



Optimization of Power Output in Horizontal Axis Wind Turbine

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Abstract: This study is aim to prepare working model of horizontal axis wind turbine (HAWT) for household usage, the power output and performance measurement is carried out & range of velocity for which it can be used is concluded.

Key words: Airfoil, up & down wind

I. INTRODUCTION

An ever increasing energy crisis occurring in the world it will be important to investigate alternative methods of generating power in ways different than, fossil fuels. Generally two tyoes of wind turbines are used, HAWT and VAWT (vertical axis wind turbine). But in VAWT there is self starting problem.

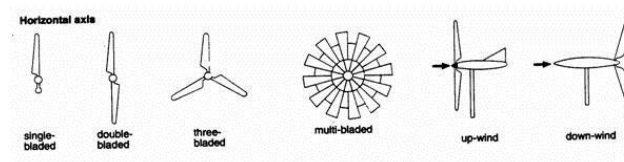


Fig 1 (a): Types of HAWT



Fig 1(b): Types of HAWT

The wind turbine which face wind stream from front side are called up wind turbines. The wind turbine which receives wind stream from the rear side are called down wind turbine.

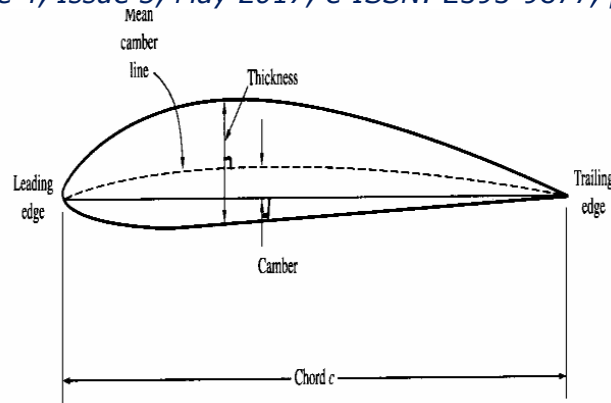


Fig. 2 Airfoil Nomenclature

NACA – National Advisory Committee for Aeronautics

- Four digit series

- first number is camber in percentage of chord
- second number is location of maximum camber in tenths of chord measured from LE
- last two digits give maximum thickness in percentage of chord

Forces acting on wind turbine

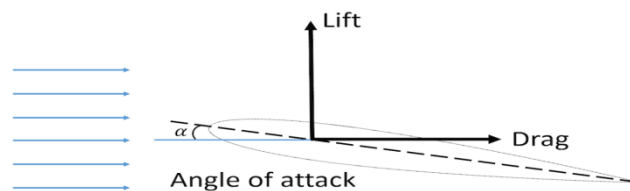


Fig. 3 Forces of wind turbine

Lift is the force that acts at a right angle to the direction of motion through the air. **Lift** is created by differences in air pressure. Thrust is the force that propels a flying machine in the direction of motion. Engines produce thrust.

Drag is the force that acts opposite to the direction of motion.

2. LITERATURE REVIEW

Prof. Ankit P. Ahuja [1] Based on the CFD analysis of the flow over NACA 0012 air foil we can conclude that at the 0 degree of AOA there is no lift force generated and if we want to increase amount of lift force and value of lift coefficient then we have to enlarge the value of AOA. By doing that obviously amount of drag force and value of drag coefficient also increased but the amount of increment in drag force and drag coefficient is quite lower compare to lift force.

Dr. S Srinivasa Prasad [2] from this paper I can say that Fluid-structure interaction plays prominent roles in many ways in the engineering fields. The stresses induced corresponding to the flow has been successfully computed using the ANSYS Workbench.

This project provides the complete exposure to the FSI problem and gives the complete study of fluid on structure and vice-versa.

R. T. Griffiths [3] A blade element method is used to establish the design and performance of horizontal axis wind turbines with streamlined centre bodies. It is applied to a rotor having centre bodies of various sizes and, for a typical centre body shape, it is shown that there is virtually no decrease in power output for hub diameters up to 20% of the rotor diameter. The omission of the centre body effects from the design procedure has very little effect on the performance

3. MODELING

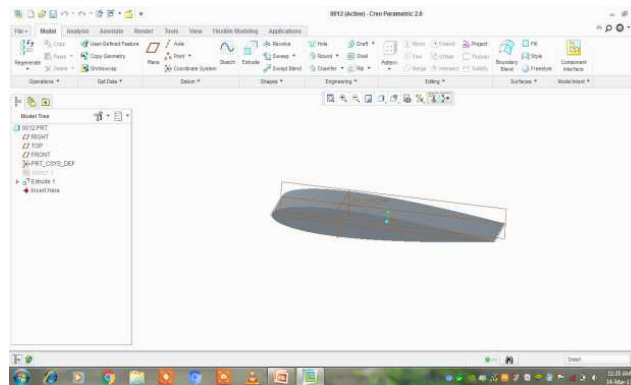


Fig. 4 NACA 0012 Blade Profile

Steps to Draw Blade Part in Creo

- 1) Select coordinate for various blade profile from UIUC airfoil data base site
- 2) Open Creo parametric software
- 3) Select plane and draw the line by sketch
- 4) By using spline curve draw the two spline curve on above & below the line which have starting and ending points are nodes of line
- 5) Apply top coordinate on upper spline and bottom coordinate on lower spline
- 6) Generate the curve and extrude it.

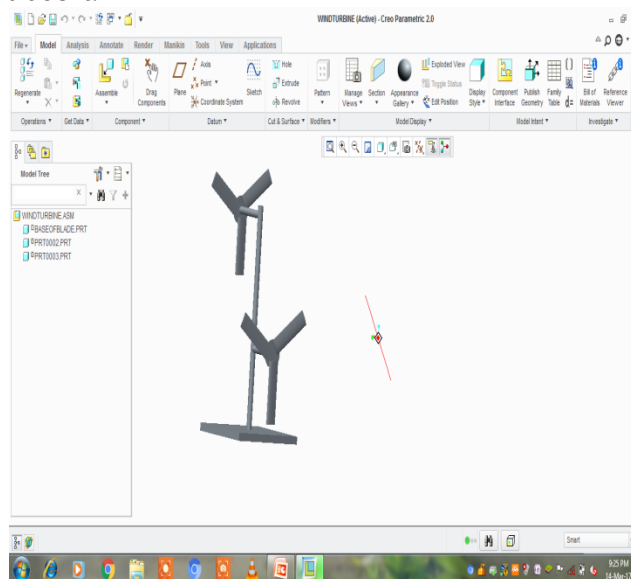


Fig. 5 Creo Assembly



Fig. 6 Working Model with up & down wind



Fig. 7 Dynamo attached with shaft

4. EXPERIMENT

How to measure power output in HAWT

1) Practical Method : After making working model we can measure power output with help of multi-meter. Which gives us data of produced voltage and current of our working model.

2) Analytical Method :

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

Where, P = Power

ρ = Density of Air

A = C/S area

Cp= Coefficient of performance

V= Velocity

Experimental Procedure:

1. Wind turbine is started and wind velocity is measured anemometer.
2. Measured RPM of both upwind and downwind turbine with tachometer
3. Measured the voltage and current of both wind mill with multimeter

Table 1. Reading at ground level

GROUND LEVEL				
Position	Voltage	Current	RPM	Velocity
Upwind	4 v	0.23 mA	103	4 m/s
DownWind	2.10 V	0.19 mA	81	

Table 2. Reading at ground level

HEIGHT LEVEL(25 feet)				
Position	Voltage	Current	RPM	Velocity
Upwind	16.75 V	12.5 mA	300	9.5 m/s
DownWind	12 V	8.9 mA	265	

5. CONCLUSION

If we attache combined upwind and downwind HAWT in same structure then we can get more power output than individual upwind or individual downwind. Only upwind can produce 16.75 V and only downwind can produce 12 V but if we combined than 28.75 V we can produce. So in combined arrangement we can produce 12 V more than upwind and 16.75 V more than down wind turbine.

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