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Experimental analysis and optimization of wind turbine for domestic application

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ABSTRACT

The conventional sources of energy are fast depleting and are causing very serious problem to the environment, for example combustion of fuels causes atmospheric pollution which is not suitable for human beings as well as other species living in the environment. The other major drawback of conventional sources is their high cost. The processes by which the conventional sources are extracted are also expensive. So there is a need to search for alternate source of energy and to extract them to meet our needs. An attempt is made to extract alternate source of energy that is wind. Wind energy is used to rotate the blade which helps the dc motor to produce dc current. By installing small wind turbine in the village and city which is situated in western ghat of Tamandu and Maharashtra, the state of Gujarat and Karnataka we can easily produce electricity due to its geographical location. This small wind turbine is able to generate the enough power for a household application in remote area. This will help the nation to overcome with the power crises problem specially in summer season

***Keywords**: Turbine, Wind Energy, Harvesting, Generating Power*

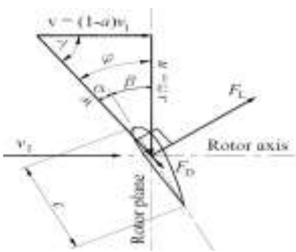
1. INTRODUCTION

The energy sources that are naturally available should be made useful in a drastic way and their energy that are naturally available should be converted in one way or the other so it can be used by the common man for his daily purposes. The advancement in technology has led a great development for harnessing energy from wind using wind turbine. The wind flow varies continuously as it is a not a constant source of energy. The wind turbine can be used tois one extract the energy from natural source.

2. DESIGN OF WIND TURBINE

The design parameters must be specific. These are:

- The number of blades
- Blade design,
- Velocity of wind,
- Lift and drag coefficient,
- Density(ρ) of the medium, (air: 1.22kg/m^3, water: 1000kg/m^3),



Overview of Aerodynamic

Shape of blade

Fabrication of Frame

The frame was fabricated with the combination of galvanized iron and mild steel using arc welding.

Methods of Fabrication

- The fabrication was done with the help of arc welding, gas welding and soldering.
- The arc welding is done to joint tail on wooden plank to maintain the air direction.
- The DC motor was attached to the wooden plank with the help of nut, bolt and washer.

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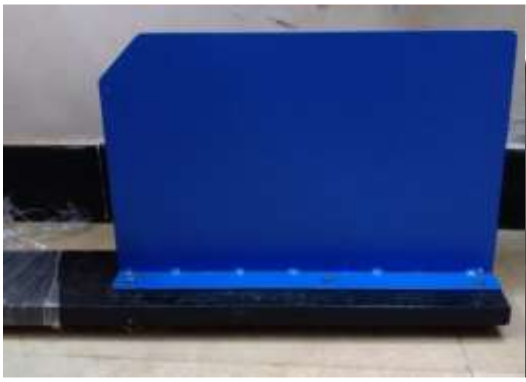
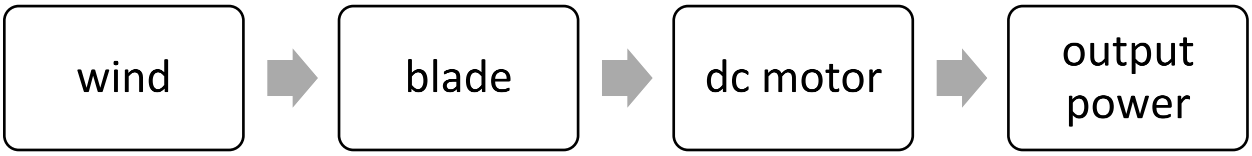
Fabrication of stiffener on stand

Assembly of dc motor on wooden plank



Wind turbine tail

Final assembly



3. BLOCK DIAGRAM FOR HARNESSING WIND TURBINE

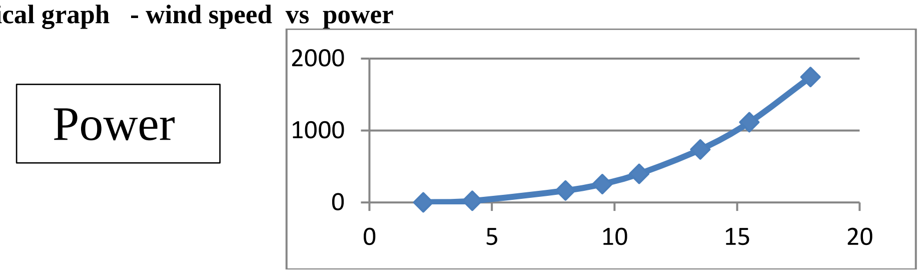
Theoretical power vs wind speed

S.NO	WIND SPEED (m/s)	POWER (W)
1	2.2	3.18
2	4.2	22.16
3	8	164.91
4	9.5	256.43
5	11	398.08
6	13.5	735.86
7	15.5	1113.75
8	18	1744.26
	Turbine power output $P_T = ½*\rho*A*V^3*Cp$ [7] Where, P =extracted power from wind, ρ =air density, A = area swept by blade (in m^2),	POWER CALCULATION P = ½*ρ*A*v3*Cp [7] Where, ρ = density of air (1.285kg/m^3) A = swept area (m^2)

	V = wind velocity(m/s), C_P= the power coefficient which is function of both tip speed ratio(λ), and blade angle(β)	

Theoretical power vs wind speed

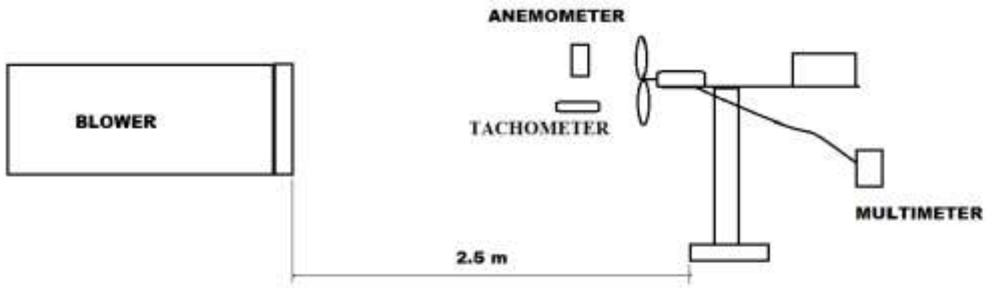
Theoretical graph - wind speed vs power



Wind speed (m/S)
X axis –Velocity of wind (m/s)
Y axis –Power (watts)

4. TESTING

After complete assembly of model, it fixed on a stand to carry out various test and analysis was done with the help of graph. The blade was made to rotate at different speeds with the help of blower and corresponding different values of RPM, voltage and current are tabulated as shown below for both load and without load condition. Based on these values various graph was plotted. The RPM of the blade was measured with the help of laser tachometer. The voltage and current were measured with the help of digital multimeter. From these values output power was calculated. The other parameter such as total power was calculated.



Test setup

The wind turbine blade was fixed on the rotor. The turbine was placed in front of the blower. The distance between the wind turbine and the blower was 2.5 m. the anemometer was placed near wind turbine measures the wind speed. The tachometer was placed in front of the turbine. A white was placed on the rotor. The laser tachometer senses this paper and give the speed of the blade in RPM. A multimeter and a 12 w bulb as a load was placed to find the corresponding voltage and current. The blower can be controlled by knob. It can blow up to 36 m/s.

For open circuit (Reading)

Table 6: Measurement at open circuit condition

S/No	Air speed (m/s)	RPM	TEMPERATURE (◦C)	VOLTAGE (V)
1.	2.2	66	27.9	1.2
2.	4.2	138	27.9	3
3.	8	234	27.8	5.2
4.	9.5	300	27.7	6.5
5.	11	330	27.5	7
6.	13.5	410	27.5	8.9
7.	15.5	456	27.3	10
8.	18	526	27.2	11.5

For (close circuit) Load (at 12V Bulb)

S/No	Air speed (m/s)	RPM	TEMPERA-TURE (◦C	VOLTAGE (V)	CURRENT (A)	POWER (W) P = V * I Where V=voltage (v) I = current (I)	EFFICIENCY
1.	2.2	-	27.9	-	-		
2.	4.2	60	27.9	1.1	0.3	0.33	0.825
3.	8	100	27.8	2.6	0.5	1.3	3.25

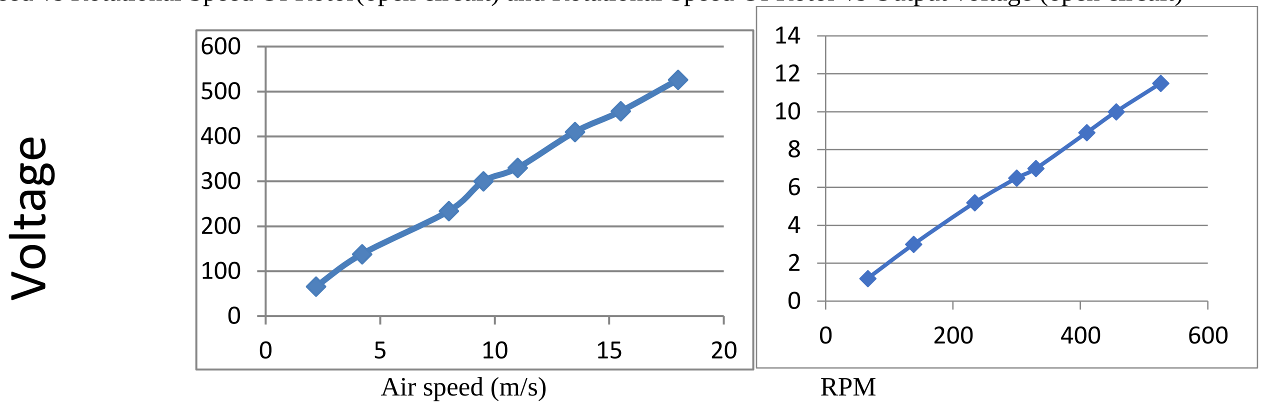
4.	9.5	170	27.7	3.5	0.8	2.8	7.0
5.	11	200	27.5	4.1	1.0	4.1	10.25
6.	13.5	260	27.5	5.0	1.1	5.1	12.75
7.	15.5	300	27.3	6.1	1.5	9.15	22.87
8.	18	320	27.2	6.2	1.9	11.78	29.45

Measurement at close circuit condition

5. RESULT AND DISCUSSION

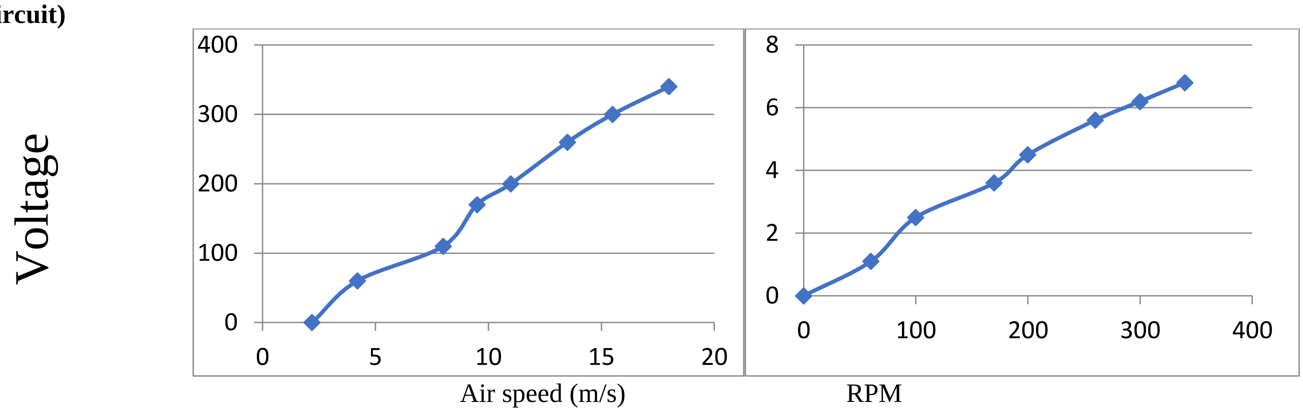
PERFORMANCE: As obtained from tabulated values, various graphs were plotted to conclude the relation between various parameters. The graph helps to find the value of particular parameter, knowing the value of other parameter of the graph.

Air speed vs Rotational Speed Of Rotor(open circuit) and Rotational Speed Of Rotor vs Output voltage (open circuit)



The above fig shows the graph of air speed vs rotational speed of rotor. As the air speed increased the rpm of rotor increases. The rotor shows a considerable rotation for air speed of 2.2 km/hr. Above fig shows the Graph of Rotational Speed Of Rotor vs Output voltage. As the rotor speed increases voltage increases. When the rotor speed is maximum output voltage is maximum.

Wind speed vs Rotational speed of rotor (closed circuit) and Graph of Rotational Speed Of Rotor vs Output voltage (close circuit)



Above fig shows the graph of wind speed vs rotational speed of rotor for closed circuit.As we apply load rpm of rotor for close circuit decreases as compared to rpm of rotor for open circuit since the currents starts following.

Above fig shows the graph of voltage produced vs rotational speed of rotor. As the rotational speed of rotor increases, voltage produced increases. For close circuit voltage produced is less compared to open circuit. As in close circuit load is applied which decreases the rpm of rotor and hence output voltage decreases.

6. CONCLUSION

The model is very portable and can be used for various applications to extract wind energy. Various tests were carried out using this model at various speed of the wind and it was observed that wind turbine blade start rotating at certain speed of the wind and thereby gain momentum gradually. As the speed of the wind increases the power generated was increased evidently. Once initial momentum was attained the speed of the propeller blades gradually increased and hence the power generation increased proportionally. The output was satisfactory as far as DC motor and PVC blades are concerned. Maximum power was generated when the turbine attained a speed of about 20 m/s, but it was also observed that a minimum speed of about 2m/s was required for the blades to gain initial momentum. The efficiency of the model can be increased with the use of composite material blades and alternator.

7. SCOPE FOR FUTURE USE

To supply power in homes by installing small wind turbine on terraces. As the wind flows the small wind turbine can be used to generate electricity with the help of dc motor. Now a days a huge demand of renewable sources of energy has arised because of lack of energy sources like petrol diesel and coal. This type of small wind turbine can easily meet these needs at small scale and are best alternative of producing electricity at household level. It can be also used for pumping water for agriculture purpose by connecting the wind turbine to reciprocating pump.

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