International Journal of Early Childhood Special Education (INT-JECSE)
DOI: 10.9756/INT-JECSE/V13I2.211203 ISSN: 1308-5581 Vol 13, Issue 02 2021

# Dual Rotor Vertical Wind Turbine

**[1]Navin [2] M.Naveen Prabu , [3]M.Kumaresan**
[1,2,3]Department of Mechanical Engineering, CMS College of Engineering and Technology,

Coimbatore-641 032, TamilNadu, India.

***Abstract*—**This is a new concept of vertical wind turbine,which was achieved by applying the dual rotor technology. This turbine can perform much better than the horizontal DRWT as wind rotating the blade are independent to each other and has a gear system to increase the rpm of generator. Vertical-axis wind turbine (VWT) have the main rotor shaft arranged vertically. Key advantages of this arrangement are that the turbine does not need to be pointed into the wind to be effective. This is an advantage on sites where the wind direction is highly variable, for example when integrated into buildings. With a vertical axis, the generator and gearbox can be placed near the ground, usinga direct drive from the rotor assembly to the ground-based gearbox, hence improving accessibility for maintenance. When turbine is mounted on a rooftop, the building generally redirects wind over the roof and this can double the wind speed at the turbine.

***Index Terms*—Dual Rotor Technology, Non-Stator Generator**

## *I.* INTRODUCTION

An innovation which can bring back renewable energy as the main source of sustaining a better life. There by neglecting the use of the conventional sources of energy which are generally non-renewable sources of energy, which are being used since along time. These sources of energy are being used extensively in such a way that their known reserves have been depleted to a greatextent.

At the same time, it is becoming increasingly difficult to discover and exploit their new deposits. It is envisaged at known deposits of petroleum in our country will get exhausted within few decades and coal reserves are expected to last only for another hundred years. The coal, petroleum, natural gas andelectricityareconventionalsourcesofenergy.

This project work is about next generation wind genera- tor system that can produce twice as much as power than conventional wind generator. It uses Dual Rotor technology and it consists of two rotors. The stator is also allowed to rotate in the opposite direction and hence it is alsocalled Non-Stator Generator. This technology can be used in making wind generator, hydraulic generators, motors etc. Also new inventionsandinnovationscanbedonebythistechnology.

In this paper Dual Rotor technology is used in wind generator as we can visually see how it works, its economic, efficient, produces no greenhouse gas emissions during the operation and uses little area.

In order to assure proper working of the Dual rotor generator, an extensive study of the blades, reconstruction ofDC Generation and supporting stand was done. These studies consist of simulating the model in Solid works, loads and forces that acts on the small generator was analyzed. Thenwith Cosmos works the Von Mises forces and displacements were calculatedandtheresultswereanalyzedtofindtheoptimalsolution. Further analysis was done using Ansys Workbench in order to verify the results mainly the Stress and deflection of the stand and the bending of the Blades while it isworking.

## UNDERSTANDING COEFFICIENT OF POWER AND BETZLIMIT

The coefficient of power of a wind turbine is ameasurement of how efficiently the wind turbine converts the energy in the wind intoelectricity.

By now you already know how to calculate the amount of electricity a wind turbine is producing, and you also knowhow to calculate the total power available in a given area of wind. To find the coefficient of power at a given wind speed, all you have to do is divide the electricity produced by the totalenergyavailableinthewindatthatspeed.

Wind turbines extract energy by slowing down the wind. For a wind turbine to be 100% efficient it would needto stop 100% of the wind - but then the rotor would have to be a solid disk and it would not turn and no kinetic energy would be converted. On the other extreme, if you had a wind turbine with just one rotor blade, most of the wind passing through the area swept by the turbine blade would miss the blade completely and so the kinetic energy would be kept by thewind.

International Journal of Early Childhood Special Education (INT-JECSE)
DOI: 10.9756/INT-JECSE/V13I2.211203 ISSN: 1308-5581 Vol 13, Issue 02 2021

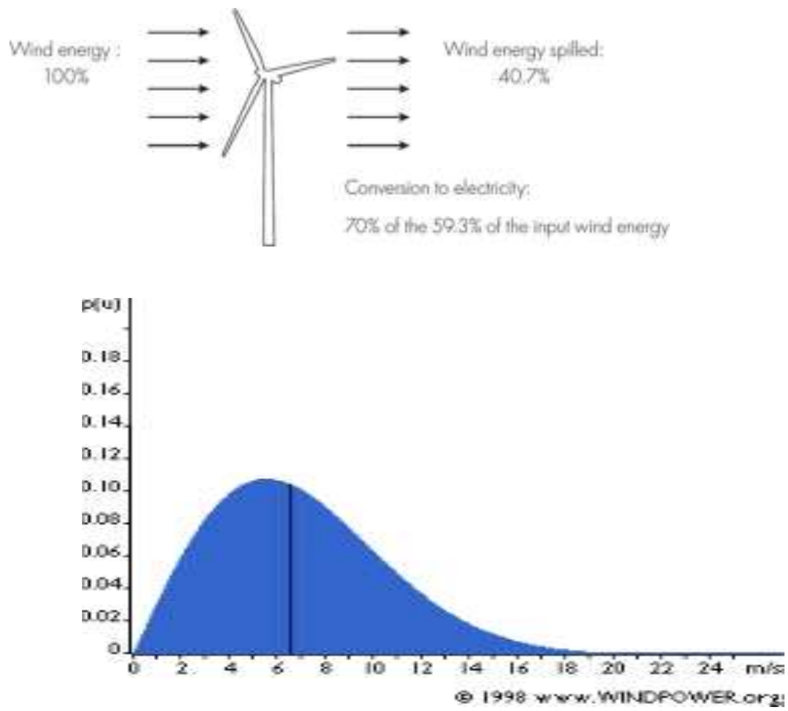
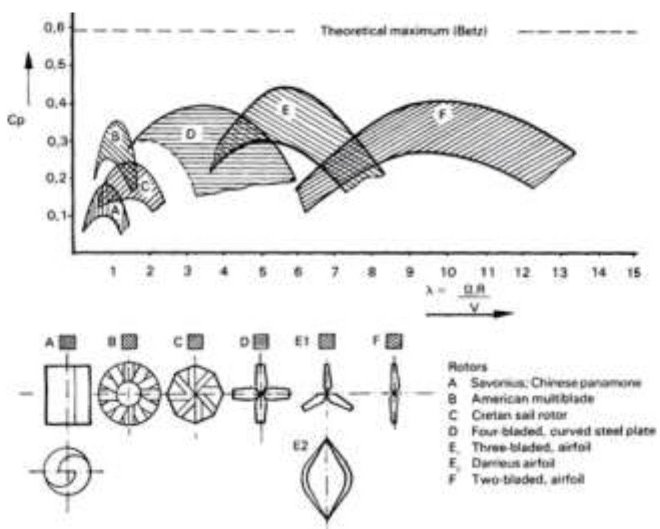



Fig. 1. Betz Limit

### *A. BETZLIMIT*

Albert Betz was a German physicist who calculated that no wind turbine could convert more than 59.3% of the kinetic energyofthewindintomechanicalenergyturningarotor.This is known as the Betz Limit, and is the theoretical maximum coefficientofpowerforanywindturbine.

In the diagram shown above, the wind turbine converts 70% of the Betz Limit into electricity. Therefore, the Cp of this wind turbine would be 0.7 x 0.59 = 0.41. So, this wind turbine converts 41% of the available wind energy into electricity. This is actually a pretty good coefficient of power. Good wind turbinesgenerallyfallinthe35-45%range.



International Journal of Early Childhood Special Education (INT-JECSE)
DOI: 10.9756/INT-JECSE/V13I2.211203 ISSN: 1308-5581 Vol 13, Issue 02 2021

Fig. 2. Cp vs tip speed ratio

Remember that the Tip Speed Ratio of a wind turbine is an essential factor to how efficient that turbine will perform. This graph to the shows the relationship between tip-speed ratio (TSR) and the coefficient of power (Cp).

***B. WINDVARIATIONS***

**Weibull Distribution**

Wind speeds in most of the world can be modelled usingthe Weibull Distribution, figure 3. This statistical tool tells us how often winds of different speeds will be seen at a location with a certain average (mean) wind speed. Knowing this helps us to choose a wind turbine with the optimal cut-in speed (the wind speed at which the turbine starts to generate usable power), and the cut-out speed (the speed at which the turbinehits the limit of its alternator and can no longer put out increased poweroutputwithfurtherincreasesinwindspeed).

Pictured above is an example of the Weibull Distribution of Wind Speeds for a site with an average (mean) wind speed of 7 meters per second. The line at 6,6 meters per second marks the *median* wind speed. 50% of the time the wind is lower than the median and 50% of the time it is stronger than the median. The shape of the Weibull Distribution depends on a parameter called,*Shape*.

The higher the value of *Shape* (from 1 to 3) the higher the medianwindspeed-i.e.locationswithlotsoflowwindspeeds as well as some very strong winds would have a value ofshape of below 2, locations with fairly consistent wind speedsaround themedianwouldhaveashapevalueof3.

***C. SMALLER WIND ENERGYSYSTEMS***

Systems smaller than 1 kW are more typically used instand- alone applications, or as part of a hybrid system with solar PV cells. A 400-watt system can be installed for $960. In the following table.1 there is a resume of the prices for the different systems. Remote systems may require operating batterystorage.Individualbatteriescostfrom96€to192€for
a heavy-duty, 12-volt, 220 amp-hour, deep-cycle type. Larger capacity batteries, those with higheramp-hour ratings, cost more.

Fig. 3. Weibull Distribution

| Type of system | estimated cost (€/KW) | battery (€) | maintenance and service | payback (years) | usefull life (years) |
|---|---|---|---|---|---|
| Grid connected | 3000-5000 | not necessar y | 2%-3% of the inicial cost | 8-16 | 20 |
| off-grid | 4000-5000 | 120-240 | 2%-3% of the inicial cost | 8-16 | 20 |
| smaller wind generator s | 1000-2000 | 120-240 | 2%-3% of the inicial cost | 7-8 | 10 |

Table. 1. Summary Cost Table

A 110-volt, 220 amp-hour battery storage system, which includes a charge controller, costs at least 1280€.

*D.* ***ECONOMIC STUDY AND ENVIRONMENTAL IMPACT FOR A SMALL WIND TURBINES***

Small wind systems involve a significant initial investment, they can be competitive with conventional energy sources when your account for a lifetime of reduced or altogether avoided utility costs, especially considering escalating fuel costs.

The cost of a wind system has two components:

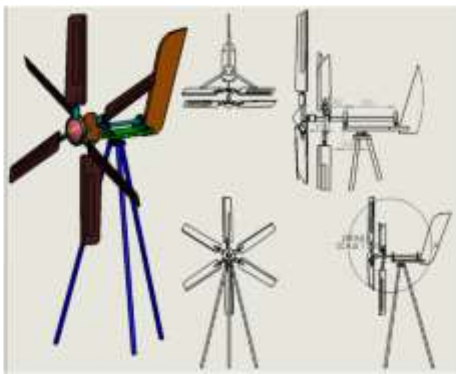
- Initial installation costs
- Operating expenses

Installation costs include the purchase price of the complete system (including tower, wiring, utility interconnection or battery storage equipment, power conditioning unit, etc.) plus delivery and permitting costs, installation charges, professional fees and taxes, also the prices of the installation changes depending of the kind of installation. There are two kinds of installations, grid-connected and off-grid systems.

Economic relevance: The Betz limit places an upper bound on the annual energy that can be extracted at a site. Even if a hypothetical wind blew consistently for a full year, no more than the Betz limit of the energy contained in that year's wind could be extracted. In practice, the annual capacity factor of a wind site varies around 25% to 40% of the energy that could be generated with constant wind.

International Journal of Early Childhood Special Education (INT-JECSE)
DOI: 10.9756/INT-JECSE/V13I2.211203 ISSN: 1308-5581 Vol 13, Issue 02 2021

Essentially increasing system economic efficiency results from increased production per unit Increases in system efficiency which are marginal decreases in cost per kwh are required to bring down the cost of electrical power production. These efficiency increases may or may not be the result of engineering efficiencies that push into the higher levels of the Betz limit. System efficiency increases in power application, transmission or storage may do the same thing at lower cost/unit of power.

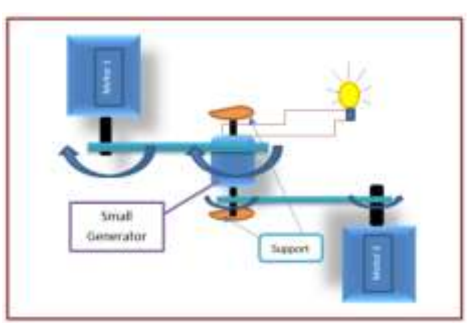


## DESIGN OF DUAL ROTOR VERTICAL WIND TURBINE

### *A. CONCEPT DEVELOPMENT*

The concept was first tested on a small motor to see if it would work. Using two motors 1 and motor 2 placed side by side the small generator which is a cycle dynamo supported at both ends. Belt are used to connect as shown in fig below motor 1 belted through the top so that the entire stator can rotate in one direction while the other motor 2 rotates the rotor.

Fig. 4. First Concept Testing



International Journal of Early Childhood Special Education (INT-JECSE)
DOI: 10.9756/INT-JECSE/V13I2.211203 ISSN: 1308-5581 Vol 13, Issue 02 2021

Fig. 5. Block Diagram of Concept

As first only motor 1 was powered keeping the rotor fixed, so that only the stator will rotate. The bulb glues a little, then again motor 2 was power keeping motor 1 off then also the bulb glued a little. Then combining both motor together the bulb glue brightly. This was the beginning of the concept of dual rotor system.
Fig. 6. Design and Fabrication of Prototype 1

This was the first prototype Dual rotor wind turbine concept design which was design, keeping in mind of the available materials at home which included fan blades, cycle dynamo, camera stand, two bearings, one MS rod, two aluminium ring to support the blades and wooden pieces.

Within a month the design was fabricated and tested under a blowing fan. First concern was whether the both blades will rotate in the opposite direction. It performed well without any problem.

Different Designs were modelled to test in the Aerospace Lab. The first two models failed because there were some problems in the fabrication. The fig below shown are the failed models.

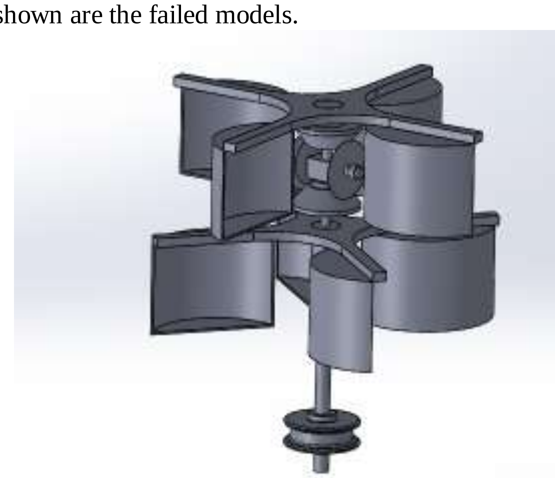


Fig. 7. Design1

International Journal of Early Childhood Special Education (INT-JECSE)
DOI: 10.9756/INT-JECSE/V13I2.211203 ISSN: 1308-5581 Vol 13, Issue 02 2021

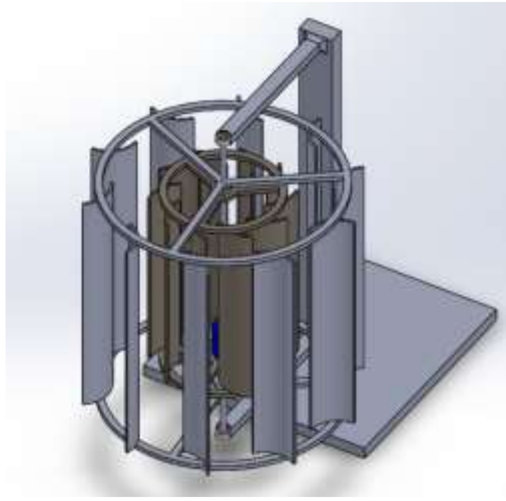


Fig. 8. Design 2

### *B. FINALISED DESIGN OF DUAL ROTOR VERTICAL WIND TURBINE*

At last with the available materials the model shown in figure 9 was fabricated. This model gives sufficient room for the rotation of all the blades. On further analysis there were no issues found. It was also designed keeping in mind the possibility of tilting the blades to its maximum. So, during testing the efficient strike angle can be obtained. Furthermore, modification has been done during fabrication.

Fig. 9. Design 3 (Final Design)

## ANALYSIS

In order to make this new innovative wind generator, there is an exhaustive study for the blades angle, the support stand to be used and the new connecting circuits to be used. This study consists in simulate with solid works the loads and forces that appear to the small generator while is working. Then with Cosmos works it has been done the graphics of Von Mises forces and displacements, seen the results of the graphics it has been designing and changing some dimensions of that parts till arrive to a good result. As both stator and rotor have to rotate independently a unique stand made of steel rode had to be calculated for each element, bearings, bolts, joints, and welds, wedges… At the end of the work there is also an economical study; with the results of the study it can be proved the viability of that inversion and it can be seen to that the generator will start to give benefices within a year.

International Journal of Early Childhood Special Education (INT-JECSE)
DOI: 10.9756/INT-JECSE/V13I2.211203 ISSN: 1308-5581 Vol 13, Issue 02 2021

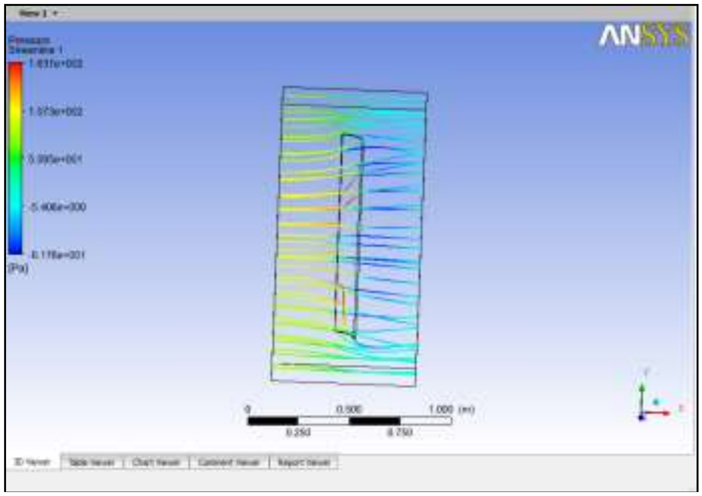



Fig. 10. Pressure of Blade Angle at 45 Degree

The above figure shows the air flow over single blade with blade angle of 45 degree. From the analysis of air flow against the blade the Maximum Pressure can be observed in the figure 10 and the value is about 16.37Pa.

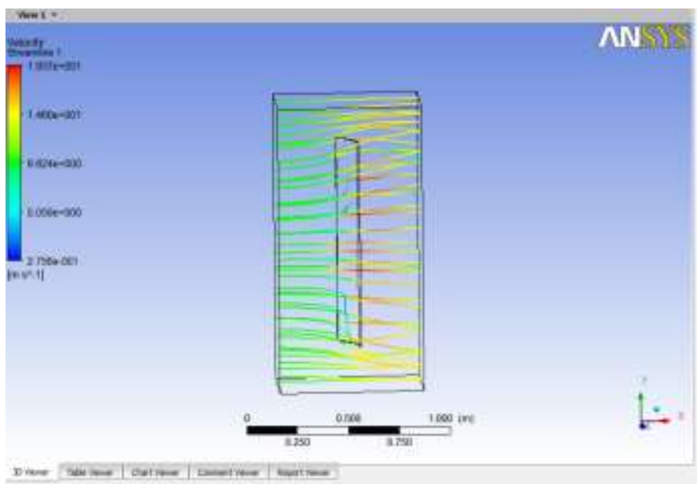



Fig. 11. Velocity of Blade Angle at 45 Degree

The above figure shows the air flow over single blade with blade angle of 45 degree. From the analysis of air flow against the blade the Maximum Velocity can be observed in the figure 11 and the value is about 19.37m/s.

International Journal of Early Childhood Special Education (INT-JECSE)
DOI: 10.9756/INT-JECSE/V13I2.211203 ISSN: 1308-5581 Vol 13, Issue 02 2021

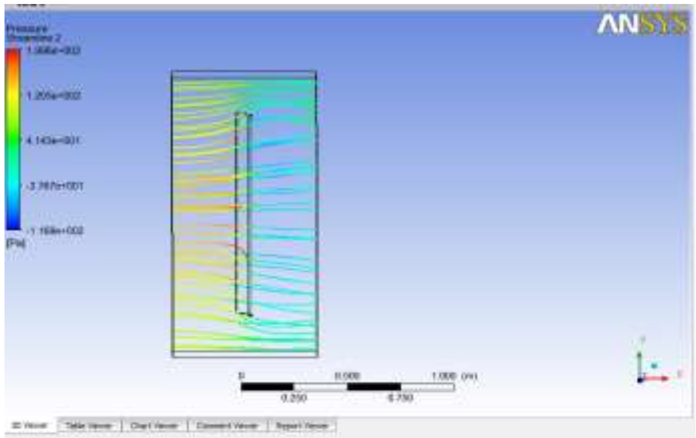


Fig. 12. Pressure of Blade Angle at 60 Degree

The above figure shows the air flow over single blade with blade angle of 60 degree. From the analysis of air flow against the blade the Maximum Pressure can be observed in the figure 12 and the value is about 19.96Pa.

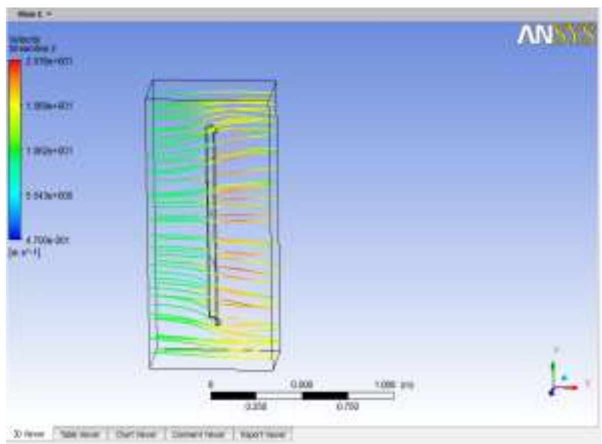


Fig. 13. Velocity of Blade Angle at 60 Degree

The above figure shows the air flow over single blade with blade angle of 60 degree. From the analysis of air flow against the blade the Maximum Velocity can be observed in the figure 13 and the value is about 20.76m/s. By performing the CFD analysis, it was easy to track the air movement over the blades we designed and also by changing the blade angles, the rate of power generation can be increased. The results for the different blade angles are shown above. From the analysis, it is evident that for 45° blade angle, the power generation is higher and maximum.

## FABRICATION OF DRVWT

### *A. DC GENERATOR*

A generator is a device that converts mechanical energy to electrical energy for use in an external circuit. The source of mechanical energy may vary widely from a hand crank to an internal combustion engine. Generators provide nearly all of the power for electric power grids.

International Journal of Early Childhood Special Education (INT-JECSE)
DOI: 10.9756/INT-JECSE/V13I2.211203 ISSN: 1308-5581 Vol 13, Issue 02 2021

Fig. 14. DC Generator

A 6v 500rpm DC generator was bought from Baharat Electric Motors at a cost of Rs 4,000. Using CNC machine, the shaft was extended their itself with additional price of Rs 1000.

Rating of PMDC Generator:

Power : 120 KW
Voltage : 12V
Speed : 600rpm
Current : 10A

### *B. BEARING*

A ball bearing is a type of rolling-element bearing that uses balls to maintain the separation between the bearing races. The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads. It achieves this by using at least two races to contain the balls and transmit the loads through the balls. In most applications, one race is stationary and the other is attached to the rotating assembly (e.g., a hub or shaft). As one of the bearing races rotates it causes the balls to rotate as well. Because the balls are rolling they have a much lower coefficient of friction than if two flat surfaces were sliding against each other. Ball bearings tend to have lower load capacity for their size than other kinds of rolling-element bearings due to the smaller contact area between the balls and races. However, they can tolerate some misalignment of the inner and outer races.

Fig. 15. Ball Bearing 16mm Día.

### *C. STAND*

International Journal of Early Childhood Special Education (INT-JECSE)
DOI: 10.9756/INT-JECSE/V13I2.211203 ISSN: 1308-5581 Vol 13, Issue 02 2021

Fig. 16. Stand

The tower or the stand is the element that sustains all the mechanisms of the small generator. There are many types of towers that can be adjusted to that application; Figure 16 MS rod being cut into different pieces, then welded together to form the stand.

***D. BLADE RING***

Fig. 17. Blade ring

Figure 17 shows inner and outer rings which holds the blades. These rings are concentric to each other and it is fabricated by using mild steel. The outer ring and inner ring has a diameter of 800 and 600 mm respectively.

***E. BLADE MADE USING ALUMINIUM***

International Journal of Early Childhood Special Education (INT-JECSE)
DOI: 10.9756/INT-JECSE/V13I2.211203 ISSN: 1308-5581 Vol 13, Issue 02 2021

Fig. 18. Blades made using Aluminium

The most common design for blades for a small wind generator are fixed step blades, that ones are not the most efficient but incorporate a system to change the attack angle depending on the speed of the wind it would increase a lot the cost of the small turbine so it has been chosen the first solution. One solution to solve the strong loads that push the blades when the pressure of the wind is high is to change the attack angle along the blade, giving bigger angles in the last part of the blade. That has been the solution chosen in the annexed part one there is a superficial design of the blades where there is designed the blade taking an attack angle and the lengthened.

### *F. PVC PIPE BLADES*

Fig. 19. PVC Pipe Cut into Blades

As the Aluminium blades are not up to the expected level. I decided to fabricate a blade in PVC. So, I bought two pieces of thickness 5mm & 6mm as I did not know which will be better. Inner diameter of 160mm and height 520mm. For best performance the ratio of height vs diameter has to be 5:1 but as it is being tested in front of the wind tunnel at small ratio the width of the blade increases.Once the PVC pipe was cut to the desired height and diameter. The blade like cutting had to be done.

International Journal of Early Childhood Special Education (INT-JECSE)
DOI: 10.9756/INT-JECSE/V13I2.211203 ISSN: 1308-5581 Vol 13, Issue 02 2021

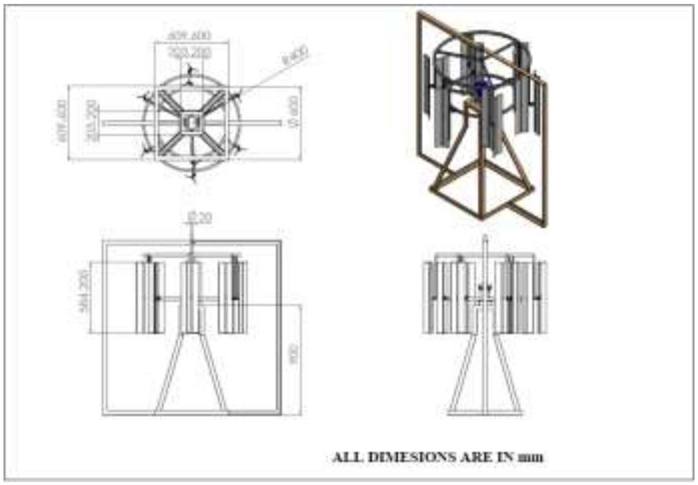



Fig. 20. Detailed drawing of DRVWT

Fig.21. Assembly with Aluminium blades

International Journal of Early Childhood Special Education (INT-JECSE)
DOI: 10.9756/INT-JECSE/V13I2.211203 ISSN: 1308-5581 Vol 13, Issue 02 2021

Fig. 22. Assembly using PVC blades

The design is done in such a way that both wooden blade and PVC blade can be fixed just by replacing with the other.

**EXPERIMENTAL SETUP**

***6.1. EQUIPMENT USED FOR RESEARCH WORK***

***Apparatus Required:***

a. Wind turbine testing tunnel
b. Anemometer
c. Tachometer
d. DC ammeter (0-2A)
e. DC Voltmeter (0-30V)
f. Rheostat (52Ω, 5A), wires.

Fig. 23. Modelled of Wind Tunnel in SolidWorks

***Rating of 3 Phase, AC induction motor:***

Power: 7.5 HP
Speed: 1440 rpm
Voltage: 415V
Current: 10.5 A
Frequency: 50 Hz
Efficiency: 87%

6.2. ***METHOD: POWER OF THE WIND AND ENERGY INPUT***

The power of a wind turbine depends on:

• The cube of the speed of the wind (speed x speed x speed = speed3)
• The area swept by the blades
• The density of the air.

To be able to calculate the energy input you need to find the speed of the wind from the fan.

1. Measure the air speed using – Anemometer
2. Find the area swept by the blades.

International Journal of Early Childhood Special Education (INT-JECSE)
DOI: 10.9756/INT-JECSE/V13I2.211203 ISSN: 1308-5581 Vol 13, Issue 02 2021

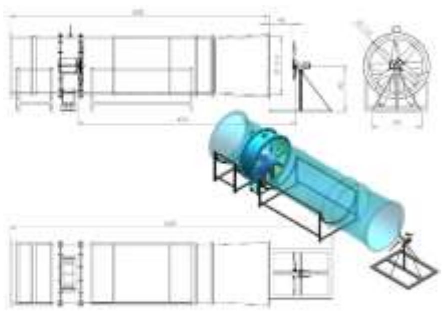
This is the biggest circle that the blades cover as they rotate. The number and shape of the blades does not matter.

- Measure the radius (in meters, m) of the area swept by finding the maximum distance from the center of the shaft to the tip of a blade.
- calculate the area swept using area ($m^2$) = $\pi$ x radius$^2$ ($m^2$) [$\pi = 3.14$]

***6.3. DESCRIPTION OF THE EXPERIMENTAL SET-UP***

A tunnel of length 5 m is placed facing a wind turbine. The diameter of the tunnel on the side facing the wind turbine is 1.14 m and the diameter on the other side is 1.04 m. An AC motor with fan is placed inside the tunnel to generate wind. The wind velocity inside the tunnel can be varied using a potentiometer up to 9 m/s. The modelling of the wind tunnel was done in solid works in detail to do a complete study. As the tunnel was in a closed room the air blown out were again re-used.

***6.3.1 EXPERIMENT 1 ON WTGS***



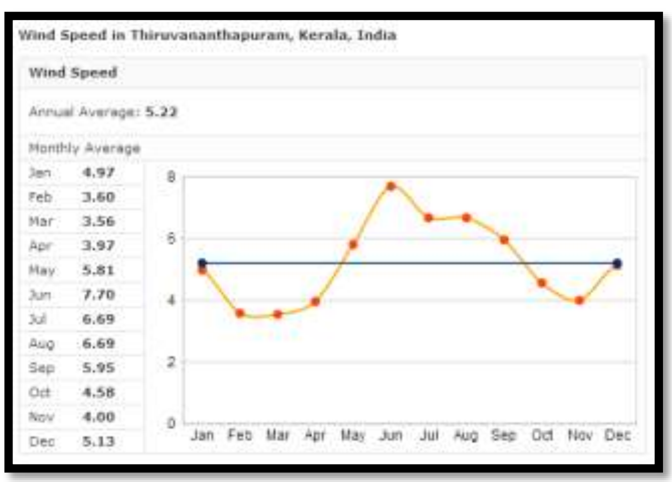
***Calculate the power:***

Assume that the density of air is 1.225 kg/$m^3$ (kilograms per cubic meter) and calculate the power of the wind that is available to the wind turbine:

Power (watts, W) = $\frac{1}{2}$x area swept by blades ($m^2$) x density of air (kg/$m^3$) x wind speed$^3$($m^3/s^3$)

***Test on Conventional Wind Turbine:***

The three blades of the wind turbine are connected to a DC generator. As the blades rotate due to wind from the tunnel, the DC generator turns on.



International Journal of Early Childhood Special Education (INT-JECSE)
DOI: 10.9756/INT-JECSE/V13I2.211203 ISSN: 1308-5581 Vol 13, Issue 02 2021

| | Observation | | | | Calculation | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sl. No | Wind speed (m/s) | N (rpm) | $V_{out}$ (volts) | $I_{out}$ (A) | $P_w$ (W) | ? | $C_p$ | $P_m$ (W) | $P_e$ (W) | % ? $_{mw}$ | % ? $_{em}$ |
| 1 | 2.5 | 112 | 1.05 | .052 | 9.76 | 2.67 | .33 | 3.22 | .054 | 33.0 | 1.67 |
| 2 | 4 | 152 | 1.35 | .062 | 39.98 | 2.26 | .38 | 15.19 | .083 | 37.9 | 0.54 |
| 3 | 6 | 220 | 2.26 | .075 | 134.94 | 2.19 | .4 | 53.97 | .169 | 40.0 | 0.31 |
| 4 | 6.5 | 240 | 2.42 | .088 | 171.57 | 2.2 | .39 | 66.91 | .212 | 38.9 | 0.31 |
| 5 | 7.5 | 282 | 3.06 | .102 | 263.56 | 2.24 | .39 | 102.8 | .312 | 39.0 | 0.30 |

Table. 2.Tabulation of WTGS

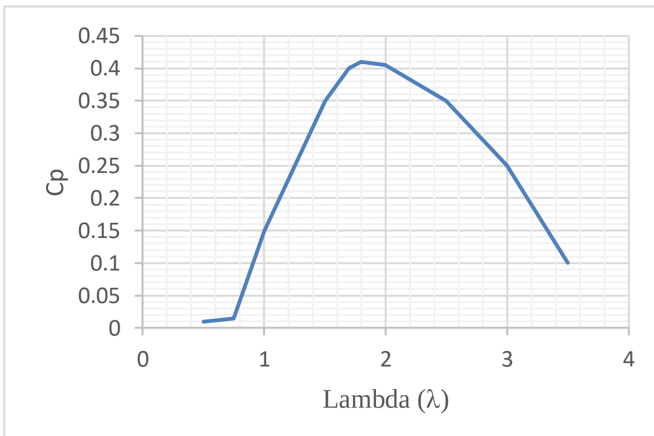



Fig.24. Block Diagram of flow of wind in DRWT

***Procedure:***

1. Start the Induction Motor (IM) of the wind tunnel system. Adjust the speed of the IM to a particular wind speed from the tunnel.
2. Measure the wind speed.
3. Vary the electrical load on the generator in steps by adjusting the rheostat. For each load setting, measure the turbine speed, output voltage and output current.
4. Tabulate the reading and calculate the efficiency of the wind energy conversion system. The value of $C_p$ for different values of tip-speed ratio can be found out using the graph given below:
   Graph. 1.Cp vs. tip-speed ratio

***OBSERVATION &TABULATION:***

Wind Speed (v) = 6 m/s ; Rotor Radius (r) =0.57 m ; A $=\pi r^2$=1.02 $m^2$ ; Density of air $\rho =$ 1.225 $kg/m^3$ (avg. value) ; N =220 rpm (23.09 rad/sec)

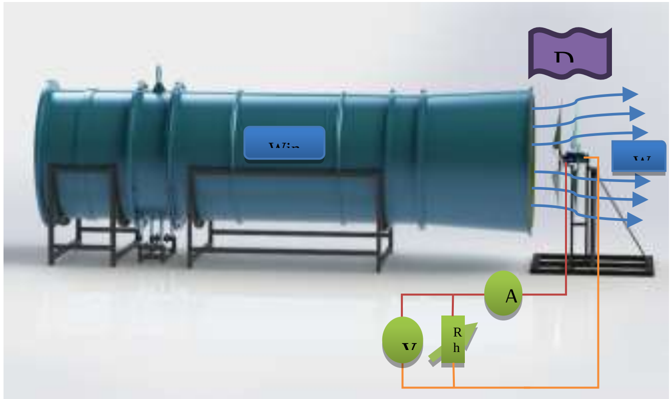
***Model Calculation:***

***Observation***

In South India average wind speed is about 5 to 6 m/s. Hence let's calculate the power for Wind Speed (v) = 6 m/s. At this speed the rotor rotated at N = 220 rpm producing a voltage V=2.26 v and I=.075.

Graph. 2. Wind Speed in Trivandrum, Kerala, India

International Journal of Early Childhood Special Education (INT-JECSE)
DOI: 10.9756/INT-JECSE/V13I2.211203 ISSN: 1308-5581 Vol 13, Issue 02 2021




| Sl. No | Observation | | | Calculation | |
|---|---|---|---|---|---|
| | **Wind speed (m/s)** | N (rpm) | V $_{out}$ (volts) | $I_{out}$ (A) | $P_e$ (W) |
| 1 | 2.5 | **502** | **0.86** | .018 | 0.015 |
| 2 | 4 | **620** | **2.31** | .144 | 0.332 |
| 3 | 6 | **740** | **3.38** | .208 | 0.703 |
| 4 | 6.5 | **800** | **4.42** | .240 | 1.060 |
| 5 | 7.5 | **880** | **5.82** | .298 | 1.734 |

**Table 7.1** Tabulation of WTGS

***Calculation***

$P_w = \frac{1}{2}\rho A v^3 = \frac{1}{2} \times 1.225 \times 1.02 \times 6^3 =$ <u>134.946 watts</u>

$\lambda = \frac{\omega R}{wind\ speed} = \frac{23.093.57}{6} = 2.19$ ; $C_p = 0.4$

$P_m = \frac{1}{2} C_p \rho A v^3 = \frac{1}{2} \times .4 \times 1.225 \times 1.02 \times 6^3 =$ <u>53.97 watts</u>

$P_e = V_{out} I_{out} =$ <u>0 .169 watts</u>

% $\eta_{mw} = P_m / P_w$ 3 100 = <u>40.0 %</u>

% $\eta_{em} = P_e / P_m$ 3 100 = <u>0.31 %</u>

***6.3.2 EXPERIMENT 2 ON DRWT***

***Test on Dual Rotor Wind Turbine:***

The three blades of the wind turbine are connected to a DC generator rotor same as above experiment and also another three blades are connected to the stator in such a way that the entire DC generator is free to rotate by connecting bearings to the rotor and making the rotor to support the entire weight of DC generator and the Blades.

International Journal of Early Childhood Special Education (INT-JECSE)
DOI: 10.9756/INT-JECSE/V13I2.211203 ISSN: 1308-5581 Vol 13, Issue 02 2021

Applying same parameters for DRWT:
Wind Speed (v) = 6 m/s ; Rotor Radius (r) =0.57 m ; A =$\pi r^2$=1.02 m$^2$ ; Density of air $\rho = 1.225\ kg/m^3$ (avg. value) ; N =220 rpm (23.09 rad/sec)

| Sl. No | Observation | | | | | | Calculation | |
|---|---|---|---|---|---|---|---|---|
| | Wind speed (m/s) | $N_{front}$ (rpm) | $N_{back}$ (rpm) | N (rpm) | $V_{out}$ (volts) | $I_{out}$ (A) | $P_e$ (W) | % ?$_{em}$ |
| 1 | 2.5 | 97 | 110 | **207** | **1.72** | .068 | 0.117 | 3.63 |
| 2 | 4 | 138 | 182 | **320** | **3.79** | .159 | 0.602 | 3.96 |
| 3 | 6 | 205 | 297 | **502** | **5.87** | .232 | 1.361 | 2.52 |
| 4 | 6.5 | 226 | 334 | **560** | **6.64** | .262 | 1.739 | 2.59 |
| 5 | 7.5 | 267 | 373 | **640** | **8.12** | .321 | 2.606 | 2.53 |

Table. 3.Tabulation of DRWT

***Calculation***
$P_e = V_{out} I_{out}$= <u>1.361 watts</u>
% $\eta_{em}$= $P_e$/ $P_m$ 3 100 = <u>2.52</u>

Table. 4. Tabulation of DRVWT by using PVC blades

| Sl. No | Observation | | | Calculation | |
|---|---|---|---|---|---|
| | Wind speed (m/s) | N (rpm) | $V_{out}$ (volts) | $I_{out}$ (A) | $P_e$ (W) |
| 1 | 2.5 | **417** | **1.15** | .011 | 0.012 |
| 2 | 4 | **530** | **3.67** | .147 | 0.539 |
| 3 | 6 | **610** | **5.85** | .212 | 1.240 |
| 4 | 6.5 | **670** | **6.95** | .293 | 2.036 |
| 5 | 7.5 | **750** | **8.50** | .361 | 2.606 |

Table. 5. Tabulation of DRVWT by using Aluminium blades

### *6.3.3. EXPERIMENT 3 ON DRVWT BY USING PVC BLADES*

### *6.3.4. EXPERIMENT 4 ON DRVWT BY USING ALUMINIUM BLADES*

International Journal of Early Childhood Special Education (INT-JECSE)
DOI: 10.9756/INT-JECSE/V13I2.211203 ISSN: 1308-5581 Vol 13, Issue 02 2021

Fig. 25. Detailed Drawing of DRWT

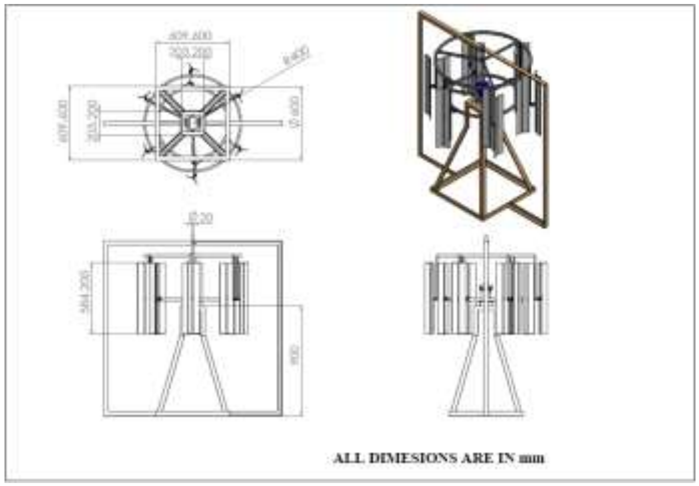



Fig. 26. Detailed Drawing of DRVWT

International Journal of Early Childhood Special Education (INT-JECSE)
DOI: 10.9756/INT-JECSE/V13I2.211203 ISSN: 1308-5581 Vol 13, Issue 02 2021

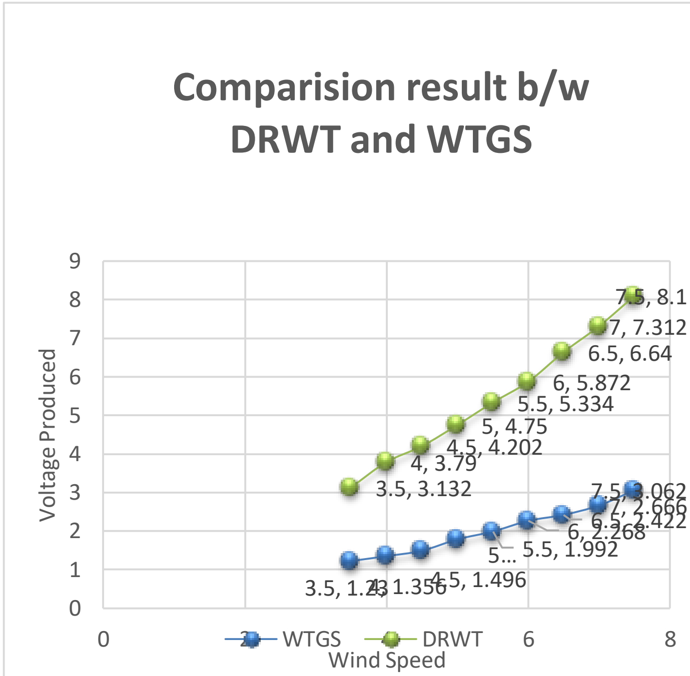



Fig. 27. Aluminium blades vs. PVC blades

To understand the correlation between the wind blower rpm vs. the voltage generated the study and experiments were carried out. In the initial stage, the single front blade alone was analyzed so as to understand the power that it produced. This represent the conventional wind turbine technology currently used. Accordingly, the readings and the voltage produced where formulated and chartered.

As the wind blower rpm was gradually raised to 750rpm, the experimentation encountered a situation in which the support stands vibrated due to the increasing wind speed and as it approached 800rpm the blades detached. Therefore, the design was again displaced and reinforced with better safety measures to avoid any further breakdown.

The experiment proved that the modified design was a tremendous success as it showed a significant rise in the power produced and the efficiency of the wind turbine. The data obtained where formulated to conclude that the proposed design was much more efficient to produce an efficient and effective power supply than the previous design.

## *XXI.* COMPARISON STUDY

### *A. COMPARISON 1: ALUMINIUM BLADES VS PVC BLADES*

Test between this two was take at a constant wind speed of 4 m/s and found that the Aluminium blades are not performing well. At 4 m/s wind speed Aluminium blades produced 2.31volts, while the PVC blades are producing 3.67volts. Due to this the remaining experiments were carried out using PVC blades only.

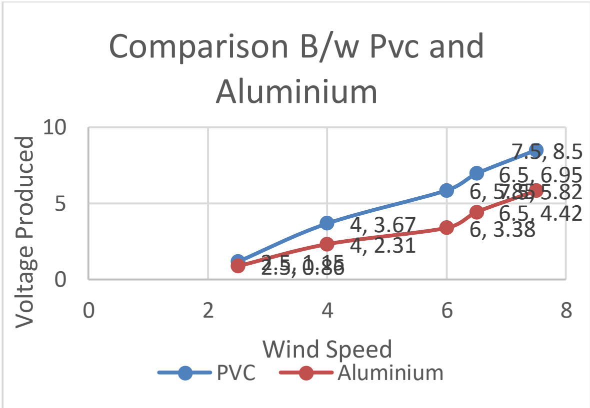
International Journal of Early Childhood Special Education (INT-JECSE)
DOI: 10.9756/INT-JECSE/V13I2.211203 ISSN: 1308-5581 Vol 13, Issue 02 2021

### *B. COMPARISON 2: WTGS vs. DRWT*

Graph. 3. Comparison WTGS vs. DRWT

The results show that initially 1.902volt difference is produced at 3.5 m/s wind speed, then at 6 m/s the difference was 3.88volt difference then finally at 7.5 m/s wind speed 5.038volts difference was obtained. This clearly means that performance of DRWT is not just producing Twice performance but more than that.Even at low wind speed it was observed that the frond blades were not rotating but the front blades were diverting the wind to the back blades making the back stator only to rotate.

### *C. COMPARISON 3: DRVWT PVC Vs Aluminium*




Graph. 4. Comparison DRVWT PVC Vs Aluminium

## *XXII.* CONCLUSION

Design and design detailing of the Dual Rotor Vertical Wind Turbine is done in SolidWorks 2013. Fabrication of the DRWT was done in the workshop in Coimbatore. Further testing was done in Aerospace Lab. Aluminium Blades and PVC Blades was compared and was found that the PVC blade is more efficient than the Aluminium Blade. So, PVC blade was used for further testing. Further analysis has to be compile to find the exact reason of the increase in performance. The DRVWT was found to be the most efficient among all other combinations of the designs.

## *XXIII.* REFERENCE

[1] P. Philip, Improved design of large wind turbine blade of fiber composites based on studies of scale effects, September 2004.

[2] John Thomas, Simulation Modelling Practice and Theory, September 1998.

[3] Larwood and W. Musial, Comprehensive Testing of Nedwind 12-Meter Wind Turbine Blades at NREL, January 2000.

[4] FerranGual Moreno, Design of a small wind generator, April 2008.

[5] Grant Ingram, Wind Turbine Blade Analysis using the Blade Element Momentum Method, October 2011.

[6] TanateChaichana, Performance Evaluation of Co-Axis Counter-Rotation Wind Turbine, May 2015.

[7] Wendi Liu, Investigation on Darrieus type straight blade vertical axis wind turbine with flexible blade, November 2015.

[8] M. Burlando, Numerical and experimental methods to investigate the behavior of vertical-axis wind turbines with stators, September 2015.

[9] Giovanni Gerardo Muscolo, Savonius to Bronzinus a comparison among vertical wind turbines, January 2014.

[10] David Verelst, Integrated simulation challenges with the Deep Wind floating vertical axis wind turbine concept, October 2015.