Design And Development of Alternate Sources of Energy Using Wind Turbulence Created by Moving Vehicles on Highway by Using VAWT'S

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Abstract— Energy conservation is a process of conquering circulatory waste energy or heat and converting it into usable power which has been continuously attracting more and more researcher interest because of the limitations of traditional power sources. The foremost aim will be to extract usable power which can run various devices having low power requirement such as mobile devices and wireless sensor networks.

In highways and railway transports, there is a wide need of replacing the existing source of energy by alternate source of energy. This report represents the method of harnessing the turbulence of winds generated by the frequently passing vehicles on highway by use of Vertical Axis Wind Turbine [VAWT]. By combining numerous VAWT, the wind turbulence created by the frequently passing vehicles on highway can be used to generate electricity which can be stored in the battery and used for the various applications such as street light or a charger station in the remote highway.

Keywords— *VAWT Vertical axis wind turbine, Tip Speed Ratio, Aerodynamic, Solidity, Computational Fluid Dynamics, Glass Reinforced Plastic*

I. INTRODUCTION

Lots of efforts have been made previously on energy conversion. Three common mechanisms used for energy scavenging are electrostatic, electromagnetic and piezoelectric. It is the energy which control whole universe and energy is the symbol of importance. Energy is a need to everyone from our ancestors to our future generation. In present the depletion of energy is at peak which requires the alternate source of energy. In addition to energy resources, energy conservation and energy use efficiency, are also key factors for avoiding the situation of energy deficiency

The aim of this research paper is the incorporation of more renewable energy to the power station by Design & build a vertical axis wind turbine to generate electricity by using the wind turbulence created by moving vehicle on highway.

II. FUNDAMENTALS OF VERTICAL AXIS WIND TURBINE

A Vertical axis wind turbines are advocated as being capable of catching the wind from all directions, and do not need an extra mechanism to turn turbine rotor by wind. A three bladed wind turbine is proposed as a candidate for further prototype testing after evaluating the effect of several parameters in turbine efficiency, torque and acceleration. Herein the turbulence which is created by the moving vehicles on highway will lead to the rotation of vanes of VAWT which is coupled by the shaft of the generator and ultimately energy is produced.By combining numerous VAWT, the wind turbulence created by the frequently passing vehicles on highway can be used to generate electricity which can be stored in the battery and used for the various applications.

III. DESIGN PARAMETERS

TURBINE TYPE

Vertical Axis Wind Turbines (VAWT): The rotational axis is perpendicular to the wind direction or the mounting surface. The main advantage is that the generator is on ground level so they are more accessible. Because of its proximity to ground, wind speeds available are lower. The design idea is to make a lift type turbine, with straight blades instead of curved. This kind of device is also called Darrius type and its power coefficient can be high.

SWEPT AREA

The swept area is the section of air that encloses the turbine in its movement, the shape of the swept area depends on the rotor configuration, this way the swept area of vertical axis wind turbine the swept area has a rectangular shape and is calculated using:

$$S = 2\,R\,L$$

Where, S is the swept area [m^2], R is the rotor radius [m], and L is the blade length [m]. The swept area limits the volume of air passing by the turbine.

POWER AND POWER COEFFICIENT

The power available from wind for a vertical axis wind turbine can be found from the following formula:

$$P_w = 0.5\rho S V_0^3$$

Where, V_o is the velocity of the wind [m/s] and ρ is the air density [kg/m^3]

The power of the turbine takes from wind is calculated using the power coefficient:

C_p = Captured mechanical power by blades ÷ Available Power in wind

C_p value represents the part of the total available power that is actually taken from wind, which can be understood as its efficiency.

For VAWT, the limit is 16/25 (64%). These limits come from the actuator disk momentum theory which assumes steady, in viscid and without swirl flow. Making an analysis of data from market small VAWT the value of maximum power coefficient has been found to be usually ranging between 0.15 and 0.22.

TIP SPEED RATIO

The power coefficient is strongly dependent on tip speed ratio, defined as the ratio between the tangential speed at blade tip and the actual wind speed.

$$TSR = \frac{tangential\ speed\ at\ the\ blade\ tip}{actual\ wind\ speed} = \frac{Rw}{v_0}$$

Where ω is the angular speed [rad/s], R is the rotor radius [m] and V_0 the ambient wind speed [m/s]. Each rotor design has an optimal tip speed ratio at which the maximum power extraction is achieved.

BLADE CHORD

The chord is the length between leading edge and trailing edge of the blade profile. The blade thickness and shape is determined by the airfoil used, in this case it will be a NACA airfoil, where the blade curvature and maximum thickness are defined as percentage of the chord.

NUMBER OF BLADES

The number of blades has a direct effect in the smoothness of rotor operation as they can compensate cycled aerodynamic loads. For easiness of building, four and three blades have been contemplated.

Three blades are more efficient than four for the same rotational speed; the final decision will be made considering the acceleration behavior, which will provide a better view of the self-starting characteristics.

SOLIDITY

The solidity σ is defined as the ratio between the total blade area and the projected turbine area. It is an important non dimensional parameter which affects self-starting capabilities and for straight bladed VAWTs is calculated with

$$\sigma = \frac{Nc}{R}$$

Where, N is the number of blades, c is the blade chord, L is the blade length and S is the swept area, it is considered that each blade sweeps the area twice.

Solidity determines when the assumptions of the momentum models are applicable, and only when using high $\sigma \geq 0.4$ a self-starting turbine is achieved

INITIAL ANGLE OF ATTACK

The initial angle of attack is the angle the blade has regarding its trajectory, considering negative the angle that locates the blade's leading edge inside the circumference described by the blade path.

The airfoil has been selected considering the availability of airfoil data for angles of attack between -30 and 30º and the final thickness of the blade which is associated with its ability to withstand the loads.

GENERATOR

For generation of electricity from the designed our vertical axis wind turbine, we chose a dynamo which has the capacity to light a bulb of 12 V and a high rpm shaft.

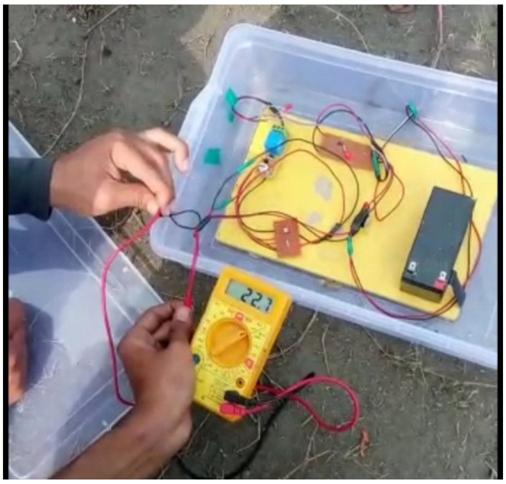
BEARING

For the smooth operation of Shaft, bearing mechanism is used. To have very less friction loss, the two ends of shaft are pivoted into the same dimension bearing. Bearings are generally provided for supporting the shaft and smooth operation of shaft.

IV. THEORETICAL DESIGN

DESIGN PARAMETRES	VALUES
NO. OF BLADES	3 Blades
ROTOR RADIUS	0.4 meter
LENGTH OF BLADE	1.0 meter
CHORD LENGTH	0.2 meter
SHAFT LENGTH	1.5 meter
WIND SPEED	12 meter/sec
AIR DENSITY	1.184 kilogram per cubic meter
SWEPT AREA	0.8 square meter
SOLIDITY	1.5
TIP SPEED RATIO	1.54
RATED BLADE SPEED	12.56 radian per second
RATED ROTATIONAL SPEED	120 rpm
RATED POWER	130 Watt
GENERATOR CAPACITY	12 Volt

V. DESIGN OF PROPOSED SYSTEM



VI. RESULT

From our observations and mathematical calculations it turn out that heavy vehicle moving on highway through its high velocity induced some velocity to air-mass which can rotate wind turbine.

After fabricating the project, we went for testing, we mounted our project on divider of Pardi Highway. We tested the project for some hours with different conditions through this we obtained the desired output. We have obtained the angular speed of the blades i.e. 60-70 rpm from which the average power generation was 30 Watt that was stored in the battery. The power stored in the battery was used for glowing 12V LED.

VII. FUTURE SCOPE

The actual process of blade designing is very complex and need to be more aerodynamically sound. The use of Computational Fluid Dynamics Software would enable a more correct design. Glass fiber reinforced plastic (GRP) would have been the ideal choice for the blade as it is lighter in weight and has a good tensile and compressive strength. Hence the blade would not damage and will have a long life.

Another important change that we can incorporate is to use a power controller circuit as the input power is not constant, the output power changes accordingly. Moreover there is a mismatch in the generator output and the power input to the battery. In order to rectify this problem we can use a power controller circuit.

VIII. CONCLUSION

The implementation of vertical axis wind turbine on road dividers would be a great asset to the Ministry of Non-Conventional Energy Resources. They can be installed on the highway with the width being only constraint. These turbines are simple in construction and require less investment. Since the turbine is in small size, it can harness a limited amount of wind. Therefore they can be used for low power application such as street lighting on highway and charging station at remote areas. Other application could be electronic diversions signal on highway and traffic lights. This can be of hybrid type where presence of sunlight by using Solar Panel.

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