Sonu Rana et al. International Journal of Recent Research Aspects ISSN: 2349-7688, Vol. 7, Issue 1, March 2020, pp. 9-13

# Designing VAWT Based Road light Poles for Highways and its implementation

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***Abstract* - In today's globalized world highways are meant to connect the countries, states, cities, towns etc. As we all know as there are no. of vehicles increasing day by day, so as there are also increasing the highways in countries. Due to increasing in highways there are demanding more Road lights on the highways so as they also demanding more electrical power.so we have find a smart and innovative solutions for the highway road light system that is wind turbine based road light poles. That is based on the renewable energy source that is vertical axis wind turbine (VAWT). In this paper we review the idea that we used here to generate electrical energy from wind pressure that is produced due to the vehicle motion on highways. The wind flow depend on the velocity of the vehicles, size of the vehicles and intensity of the traffic. So, in this paper we are trying to throw some light on techniques of utilizing green energy on highways on fruitful manner.**

***Keywords:* Highways, Road lights, Renewable source, vertical axis wind turbine, electrical energy from wind pressure.**

## I. INTRODUCTION

Highways from the name it is very clear that any public street or other public street or other public path on land. It is mainly used for major roads but also includes public ways and public routes. Indian road network of 33lakh kilometers is second largest in the world and consist of:

| HIGHWAY | LENGTH (in KM) |
|---|---|
| Expressway | 200 |
| National highways | 96,260.72 |
| State highways | 1,31,899 |
| Major district highways | 4,67,763 |
| Rural and other roads | 26,50,000 |
| TOATAL LENGTH | 33 LAKHS KMS (approx...) |

TABLE 1: Indian Road Network

Source: http://www.nhai.org/roadnetwork.htm

About 65% of freight and 80% passenger traffic is carried by roads. No. of vehicles has been growing at an average of 10.16% per annum over the last five years. As the number of vehicles are increasing simultaneously there are o. highways are also increasing.so as the highways are increasing they need more road lights and more consumption of electricity. So we have to find a way that can energy efficient and less consumption of electricity on roads. We can use a wind energy for the generation of electricity for road light. Vertical axis wind turbine can be used in the pole of road light that can generate electricity from the moving vehicles. Wind energy is considered the fastest growing source of clean energy. However, it is limited by its variable nature. Highways can provide a considerable amount of wind to drive a turbine due to high vehicle traffic due to the pressure difference in the air adjoining the vehicle wind will generated [5]. Small vertical axis wind turbine can be installed on the poles of the road lights on highways. The turbine will be placed on the pole placed in the centre of the four lane roads so that wind flow from both sides of the highways will be acting tangentially in opposite directions on both sides of turbine. These types of turbine can be installed on express highways and other high speed traffic areas to generate electricity [8]. The turbine can be used globally as an unlimited power source for street lights and other public amenities.

## II. OBJECTIVE

The objective behind the designing a highway wind turbine is to contribute towards the national trend in wind energy production in a feasible way. Wind turbines are traditionally employed in rural areas. The turbines will use the wind draft created by vehicles on the highways to generate electricity.

## III. USE OF WIND ENERGY

Wind energy is one of the oldest sources of energy used by mankind. Wind represents the kinetic energy of the atmosphere. Wind is caused by a force developed due to differences in atmospheric pressure. The energy which is generated by the flow of wind using wind turbines is called wind energy. It is a renewable source of energy which can be used as an alternative to fossil fuels. Wind energy is a clean energy which does not create pollution or releasing any harmful gases i.e. Greenhouse gases. At highways there is availability of wind by the motion of moving vehicles. When a free moving air particle is disturbed by forceful object succeeding in its path a pressure is developed at the body of the object and it is delivered to the surrounding near objects. By this phenomenon wind turbine is placed on the street light. Generally all the large wind turbine have same structure consist of a horizontal axis wind turbine having upwind rotor with three blades. Today in wind turbine we use the combination of variable speed generators and partial or full scale power converter between the turbine generator and the collector system. A wind turbine is a device that converts kinetic energy from the wind into electrical power. We can use windmill application on highway because a considerable

 

amount of wind is produced by vehicles. The wind turbine will be placed on medians therefore air flow from both side of highway will be considered in the design.

## IV. PROPOSED DESIGN

To design a vertical axis wind turbine to utilize wind produced by moving vehicles to generate electricity. These turbines will be placed along the roadways that have high volume of fast moving traffic. The electricity generated will then be stored in batteries. Since the electricity produced will be direct current (DC) it must be converted to alternating current (AC) before it can be used for lighting the street lamps, sold the grid or any of the man ways we use electricity today this means the DC current must be pasted through an inverter first before it is used. Figure 2 shows a sample vertical axis wind turbine with part labels however, the turbine we are designing will likely reflect the design in figure 3 by TAK studios

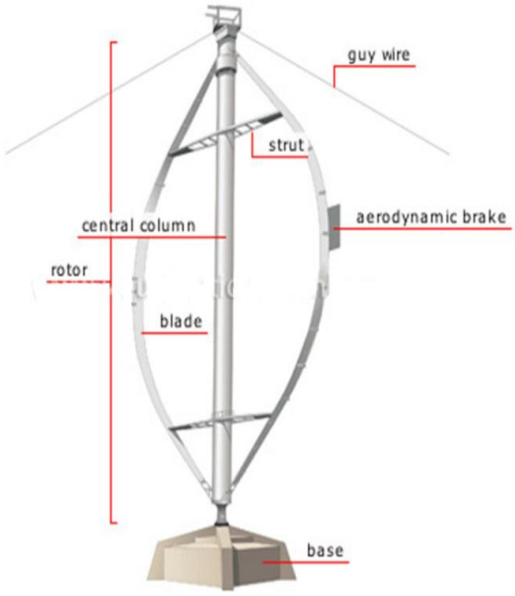


Fig. 1 Labeled parts of a Vertical wind turbine

FIG. 2 Tak studio design

## V. Design methodology

Before starting the design of the wind turbine, it should be made sure that sufficient wind energy is generated by the moving vehicles on the highways for the operation of the turbine. So, wind readings (peak values) were taken from different places in Salem highway at different intervals. The graphical representation of wind readings from highway is shown in fig. 1. The natural wind speed is not considered here.From the readings taken, it was found that average wind speed available on highway median is around 6 m/s.Also, it is found that wind speed is higher during the night time. From the readings taken from the highways, it was noticed that wind speed is varying with respect to the height from the ground and maximum wind speed is obtained between 1 metre and 2 metres from the ground level.

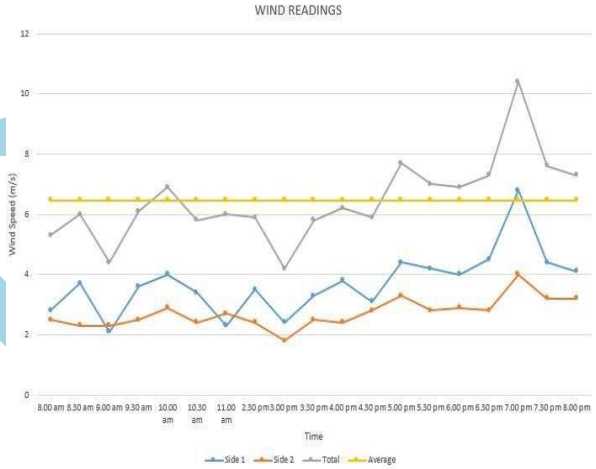


Fig. 3: Wind readings from Salem highway

*A) Tower height and design*: The height of the tower is very much important for a windmill. In VAHW the tower is kept little sort to obtain whole air density passing from the vehicle. We also should concentrate in the design of the tower because it should able to withstand for its own weight and also in the speed of the wind.

*B) Shape of the blade*: As discussed earlier the shape of the wind mill blades is the important one if one could place an efficient design of a blade then the efficiency of the windmill will be increased.

The various windmill shapes are as follows;

*a) Flat, unmodified blade surface.*

*b) Wing shape with one leading edge*

*c) Both edges tapered to a thin line.*

*d) Both edges leading blade*

 

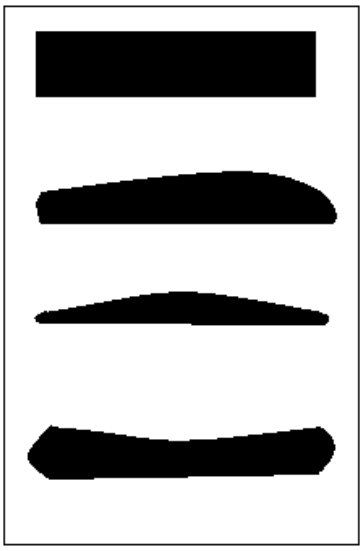

FIG. 4 various shapes of the blades

*C) DESIGN OF BLADES*: For the design of blades the selection material is very much important .because the material that we are selecting should be more weight less and it should able to withstand at high air pressure. For that a special grade of aluminium metal can be used it has light weight and it can able to withstand at high air pressure .the next important thing is to choose a blade shape. The c-type blade is suitable for vertical axis highway windmill(VAHW).Because it shape can able to collect maximum air pressure and it can able to give maximum energy transformation from forced wind energy to rotational mechanical energy. The shape of the blade used is shown below

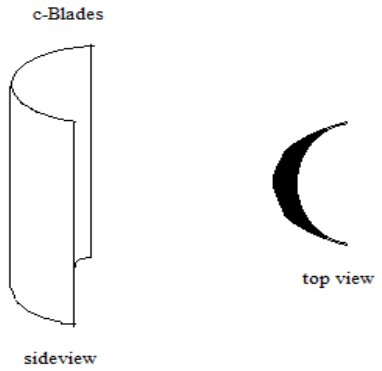


Fig 5 views of Blades

*D) DC GENERATOR IN VAWT*: The alternators or generators are the heart of the windmill and it must be properly sized to match your swept area and to produce right type of power to match your application. The unit needs to make higher voltages at lower rpms, otherwise it is not suited for wind power use, even motors can also be used a generators. In this vertical axis highway windmill we are using two dc generators coupled with the wind blade turbine.

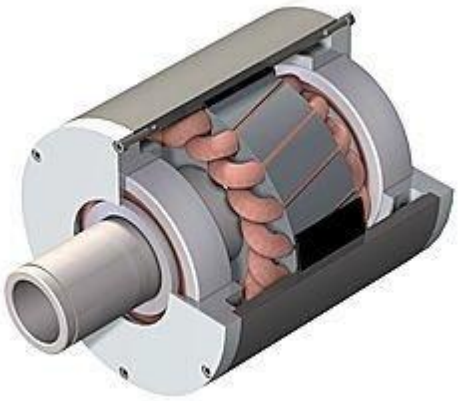

FIG 6 DC Generator

Wind generators come in various voltages such as 12volts, 24volts and 48volts DC and in a range of currents up to 80amps at 12volts. The wind generator is a square torque machine and the output increases exponentially with increasing wind speed. Most quality wind generators come with a blade stall facility that "stalls" the blades at high wind speed. Available also is an electrical blade lock that locks the generator on the throw of a switch. This prevents the generator turning when servicing is in progress. Wind generator technology is very mature technology and has been used by yachtsmen for at least the last 20 years. The technology is reliable and reasonable priced. Maintenance of a wind generator is simple, just grease the front and rear bearings and check all bolts and connections on a basis Wind generators are capable of producing large amounts of current, up to 80amps at 12volts and should always be fitted with a charge controller containing a power dump system. Wind Generators are a cost efficient way of producing power using a sustainable energy force the wind. They indicate easily into an Hybrid Power System and work well with solar arrays. The solar array controller can also be used by the wind generator to control and dump any excess power produced by the hybrid system. If the sun does not shine hopefully the wind will be blowing yearly

*a) Start up speed:*

This wind speed at which the rotors starts turning. It should spin smoothly and easily when you turn it by hand, and keep spinning for few seconds. Designs that „cog" from magnetic force or that use gears or pulley to increase shaft speed will be poor at start up. A good design can start spinning in 5 mph winds cut in at 7 mph.

*b) Inefficiency:*

Every generator has a certain speed at which it runs most efficiently. But since the wind is not constant, we must try to design to happy medium. As the wind speed rises, the raw power coming into the generator from the wind becomes more than the generator can effectively Use, and it gets more and more inefficient. This power is wasted as heat in the stator coils.

*E) VOLTAGE REGULATORS:* Voltage regulator is used to regulate voltage level. When a steady, reliable voltage is needed, then voltage regulator is the preferred device. It generates a fixed output voltage that remains constant for any

 

changes in an input voltage or load conditions. It acts as a buffer for protecting components from damages. Most common voltage regulator is of series 78xx (sometimes L78xx, LM78xx, MC78xx...) which is a family of self-contained fixed linear voltage regulator integrated circuit.

*F*) BATTERIES**:** The batteries in the system provide to store the electricity that is generated from the Hybrid energy system. Any required capacity can be obtained by serial or parallel connections of the batteries. It is connected to the bidirectional polarity controller for its protection and implemented with solar tracking system in order to provide operation of the tracker.

*G) INVERTERS:* Energy stored in the battery is drawn by electrical loads through the inverter, which converts DC power into AC power. The inverter has in-built protection for Short-Circuit; Reverse Polarity, Low Battery Voltage and Over Load.

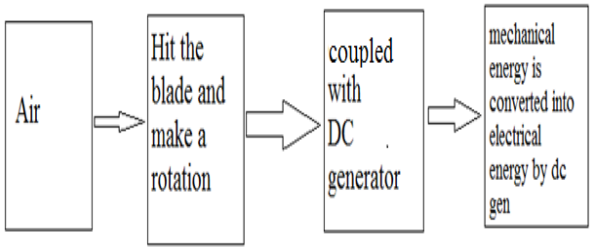


FIG 8 Block diagram of system

The energy conversion process is explained by several following steps:

***Step-1:*** In the first step the forced wind and middle part of the highway will hit wind turbine blades and make a rotation in it The wind turbine blade will rotate at clockwise direction even when the vehicle move in any of the side of the highway. Because the arrangement of the wind turbine blades are in that manner.

***Step-2:*** The vertical axis highway windmill the wind blade turbine is coupled with the two generators .one is in the top and the other one is at the bottom of the wind turbine blades. When the turbine blade rotate the coupled generators will produce electricity in both direction.

***Step-3:*** Thus the mechanical energy is converted into electrical energy by using dc generator and this produced power is stored in the battery and is utilised by application wise.

## VI. CALCULATIONS:

*1) The power in the Wind*

The power in the wind can be computed by using the concepts of kinetics. The wind mill works on the principle of converting kinetic energy of the wind to mechanical energy. The kinetic energy of any particle is equal to one half its mass times the square of its velocity, or ½ mv2. The amount of air passing in unit time through an area A, with velocity V, is A. V, & its mass M is equal to its Volume multiplied by its density of air, or

m = AV……..(1)

(m is the mass of air transferring the area A swept by the rotating blades of a wind mill type generator

Substituting this value of the mass in expression of K.E.

Substituting this value of the mass in expression of K.E.= ½ AV.V2 watts= ½

AV3 watt…….. (2)

Second equation tells us that the power available is proportional to air density (1.225 kg/m3) & is proportional to the intercept area. Since the area is normally circular of diameter D in horizontal axis aero turbines, then

$$A = \frac{\pi \quad D^2}{4} \quad \text{(Sq.m)}$$

*2) Wind velocity vs. power output*

Power output= (1/2) Av^3

- Air density at that particular height and location, (normally 1.225 kg/m3) A- Swept area by blades=3.33 each

V- Wind velocity in m/s.

| Sr. No | Wind Velocity (m/s) | Output (Watts) |
|---|---|---|
| 1 | 3 | 55.09 |
| 2 | 4 | 130.33 |
| 3 | 5 | 254.95 |
| 4 | 6 | 440.55 |
| 5 | 7 | 699.59 |

TABLE 2. Wind velocity vs. power output

 

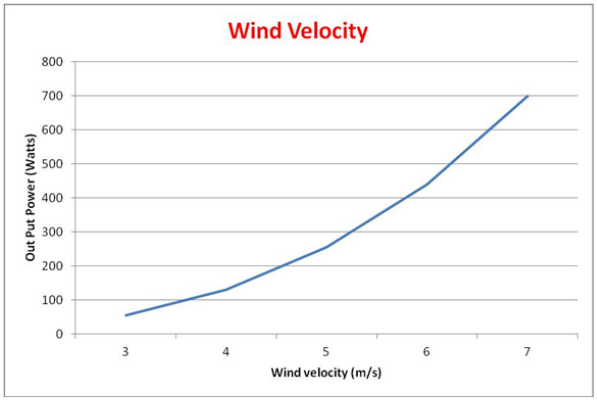


fig 9 Wind Velocity

## VII. CONCLUSION

The proposed model of vertical axis wind mill will be a good source of renewable energy on highways. The wind energy generated by the moving vehicles on highways can be utilized to generate electrical energy which can be stored in a battery and used for purposes like street lighting, traffic signals, road studs etc. This design concept is meant to be sustainable and environmentally friendly. If these types of turbines can be installed on long high speed express highways like golden quadrilateral, a considerable amount of electrical energy can be generated, which can solve the issue of energy crisis to a large extend.

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