpm

i.e 8.3 revolutions per second

Now $\omega = 2\pi \times$ frequency

$$= 2\pi \times 8.3$$

$\omega = 50.38$ revolutions per second

Now velocity of rotor tip $v = \omega r$

$$v = 50.38 \times 0.394$$

$$= 19.64 \text{ m/s}$$

Now, $\lambda = \omega r / v = v / V = 19.64 / 7 = 2.8$

Now no of blades are

$$\lambda = 4 \pi / n$$

$$2.8 = 4 \pi / n$$

$$n = 4.41$$

i.e minimum 4 blades required to drive this machine & produce optimum power.

From reference number , we can use 6 balde machine which gives equation power at desired wind and speed.

Now 6 blades are arranged at 360°equally 60°angle.

From reference No.2 α = Angle of attack is optimum 5 to 15°. So we will select 7 ° at initial level.

Now, Torque generated by turbine blade.

$$d = 0.98 \text{m}$$

$$A = \pi / 4 d^2 = 0.75 \text{ m}^2$$

$$\text{Torque of blade } T_B = 1/2 \rho A.V.^2 C_t$$

$$C_t = \text{torque coefficient} = c_p / \lambda = 0.54 / 2.8 = 0.192$$

Now,

$$T_B = 1/2 \times 1.225 \times 0.75 \times 7^2 \times 0.192$$

$$T_B = 4.3 \text{ Nm}$$

Per Blade torque is 0.72 Nm.

This value is much more then desired torque.

Equation of generator

Starting torque = T_1 or T_{start}

$$T_{st.} = 1/2 \times \rho A.V^2 \times C_t$$

Now consider v_1 is start in per cut in wind velocity cm/s.

ie. 3.5 m/s.

So $T_{st} > T_{gen}$

$$T_{st} = 1.06 \text{ Nm} > T_{gen} [0.954]$$

So we claim that Turbine will start at 3.5 m/s wind velocity.

Now, final blade dimensions are - Final Rotor Specifications.

No. of elements- 20

Rotor Radius -0.986 m

Hub Chord length - 0.146 m

Tip Chord length-0.034 m

RPM -500 rpm (480)

Angular Speed --50.2 rad / sec

Rotor total swept area - 0.763 m²

C_p -0.54 Benz/ 0.313 Actual

No. of Blade =6 Nos

Now Design of Blade by Blude Elements Method

Now, from reference, we select aerofoil NACA 4412.

From lift and drag characteristic data, we select NACA 4412.

- 1) Manufacturing Feasibility
- 2) Available wind data - aerodynamic performance
- 3) Cost of production

Now from aerodynamic data of NACA 4412

From data $C_L = 1.02$ and 1.12 & drag $C_d = 0.06$

Now,

Radius of Blade = length of Blade

$$= 394 \text{ mm} \cong 395 \text{ mm}$$

Angle of attack= selection from Graph

Relative Angle (ϕ)=

Rotor Solidity = δ

Axial induction factor = a

Radial Induction factor = a'

Now, from reference: - wind Turbine design - Soren Gundtoft

$P(r)$ = Angle of Relative wind to rotor axis

$\phi(r)$ = Angle of Relative wind to rotor plane

$\beta(r)$ = Pitch angle of blade

$\alpha(r)$ = Angle of attack of Blade

Now divide Total length of Blade in 10 small elements.

i.e. we get 20 numbers of distance,

$$\text{Chord length max} = C_{\text{max}} = 16\pi / (9 N \lambda \sqrt{4/9 + [\lambda_r + 21(9 \lambda_r)]^2})$$

Where,

λ = Tip speed ratio at Tip.

λ_r = Local radius tip speed ratio.

We got, max chord = 146 mm

Min chord = 37 \cong 40 mm

Now see, the Graph shows, variation or increase in Chord length with respect to radius of Blade i.e.

*This graph specifies the design is quite optimum and chord is varying quite smoothly along the length. This indicates the facing more smooth load because of uniform area available and no abrupt change in profile shows easiness in manufacturing.

It's close to linear increment as shown in graph.

Now from Excel sheet we got,

Angle of relative wind to rotor plane.

i.e. ϕ = relative wind Angle =

$$\tan^{-1} \frac{2}{3 \lambda_r} \dots\dots\dots(1)$$

λ_r = local radial tip speed ratio.

Now, Angle of pitching is given by β

$$\beta = 90 - \frac{2}{3} \left\{ \tan^{-1} \frac{1}{\lambda_r} \dots\dots\dots(2) \right\}$$

From equation (1) and (2) we get axial induction factor and radial induction factor.

But our wind turbine is not having auto pitching i.e This is fix blade Turbine, due to that the effect if axial induction factor i.e. [a] and Radial Induction factor i.e [a'] is negligible.

Now,

$$\text{Rotor Solidity} = \delta = \frac{B \times C}{2\pi r}$$

$$= \frac{6 \times 0.146}{2 \times \pi \times 0.394}$$

$$= 0.353 \times 100$$

$$\delta = 35.3\%$$

Now from solidity we get, amount of area or portion actually facing wind force. Solidity increase with No. of Blade i.e. 6, 10, 20

For,

$\delta=0.53 = 58\%$ at 10 numbers of blade

$\delta = 0.98 = 98\%$ at 20 numbers of blades

Blade solidity indirectly proportional to η of m/c.

Now

Lift force by blade at various chord lengths.

$$F_L = \frac{1}{2} \rho \cdot V^2 \cdot C_m \times C_L$$

$$F_D = \frac{1}{2} \rho \cdot V^2 \cdot C \times C_D$$

Reference- Theory of wings sections- IzaH, Abbott and A.E. Deenthes.

Now from Graph, we get lift force at each element of varying chord. Now see the Graph. It F_L verses Radius.

Now, C_L an C_d from - data sheet .(Attached.)

$$F_L = \frac{1}{2} 1.22 \cdot 7^2 \times 0.146 \times 1.12 = 5.007 \text{ N}$$

$$F_D = \frac{1}{2} 1.22 \times 7^2 \times 0.146 \times 0.06 = 0.262 \text{ N}$$

$F_L = 5.007 \text{ N}$

$$F_D = 0.262 \text{ N}$$

$\eta \Rightarrow$ Efficiency of turbine.

Now Rotor overall efficiency = Wake efficiency x profile efficiency x tip efficiency

Where
$$\eta_{\text{ove}} = \eta_{\text{wake}} \times \eta_{\text{profile}} \times \eta_{\text{tip}}$$

Now η_{wake} is directly related to wake loss on the basis of Schmitz Theory.

$$\eta_{\text{Wake}} = \frac{C_{p.\text{act}}}{C_{p.\text{Benz}}}$$

$\eta_{\text{tip loss}}$ = this is the η of rotor blade shape (aerodynamic).

In Operation three will be high negative press compared to lower size of blade.

This pressure diff occur due to blade aerofoil profile cut the wind slab and generate low and high pressure region when wind travels more distance compared to lower region.

And this kind of system is lift base by

$$\eta_{\text{tip}} = \left[1 - \frac{0.92}{B \sqrt{X^2 + 4/9}} \right]^2$$

$$X = \lambda$$

η_{prof} = This include profile limitations which are depend on theoretical & practical output of profile.

It also depends up on manufacturing limitations to following perfect co- ordinates of system.

$$\eta_{\text{profile}} = 1 - \frac{X}{GR} \text{ or } 1 - \frac{3rX}{2RGR}$$

$$= 1 - \frac{C_D}{C_L} \times \tan(r)$$

Now, Performance of Rotor =

$$\eta_{\text{wake}} = \frac{C_{Pact}}{C_{PBenz}}$$

$$C_{Pact} = \frac{8P}{\pi \rho d^2 v^3} = 0.313$$

$$\eta_{\text{wake}} = \frac{C_{pact}}{0.54} = 0.58$$

$$\eta_{tip} = \left[1 - \frac{0.92}{B \sqrt{X^2 + 4/9}} \right]^2$$

$$\eta_{tip} = 0.86$$

$$\eta_{profile} = 1 - \frac{C_D}{C_I} \tan v = 0.873$$

$$\eta_{love} = \eta_{Wake} \times \eta_{profile} \times \eta_{tip}$$

$$= 0.371 = 37 \% \text{ of turbine.}$$

So overall efficiency of wind turbine is 37 %.

9. RESULT

WI ND SPE ED	PO WE R o/p	THEORA TICAL POWER	BETZ'S LIMIT	GEN EFFICI NCY	EFFICINCY
3	5	292.9996 8	172.869 8112	138.29 58	3.615438
4	50	694.5177 6	409.765 4784	327.81 24	15.25263
5	135	1356.48	800.323 2	640.25 86	21.08523
6	235	2343.997 44	1382.95 849	1106.3 67	21.2407
7	279	3722.181 12	2196.08 6861	1756.8 69	15.88052
8	325	5556.142 08	3278.12 3827	2622.4 99	12.39276
9	367	7910.991 36	4667.48 4902	3733.9 88	9.828634

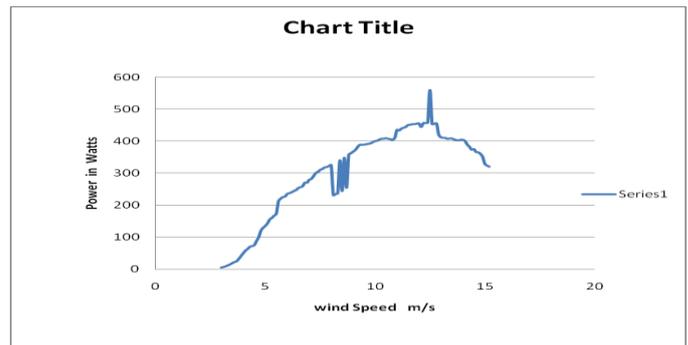


Fig.5.1 Power Vs Wind Speed

As per the result shows in the graph, we analyses various important entities from it. From the simple observation we analyses the wind speed directly proportional to power output of wind turbine and this is up to the designed rated speed limit. After the rated speed this power curve is getting decrimental due to the internal losses in the wind turbine generator also losses in electronic control and conversion unit due to excess voltage.

Also we observed from the readings in table the wind speed is continuously changing due to that the desire power output will always varies. This will not complete the target power output in given time. We observed, if the variation in the wind is 1 %, the power will vary by 3% rate. This is due to the velocity cube is directly proportional to power. From the results, we understand the wind energy power output is strongly dependent and not consistent throughout the day, due to exact power produced by turbine per day at actual is very difficult to calculate. Here our objective of the project is well satisfied, as turbine producing adequate power at available wind speed, this power is quite less then theoretical power output because of losses.

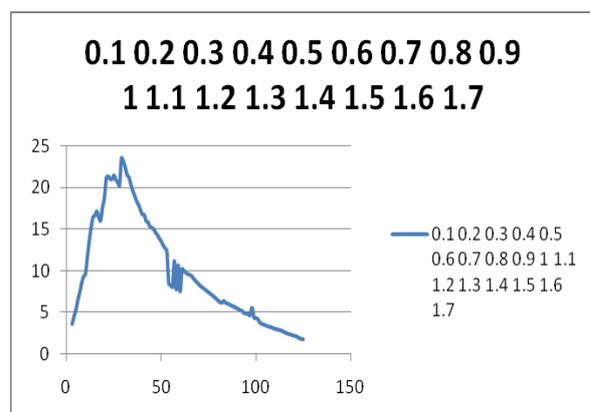


Fig 5.2 Wind Speed Vs Power

10. Conclusions

The structure in which the project was based firstly aimed to study of traditional and modern machines, permitting a selection of models for fabrication. The results of prototypes fabrication were satisfactory about the fidelity to the drafts and to material used, especially about weight and finishing. Tests in wind turbine at field permit to obtain information of the model prototype, such as power output, torque as function of TSR. With this information, tests with high solidity models, to which were presented the main results obtained in laboratory were emphasized. In function of the qualities techniques, permanent magnet generators were used, due to the high energetic concentration of the magnets, the brushes absence and the largest number of magnets that can be placed. The necessity of a study on the electric generators area ended up creating the PRO-GIP program, used in the project of permanent magnets generators. The result is satisfactory and it observed that output is strongly depending on whether conditions. Wind flow is varies rapidly due to continuous variation in output observed.

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