International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 09 | Sep 2018 www.irjet.net p-ISSN: 2395-0072

# Electricity generation by using high velocity wind produced due to motion of vehicle.

**Vaibhav Rangrao Kumbhar[1], Pushkar Rajendra Bahirat[2], Atharva Chandrashekhar Kale[3], Sagar Vitthal Garad[4]**

*[1,2,4]Scholar, Mechanical Engineer, AISSMS College of Engineering, Pune, Savitribai Phule Pune University*
*[3]Scholar, Mechanical Engineer, NBN Sinhgad School of Engineering, Pune, Savitribai Phule Pune University*

---

***Abstract*:-** *Energy demand is increasing everyday as we take a step towards development. The use of non-renewable energy sources such as fossil fuels is leading to increase in pollution. Fossil fuels are going to exhaust one day. To serve energy need of future generation development of renewable energy (i.e. solar, wind, geothermal, tidal) is important. Wind is a source of energy which has been used since old ages in windmills for pumping water, grinding flour and eventually for the generation of electricity. The objective of this work is to study a device used to harness high velocity wind energy, generated due to motion of the moving vehicle, for the generation of electricity by using a turbine mounted on it. The electricity produced will run various loads present in the vehicle such as charging points, fans, lights, etc. The excess power can be stored in a battery for further use. Or, all the energy can be stored in the battery and used to run the vehicle itself. This will help to cut down the usage of non-renewable sources which are on the verge of extinction and the entire process is non-polluting.*

**Keywords- turbine, electricity, moving vehicle, high velocity wind.**

## 1. INTRODUCTION

Wind is a source of renewable energy which is obtained from air current flowing across the earth's surface. It is one of the fastest growing sources used to generate electricity in the world today. These growth trends can be linked to the multi-dimensional benefits associated with green power, sustainable development and affordable power. Moreover it is more efficient than most of the fossil fuels used. Renewable energy resources exist over wide geographical areas, in contrast to other energy sources which are concentrated in a limited number of regions. Rapid development of renewable energy and energy efficiency is resulting in significant energy security, climate change mitigation and economic benefits.

Wind or air in motion contains kinetic energy which can be converted into mechanical power by means of wind turbine which is connected to a generator to produce electricity. At present, there are many ways to generate electricity by using non-renewable energy sources (e.g. Coal, Thermal, and Nuclear). But these power generation techniques result in pollution and so power generation using renewable source is essential.

The prime focus of this paper is to study a device used to harness high velocity wind energy, generated due to motion of the moving vehicle, for generation of electricity by using a turbine mounted on it. Wind turbine consist of a set of blades attached to a rotor hub, which together forms the rotor; this rotor deflects the airflow, which creates a force on the blades, which in turn produces a torque on the shaft and the rotor rotates around a horizontal axis.

The shaft is attached to a gearbox of the generator. The generator generates electricity, which is given to an AC to DC convertor. The converted DC voltage can be supplied to the various loads in the vehicle as per requirements. In case of hybrid vehicles this converted DC voltage can be used to directly charge the battery or run the vehicle itself. This kind of hybrid vehicle can be independent of the external electrical source required to run the vehicle.

A wind turbine is defined as a type of device that transforms kinetic energy of the wind to electric power.

The outcome of about a millennium of development and engineering in windmills, current wind turbines are produced in a broad range of both vertical and horizontal axes. The small turbines are implemented for different applications such as charging of the batteries of boats or to power traffic signals.

The use of alternative energy sources in automobile is gaining importance with each passing year due to the rapid depletion of available energy resources, the rise in fuel prices depending on this depletion and environmental factors. The most important factors in the acceptance of alternative energy sources are the initial purchase cost of the system, the cheapness of the fuel, vehicle performance and the environmental impact [1].

Depletion of crude oil resources and some environmental factors like global warming have been pushing automobile makers and the scientific communities to study the use of alternative energy sources in automobile, such as LPG, CNG, hydrogen, biodiesel, ethanol and methanol, could be used as alternatives for gasoline. A comparative analysis is performed for fuels. According to the comparison, LPG and CNG are best alternative fuels for economic reasons, while electric and fuel cell vehicles stand out for their no emission advantages. Also, hydrogen can be considered as a key fuel due to its usage as an energy source for both internal combustion engines and fuel cell vehicles [1].

There are generally two types of wind turbines.

### a) Horizontal Axis Wind Turbine (HAWT):

Figure 1: Horizontal Axis Wind Turbine

A horizontal axis wind turbine has currently been modernized from the traditional windmill designs that have been used for many centuries. A nacelle installed perpendicular to the turbine tower and horizontal in terms of the ground defines the name of the turbine. Most common models for drawing energy from wind, the horizontal wind turbines offer a great advantage. [4] The main components of a horizontal axis wind turbine are given below:

- Rotor shaft

- Electrical generator

- A gearbox to increase the rotation speed of the blades.

- Turbine blades

### b) Vertical Axis Wind Turbine (VAWT):

Figure 2: Vertical Axis Wind Turbine

There are generally two types of VAWTs; namely the Savonius and the Darrieus. The Savonius functions similar to a water wheel that uses drag force. On the other hand, the Darrieus makes use of blades similar to the blades used on HAWTs. VAWTs commonly function nearer to the ground than HAWTs, and have the benefit of enabling placement of heavy equipment, such as the gearbox and generator, close to the ground level and not in the nacelle. [4] However, the winds are lower near ground level; hence for a similar wind and capture area a less amount of power is generated.

## 2. OBJECTIVE AND METHODOLOGY:

- Selection of wind turbine and generator.
- Design and manufacturing of control circuit. (AC to constant 5V DC)
- To fabricate a sustainable, innovative and environmental friendly model for electricity generation and reduce pollution.

To fulfill above objectives, following methodology is used:

- Step 1- Determination of maximum velocity of wind while travelling in the vehicle by anemometer.
- Step 2- Use of the available wind turbine, DC motor and/or CPU cooling fan as generator.
- Step 3- Design and fabrication of the control circuit.
- Step 4- Connections and implementation of model.
- Step 5- Test performance on developed model.
- Step 6- Result & Conclusion.

## 3. DESCRIPTION:

### 3.1. Selection of Wind Turbine:

The selection of the wind turbine depends on the vehicle on which we are mounting the turbine. If we are mounting on large vehicles (e.g. trucks, busses, trains) the turbine will be bigger than the turbine to be mounted on small vehicles (e.g. two wheelers, cars). The turbine should not pan or oscillate due to vibration produced in the vehicle. To achieve this, turbine weight should be balanced by using a horizontal axis swift turbine. Traditional wind turbine generates some noise as the wind travels along the length of the blades, while the outer ring on swift acts as a diffuser. As the wind travels down the blades it is dispersed along the outer ring, significantly reducing the sound and keeping the turbine silent.

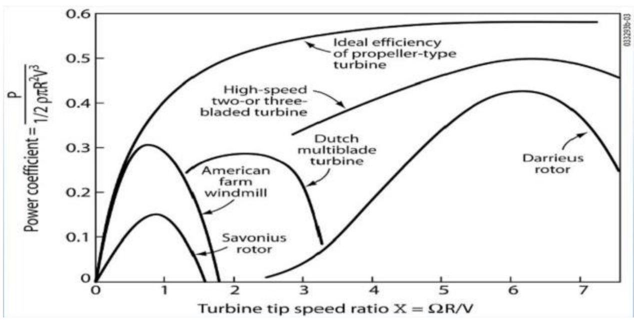



Figure 3: Selection of Turbine.

### 3.2. Positioning:

The wind turbine is mounted in front or on the roof of the vehicle with rigid support. Metal rods can be used to provide mechanical support to the turbine [6]. The turbine blade is provided with a properly designed support and a casing for other parts to provide safety from huge wind pressure. The turbine is placed in such a way that it gets maximum support and extracts maximum power from the wind. When the vehicle moves with an average speed the high velocity wind strikes on the turbine and the rotor starts rotating. The speed of the rotor also depends on the position of the turbine on the vehicle. The turbine is placed along the path of the wind flow. When the vehicle moves, the turbine rotates.

### 3.3. Storage of Electrical Energy:

- Due to high velocity wind generated by motion of the vehicle, turbine rotates with maximum speed.
- A coil is placed on the shaft of the turbine which rotates in a strong magnetic field which is produced by permanent magnet.
- EMF is produced in the coil as it rotates in the magnetic field (Faraday's law). The generated electricity can be given to various loads present in the vehicle (e.g. fans, lights or components which are working on electrical power) or excess electricity produced can be stored in a battery.

## 4. MATHEMATICAL MODEL:

The following are the definition of various variables used in this model:

E = Kinetic Energy ρ = Density (kg/m³)

A = Swept Area (m²) m = Mass (kg)

v = Wind Speed (m/s) $C_p$ = Power Coefficient

P = Power (W) r = Radius (m)

$\frac{dm}{dt}$ = Mass flow rate (kg/s) x = distance (m)

$\frac{dE}{dt}$ = Energy Flow Rate (J/s) t = time (s)

Under constant acceleration, the kinetic energy of an object having mass m and velocity v is equal to the work done W in displacing that object from rest to a distance S under a force F, i.e.:

$$E = W = F.S$$

According to Newton's Law, we have:

$$F = ma$$

Hence,

$$E = m \times a \times s \ldots (1)$$

Using the third equation of motion:

$$v^2 = u^2 + 2as$$

We get:

$$a = \frac{v^2 - u^2}{2s}$$

Since the initial velocity of the object is zero, i.e.

$u = 0$, we get:

$$a = \frac{v^2}{2s}$$

Substituting it in equation (1), we get that the kinetic energy of a mass in motions is:

$$E = \frac{mv^2}{2}$$

The power in the wind is given by the rate of change of energy;

$$P = \frac{dE}{dt} = \frac{v^2}{2}\frac{dm}{dt}$$

$$\frac{dm}{dt} = \rho A \frac{dx}{dt}$$

And the rate of change of distance is given by:

$$\frac{dx}{dt} = V$$

We get,

$$\frac{dm}{dt} = \rho AV$$

Hence power can be expressed as:

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

The theoretical maximum power efficiency of any design of wind turbine is 0.59.

This coefficient is called "power coefficient" which denotes power efficiency.

$$Cp\ max = 0.59$$

Hence the maximum power available from wind is given by:

$$P\ available = Cp\frac{\rho AV^3}{2}$$

## 5. WORKING PROTOTYPE:

### 5.1. Selection of the Turbine and Generator:

We select CPU cooling fan which is used as turbine rotor as well as generator.

Table 1: Specification of cooling fan

| Parameter | Specification |
|---|---|
| Height | 100 mm |
| Width | 100 mm |
| Rated power | 5 W |
| Max, current | 0.3A |

### 5.2. Design and Manufacturing of the Control Circuit.

The voltage generated by the fan at the output will be in the form of the AC. To convert AC voltage to 5V DC we use a control circuit.

The components and circuit diagram are given below.

1. Bridge rectifier
2. Capacitor
3. IC
4. Charging pin adapter
5. Connecting wires

**Circuit diagram:**

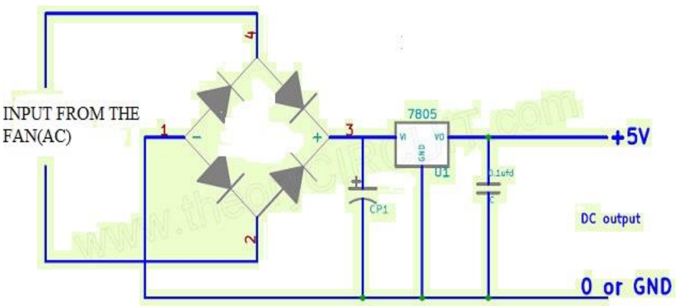
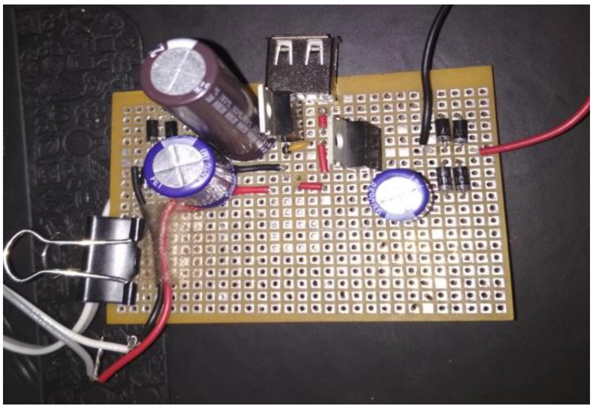



Figure 4: Control Circuit Diagram.

Table 2: Component and specifications:

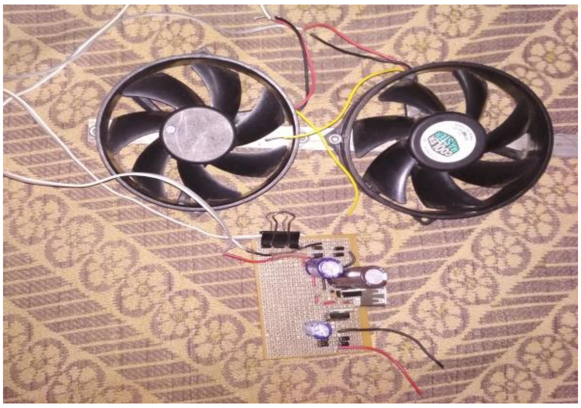
| Sr. No. | Component | Specifications | Quantity |
|---|---|---|---|
| 1. | Diode | -- | 4 |
| 2. | Capacitor | 1. 2200 µf<br>2. 0.01 µf | 1 |
| 3. | IC | 7805 | 1 |
| 4. | Female adp | | 1 |



Photograph of the converting circuit

## 6. CONSTRUCTION:

We use CPU cooing fan as a turbine as well as a generator. Wires from the fan are connected to the rectifier which is the input to the control circuit and a female adaptor is at the output and mobile is connected to the output.



Photograph of the actual model prototype

## 7. OBSERVATION:

After the assembly of the model, it is mounted at the front of a four wheeler near the number plate or on the leg guards of a two wheeler for testing.

When vehicle starts to move, the rotor starts rotating due to high velocity wind induced. The turbine, also acting as a generator, generates electricity. If the velocity of vehicle is high, induced wind velocity will be high and power produced will be higher.

In the experiment conducted:

- Initially when the vehicle starts moving at a low speed the turbine also rotates at the low speed and hence it does not show any output voltage.
- At a certain speed the output starts showing a constant 5V DC.
- As the speed increases the turbine starts rotating faster and output current increases.

- This electricity generated by mounting the turbine on a two wheeler was used to charge a mobile phone (generally charged by using a 5V 1A charger).

## 8. RESULT:

The power developed by the fan at various vehicle speeds is given in the table below.

| Sr. No | Velocity( m/s) | Voltage measured (V) | Current measured (A) | Power (W) |
|---|---|---|---|---|
| 1 | 16.67 | 40 | 0.2 | 8 |
| 2 | 13.89 | 32 | 0.18 | 5.76 |
| 3 | 11.11 | 23 | 0.15 | 3.45 |
| 4 | 8.33 | 10 | 0.1 | 1 |
| 5 | 5.56 | 7 | 0.05 | 0.35 |

Analytical power calculations for fan dimensions:

1) Diameter of the fan = 76 mm.

2) Normal range of speed = 40- 80km/hr.

3) Air density at sea level at 25°C = 1.225 kg/m$^3$.

Analytical calculations for different velocity of air:

Area of action = $A = \pi r^2$

$$= 3.14 \times 34^2\ mm^2$$

$$= 4534.16 \times 10^{-3} m^2.$$

1) Consider vehicle is travelling with 60 $\frac{km}{hr}$.

$$V = \frac{60 \times 1000}{3600}$$

$$V = 16.67\ {}^{m}/_{s}.$$

Maximum power that can be produced:

$$P\ max = ½\ \rho\ A\ v^3$$

$$= 1.225 \times 4534.16 \times 10^{-3} m^2. \times 16.63^3$$

$$= 25.53\ W$$

$$P\ max = 25.53\ W.$$

$$Total\ power\ available = 0.3 \times 25.53\ w$$

$$= 7.66\ W$$

## 9. CONCLUSIONS:

- This paper proposes an effective mean of harnessing the wind energy by the motion of the vehicle.
- If implemented, it will meet up the power requirements for future generation.
- This method is reliable.
- Generated electricity is completely pollution free and does not have any impact on the environment.
- From the above result it is seen that for different velocities of air, as velocity of air increases output power also increases, i.e.

$$P \propto V^3$$

Keeping area of swept constant.

- If we use customized motors & rotors then we can achieve better results.
- We can also use vertical axis turbine instead of horizontal axis turbine to generate electricity.

## 10. FUTURE SCOPE:

It can be used on any moving vehicle to harness energy from the wind and the generated electricity can be used to charge your electrical devices, provide electrical energy to various loads present in the vehicle or to run vehicle itself.

In future, implementation of such technology can be a potential alternative source of fuel for the hybrid vehicles.

## ACKNOWLEDGMENT:

It gives us a great pleasure to present the research paper on “Use of high velocity wind produced due to motion of vehicle to generate electricity”.

We are grateful to Prof. V. S. Wagare for technical assistance and Prof. Y. B. Karandikar who moderated this paper and in that line improved the manuscript significantly.

## REFERENCES

1. Ugurlu, S. Oztuna.—A comparative analysis study of alternative energy sources for automobiles. International journal of hydrogen energy xxx , 2015,pp. 1 -1 1.
2. Wind Turbine Power Calculations RWE npower renewables.
3. Sathyajit Mathew: Wind Energy Fundamentals, resource analysis and economics
4. Study on the wind turbine: Yamin Sarathi

5. Small wind research tubine: D.corbus and M.meadors

6. Wind Power Fundamentals (MIT)

7. Wind energy technology: Current status and R&D future : R. thresher and M. robinson

8. Kostyantyn Protsenko, Dewei Xu. Modelling And Control of Brushless Doubly-Fed Induction Generators in Wind Energy Applications [J].IEEE Trans. On Power Electronics,2008 , 23(3) : 1191-1197