

# FABRICATION OF VERTICAL AXIS WINDTURBINE FOR GENERATION OF ELECTRICITY ON HIGHWAYS

Mani R<sup>1</sup>, Ajith Kumar M<sup>2</sup>, Akash Sharma S<sup>3</sup>, Janarthanan S<sup>4</sup>, Jayakumar R<sup>5</sup>

<sup>1</sup> Associate Professor, Mechanical Engineering, Vidya Vikas College of Engineering and Technology, Tamil Nadu, India

<sup>2,3,4,5</sup> UG Scholar Mechanical Engineering, Vidya Vikas College of Engineering and Technology, Tamil Nadu, India

## ABSTRACT

In today's living the demand on electricity is much superior than producing it. One of the biggest issues to be focused is that natural resources are going to be refined in the upcoming years. The global demand for energy is increasing hasty due to rapid rise in population and industrialization, and by depleting the energy sources, simultaneously. At present, approximately 70% of electrical energy is produced by thermal power plants where fossil fuels such as coal, diesel etc. are used as sources. As we realize that fossil fuels are going to be exhausted, therefore we're trying to develop alternative for the generation of power; the renewable energy. It is also considered due to the continuous rising cost of fossil fuel and growing anxiety on climate change, such as global warming, generated by widespread and on purpose utilize of fossil fuels, mainly in the electric power generating plants and transport.

**Keyword:** - Electricity, Renewable Energy, Pollution, Fossil Fuel, etc.....

## 1.INTRODUCTION:

Renewable energy is generally electricity supplied from sources, such as wind power, solar power, geothermal energy, hydropower and other various forms. The renewable energy is also considered as an alternative energy to be utilized instead of fossil fuels, which is inflating the cost of fossil fuel. And, Global warming will continue unless dependence on fossil is reduced, so the wind energy could be having a key role in reducing greenhouse gas emissions. In the past, the kinetic energy of the wind energy was harnessed by windmill to perform mechanical work. Vertical axis wind turbines (VAWTs) are a type of wind turbine where the main rotor shaft is positioned in vertical coordinate. The advantages are that generators and gearboxes can be placed close to the ground, and that VAWTs do not need to be pointed into the wind. The main benefit of VAWT is that it can generate power in all directions of wind flow. Wind energy sources are one of the highly available and reliable renewable energy resources. Sporadic availability of wind energy makes a restriction on its consumption and the consumption can be compensated by proper utilization of the area where wind flow is higher. For this crisis, Highways would be the better solutions. Highways are the spine of any nation for development; it remains full of activity in day and night. Wind turbulence created by the vehicles on the road can help us to generate electrical energy. From a report, Tamil Nadu has shown outstanding progress in the field of wind energy utilizing almost with a potential of about 41.94% of India's total wind installations. Tamil Nadu is also the state with most wind generating capacity of about 6490 MW at the end of August 2014. These days, the vehicle density is rising with huge pace and because of the enlargement in road transportation; large amount of wind energy will be generated by the moving vehicles on these highways. This project intends to extract this energy in the most efficient manner. In this project, we are implementing Vertical axis wind turbines (VAWTs); which are a type of wind turbine where the main rotor shaft is set vertically. The wind turbines will be placed on the medians therefore fluid flow from both sides of the highway will be considered. Using all of the collected data, existing streetlights on the medians can be integrated with these

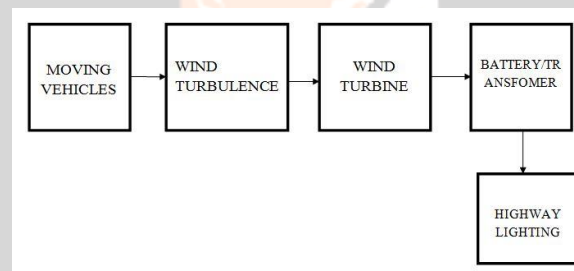
wind turbines. Additionally, since the wind source will fluctuate, a storage system for the power generated will be designed to distribute and maintain a constant source of power.

### 1.1 MOTIVATION FOR THE PROJECT:

In view of the fact, that we are depending mostly on non-renewable sources, and they are depleting in a very fast manner. In addition, there is a lack of electric power in the world. Also, the toxic waste generation due to conventional sources like coal, diesel etc. is also a major crisis. For these reasons, we are trying for incorporation of more renewable energy resources (like solar, wind etc.) into the grid to support the increasing power demand. These renewable sources are long term sources of energy and only the capital cost is noteworthy for its implementation.

These days, the vehicle density is increasing by a very fast rate and because of the development in road transportation facilities such as the development of express highways and national highways, where vehicles move in immense speed. It could generate large amount of wind energy by the moving vehicles on these highways.

### 1.2 BLOCK DIAGRAM:



Block Diagram for Proposed Model

### 1.3 FACTORS TO BE CONSIDERED:

Before implementing the concept in real life, there are various factors which are to be considered. And the various considerations are,

#### I. Wind speed:

The speed of the wind is the vital factor to be considered for the generation of electricity through the wind turbine. There must be enough wind energy developed in order to produce the required electrical energy from the project.

#### II. Tower height and design:

The height of the tower is also the essential factor for the wind turbine. In VAWT the tower is kept little nearer to obtain whole air density from the vehicles. We should also contemplate in the design of the tower because it should withstand its own weight, and the weight of blades during both, in static and in dynamic conditions.

#### III. Shape of the blade:

The design of blades is to be considered for the reason that, the efficiency of the project would be majorly depended on the blade. Efficient blade design would reflect better efficiency from the wind turbine.

The various windmill shapes are as follows;

- a) Flat and unmodified blade surface.
- b) Wing shaped with one leading edge.
- c) Tapered edges to a thin line.
- d) Both edges leading blade.

#### IV. Tip speed ratio:

Tip speed ratio characterizes the speed of the wind that hit the tips of the blades and makes a rotation. The greater tip speed ratio, the greater efficiency would be obtained from the wind turbine.

## 2. COMPONENTS DESCRIPTION:

### 2.1 SHAFT:

A shaft is a rotating machine element, usually circular in cross section, which is used to transmit power from one part to another, or from a machine which produces power to a machine which absorbs power. The various members such as pulleys and gears are mounted on it. The shaft is used for the reason that it is responsible for converting the mechanical energy of the blades into the rotational energy and thereby, transmitting it to the generator. It also transmits the mechanical energy to the generator, which in turn uses this to convert into electrical work. For VAWTs, the shaft is also responsible for the structural stability of the whole structure, as it transmits the power while at the same time all the blades are directly attached to it. Solid shaft of mild-steel was elected since it is tough compared to the other options. It is one of the most commonly used constructive material which can be made readily available natural materials. The carbon content in MS is relatively low which makes the material mechanically stronger. It has a property of satisfying weldability and machinability. The diameter of shaft is chosen as 38cm and the length is 180cm, in order to withstand the structural weight of blades in static as well as in dynamic condition.



### 2.2 BLADE SELECTION:

Blade selection is one of the most important step in the intend of a wind turbine. Blades are the reason which converts kinetic energy of the wind into the rotational energy in the shaft. Two or three blades are the typical but we have chosen four blades to resolve a few issues with vibrations, noise and that of starting. In addition, when the four blades are implemented, slightest one blade will be making a forever direct contact with the wind. In the direction of maximizing the power extraction, the use of cambered or angled blades would be great helpful so that these shapes will significantly improve the performance. We have included four semi shaped PVC pipes in the form of blades to compensate the economic issues and to make use of wind in an appropriate manner. The conical shape of blade would prompt the shaft to move furthermore than the actual wind obtained. And the PVC pipes stands with a greater advantage of resisting the breakage reasons.

### 2.3 BEARINGS:

A bearing is machine elements that constrains relative motion to only the desired motion, and diminish friction between moving parts. Bearings can be classified broadly according to the type of operation, the motions allowed, or to the directions of the loads applied to the parts.

There are at least 6 common types of bearing, each of which operates on different principles:

- Plain bearing, also known by the specific styles: bushing, journal bearing, sleeve bearing, rifle bearing
- Rolling-element bearing such as ball bearings and roller bearings
- Jewel bearing, in which the load is carried by rolling the axle slightly off-center
- Fluid bearing, in which the load is carried by a gas or liquid
- Magnetic bearing, in which the load is carried by a magnetic field
- Flexure bearing, in which the motion is supported by a load element which bends.

We have used Ball Bearing because of its higher stiffness and high moment load capacity than compared with the other bearings. The key purpose of a ball bearing is to reduce rotational friction and support radial as well as axial loads. It achieves the same by using at least two races to contain the balls and transmit the loads through the balls. For a ball bearing, in order to have its nominal lifespan at its nominal maximum load, it must be lubricated with a proper lubricant (oil or grease) that has at least the minimum dynamic viscosity recommended for that bearing. The recommended dynamic viscosity is inversely proportional to diameter of bearing.

The recommended dynamic viscosity decreases with rotating frequency. As a rough indication: for less than 3000 RPM, recommended viscosity increases with factor 6 for a factor 10 decrease in speed, and for more than 3000 RPM, recommended viscosity decreases with factor 3 for a factor 10 increase in speed. We have used two ball bearings to withstand the axial load while the system is in dynamic condition and to reduce the axial moment.

### 2.3 TRANSMISSION SYSYTEM:

A transmission system is used to transform the energy from one part of the system to another part, for the reason of utilizing the energy in a proper manner. A gear or cogwheel is a rotating machine part having cut teeth, or cogs, which mesh with another toothed part to transmit torque. Geared devices can change the speed, torque, and direction of a power source. Gears almost always produce a change in torque, creating a mechanical advantage, through their gear ratio, and thus may be considered a simple machine. The teeth on the two meshing gears all have the same shape. Two or more meshing gears, working in a sequence, are called a gear train or a transmission. A gear can mesh with a linear toothed part, called a rack, thereby producing translation instead of rotation. An advantage of gears is that the teeth of a gear prevent slippage. When two gears mesh, if one gear is bigger than the other, a mechanical advantage is produced, with the rotational speeds, and the torques, of the two gears differing in proportion to their diameters. In transmissions with multiple gear ratios—such as bicycles, motorcycles, and cars—the term "gear" as in "first gear" refers to a gear ratio rather than an actual physical gear. Molded plastic gears have long provided alternatives to metal gears in lightly loaded drives. They transmit power quietly and often without lubrication in applications such as food processors, windshield wiper drives, and even watches. They also reduce the number of parts and resist chemicals in many applications. Plastics have much lower strengths than metals. For example, bending strength ranges from 12,000 to 45,000 psi, depending on the specific material. This means larger gears to carry the same load. Gears are used for power transmission from one shaft to another where slippage is not admissible, gear being used instead of belts. The number of teeth of gear is 96 and for pinion is 24 which is the standard size.

### 2.4 ALTERNATOR:

Alternator is a device which is used to convert mechanical energy (rotation) into electrical energy by the principle of electromagnetic induction. The present cylindrical type alternator can be coupled to VAWT for energy generation, but it is not easy to maintain and service this type of alternators. So to bring compactness in the alternator design disc type alternators are chosen which can make the task of maintenance and service so easy and cost efficient. The disc type alternator can be designed using permanent magnet as a magnetic field for the alternator. The armature is made using the copper wire coils. The disc which the permanent magnet is placed acts as

rotor and is coupled to the wind turbine shaft. The use of permanent magnets reduces the involvement of slip rings and brushes. Another disc acts as stator in which armature windings are placed. The disc is arranged in face to face manner with a minimum air gap, thus acts as an alternator.



**Fig..3 Alternator**

For designing a high power alternator wound field coils can be replaced in the disc instead of permanent magnet. These field windings can be excited externally as per the load conditions using a self charging battery backup

| VARIABLES             | RANGE    |
|-----------------------|----------|
| Voltage               | 3-12 V   |
| Rated Volt            | 9V       |
| No Load Speed         | 20160rpm |
| Starting Rated Torque | 1000G.CM |
| Rated Starting Torque | 600G.CM  |
| Rated power           | 20W      |
| No Load Curve         | 680MA    |

**Table 1.Alternator Specification**

## 2.5 BATTERY:

The electrical energy generated from the alternator is to be saved and hence storage element- Battery is used. It stores electrical energy and discharges output whenever required. An electric battery is a device consisting of one or more electrochemical cells with external connections provided to power required electrical devices. A battery has a positive terminal, or cathode, and a negative terminal, or anode. The terminal marked positive is at a higher electrical potential energy than is the terminal marked negative and the terminal marked negative will be the source of electrons that when connected to an external circuit will flow and deliver energy to an external device. When a battery is connected to an external circuit, electrolytes are able to move as ions within, allowing the chemical reactions to be completed at the separate terminals and so deliver energy to the external circuit. It is nothing but the movement of those ions within the battery which allows current to flow out of the battery to perform required work. Historically the term "battery" specifically referred to a device composed of multiple cells, however the usage has



evolved to additionally include devices composed of a single cell. The two major types of batteries are –i) Primary battery and ii) Secondary battery. Primary (single-use or "disposable") batteries can be used only once and discarded; because the electrode materials are irreversibly changed during discharge. The common examples for primary batteries are the alkaline battery used for flashlights and a multitude of portable devices. Another type of battery-Secondary (rechargeable batteries) can be discharged and recharged multiple times; the original composition of the electrodes can be restored by reverse current. Examples of these type of batteries includes the lead-acid batteries used in vehicles and lithium-ion batteries used for portable electronics. Rechargeable batteries initially cost more than disposable batteries, but have a much lower cost of ownership and environmental impact, as they can be recharged inexpensively and many times before they need any replacement. Some rechargeable battery types are available in the same sizes and voltages as disposable types, and can be used interchangeably with them. In order to facilitate recharging ability, we have used 12V battery to save the electricity generated from the generator. They have the ability to dispose enough energy for the application.

### 3. WORKING PROCEDURE:

The VAWT arrangement is the mechanical arrangement which provides ease in operation. The rotating speed of the blades completely depended upon the wind strength. The shaft is coupled with the dynamo (alternator). So whenever the shaft is rotated due to wind, the dynamo also tends to rotate

While the wind is forced by passing vehicles, there will be enough wind developed to make the blades rotate. As the turbine is modified with four blade structure, it can make more contact with the wind flowing thus can perform with a boost up in its speed. If the speed of the turbine increases it directly result in increasing the speed of the alternator so at the output terminal an increased power is obtained. The output is increased by the implementation of the chain drive. It increases the output percentage more than of its actual output. The electrical energy produced the windmill can be stored in battery bank which is placed under the windmill and the saved power is used at night time for lighting purpose on the highway. So if a larger power generating alternator is used the electricity generated can be utilized to the nearby small villages, highway lights and toll-booths located in few yards away from the highway.

### 4. RESULT AND DISCUSSIONS

#### RESULT:

| WIND VELOCITY<br>(m/s) | SPEED OF SHAFT<br>ROTATION<br>(rpm) | POWER GENERATED<br>(W) |
|------------------------|-------------------------------------|------------------------|
| 3.0                    | 23                                  | 1.254                  |
| 4.5                    | 27                                  | 2.02                   |
| 6.0                    | 28                                  | 2.68                   |
| 7.5                    | 31                                  | 3.02                   |

**TABLE 2 Results**

The table 9.1 shows the obtained output from the proposed model. This vertical axis wind turbine gives an idea about the new way of power generation.

### 5. CONCLUSION

The power generation using VAWT is an eco-friendly method and power produced here is almost a continuous one. Design of the frame is also a very important factor, as light frame may lead to instability in high wind condition. Also there is a problem of vibration which may lead to excessive lateral loading. Number of blades can be reduced to two and the experimentation can be carried out for smaller application. By using the dimensionless numbers various calculations can be carried out. Shaft material is also an important factor, composite materials could be used and the analysis can be carried out. Shape of the blades can be changed to helical shape and the speed of rotation of the shaft can be noted with the current method. Vertical axis windmill is extremely simple design and it is cost effective. In current condition, the performance of VAWT with four blades exceeds that of the

one with two blades. It makes the four-bladed wind turbine more promising especially in areas with frequent light winds.

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