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Bladeless Wind Power Generation

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ABSTRACT:-

Bladeless Wind Power Generation uses a radically new approach to capturing wind energy. The device captures the energy of vortices, an aerodynamic effect that has plagued structural engineers and architects for ages (vortex shedding effect). As the wind bypasses a fixed structure, it's flow changes and generates a cyclical pattern of vortices. Once these forces are strong enough, the fixed structure starts oscillating. Instead of avoiding these aerodynamic instabilities our design maximizes the resulting oscillation and captures that energy. Naturally, the design of such device is completely different from a traditional turbine. Instead of the usual tower, nacelle and blades, the device has a fixed mast, a power generator and a hollow, lightweight and semi rigid fiberglass cylinder on top. This puts the technology at the very low range of capital intensity for such projects, it also makes it highly competitive not only against generations of alternative or renewable energy, but even compared to conventional technologies.

1. INTRODUCTION

Wind power has become a legitimate source of energy over the past few decades as larger, more efficient turbine designs have produced ever-increasing amounts of power. But even though the industry saw a record 6,730 billion global investment in 2014, turbine growth may be reaching its limits. Bladeless turbines will generate electricity for 40 percent lesser in cost compared with conventional wind turbines. In conventional wind power generation transportation is increasingly challenging because of the size of the components: individual blades and tower sections often require specialized trucks and straight, wide roads. Today's wind turbines are also incredibly top heavy. Generators and gearboxes sitting on support towers 100 meters off the ground can weigh more than 100 tons. As the weight and height of turbines increase, the materials costs of wider, stronger support towers, as well as the cost of maintaining components housed so far from the ground, are cutting into the efficiency benefits of larger turbines. The alternative energy industry has repeatedly tried to solve these issues to no avail. But this latest entry promises a radically different type of wind turbine: a bladeless cylinder that oscillates or vibrates. The Bladeless Turbine harness vortices, the spinning motion of air or other fluids. When wind passes one of the cylindrical turbines, it shears off the downwind side of the cylinder in a spinning whirlpool or vortex. That vortex then exerts force on the cylinder, causing it to vibrate. The kinetic energy of the oscillating cylinder is converted to electricity through a linear generator

Similar to those used to harness wave energy. It consists of a conical cylinder fixed vertically with an elastic rod. The cylinder oscillates in the wind, which then generates electricity through a system of coils and magnets.

The outer conical cylinder is designed to be substantially rigid and has the ability to vibrate, remaining anchored to the bottom rod. The top of the cylinder is unconstrained and has the maximum amplitude of the oscillation. The structure is built using resins reinforced with carbon or glass fiber, materials used in conventional wind turbine blades. The inner cylindrical rod, which will penetrate into the mast for 10% - 20% of its length (depending on the size of the mast), is anchored to it at its top and secured to the ground at its bottom part. It is built to provide highest resistance to the fatigue and allow its elasticity to absorb the vibrations generated by the cylinder. A semi- rigid coupling allows the upper section of the turbine to flutter in the wind while a linear alternator housed in the lower section converts the movements into electricity.

The bladeless wind generator generates electricity through a "classic" system of coils and magnet. The cost reductions come from reduced manufacturing costs: the tower and the generator equipment are, basically, one and the same. This allows us to bypass the need for a

Nacelle, the support mechanisms and the blades, that are the priciest components in the conventional wind generators. Manufacturing savings are roughly estimated at around 51 % of the usual wind turbine production cost. The manufacturing, transportation, construction and assembly are also simplified and are typical for the wind industry. The bladeless turbine currently takes up as much as 30% of the area of a conventional generator, with maximum amplitude around a diameter at the top. It can capture about 40% of the wind power contained in the air, which is a more than reasonable capacity, and at same height as many modern wind turbines. The system does loose some electrical conversion capacity (reaching 70% yield of a conventional alternator), because the design is so focused on avoiding and wear and tear .It aims to be a "greener" wind alternative. The impact on the bird population is expected to be much smaller, because it doesn't require the same type or magnitude of movement as the traditional wind turbine, allowing for higher visibility. With the oscillation frequency of the equipment very low, the impact sound level is nonexistent, opening the possibility to make the future wind farms completely silent.

Fig 1.1:Bladeless wind

II. OBJECTIVE FOR OUR PROJECT

- To create a wind turbine without blades.
- Due to the absence of blades, these type of windmills can be used in variety of location such as building roof top, sea shores, road sides and railways etc.
- It will eliminate most of the existing problem in conventional wind turbine like need of larger area, unidirectional rotation, etc.

2. METHODOLOGY

The main principle behind bladeless wind generator is the conversion of linear oscillation of mast to rotational motion. As the mast is subjected to wind energy, it tends to oscillate due to the vortices formed around the structure of the mast, which can be converted to rotational force to generate electricity. In the bladeless wind system configuration, the mast is fixed with respect to the ground and the rib structure at the top of the mast comprising of thread arrangement is used for pulling the threads attached to it. Energy is obtained by continuously oscillation of the mast. The mast utilizes wind power to pull the threads along with the chain attached to the sprockets which drive the shaft which intern rotates the alternator to generate power. During the oscillation of the mast, the mast tries to oscillate in any direction depending on the wind direction.

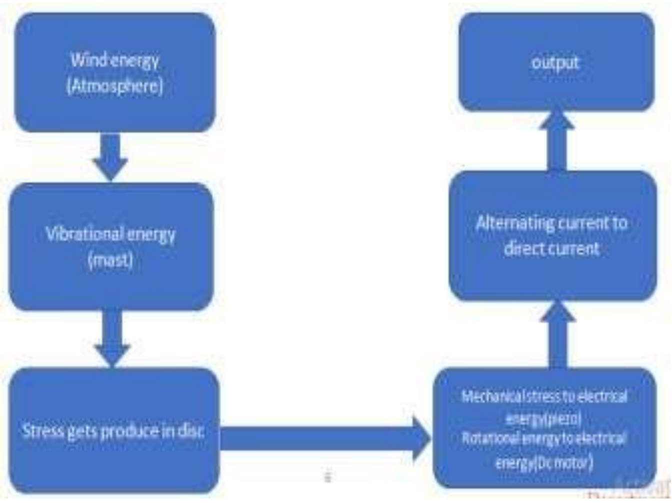


Fig 2.1 Pictorial representation of Methodology

The rib structure at the top of the mast is attached with six threads to absorb the energy from the wind. Each set of the thread arrangement of the rib structure corresponds to one sprocket on the shaft which is driven by the chain which is pulled by the thread. Hence three sprockets are available in the shaft out of which, at least one of the sprockets is always in motion during the oscillation of the mast. The arrangement of the threads on the mast is such that the power is generated on all direction of oscillation of the mast. Each of the threads is joined with the chain which drives the sprocket attached to the shaft to generate the maximum amount of power. The thread joined with the chain is fixed with a spring mechanism; during the oscillation of the mast one of the six threads is pulled which make the chain to drive the sprocket on the shaft. After the maximum oscillation on one side is reached, the mast returns to its initial position and then continues the oscillation on the other side where in the other arrangement of the threads and sprocket drives the shaft hence providing the continues movement of the shaft.

Such operation has been developed and tested through numerical simulations, considering a quite accurate model, which takes into account the aerodynamic characteristics of the mast and the strength of the threads, and employing self-tuning magnetic coupling system to maximize the net generated energy. So that it can operate in a wider range of wind speeds and also withstand the high wind velocities.

This system allows maximizing the oscillation amplitudes when wind intensifies. When the wind strikes the mast, it starts to oscillate due to the vortices formed around the structure and suspension spring placed at the bottom of the mast. The energy absorbed by the spring during the oscillation of the mast contributes to the increase in the amplitude of the oscillations. The rib structure with the six thread arrangement at the top of the mast is attached to the bottom chain drives through the guide ways which helps the mast to oscillate in any direction of the wind .During the back and forth oscillation of the mast, one of the six threads is pulled from the rib structure of the mast depending upon the direction of the wind. The thread being pulled due to the oscillation of the mast is connected to chain which drive the sprocket on the shaft. Each set of the thread arrangement of the rib structure corresponds to one sprocket on the shaft which is driven by the chain which is pulled by the thread. Hence three sprockets are available in the shaft out of which one of the sprockets always is always in motion during the oscillation of the mast.

The thread mechanism is provided with guide ways and pulleys for maximum transfer of the pulling force from the oscillation to the sprockets of the shaft. It also helps to increase the tensile strength of the threads which is necessary to increase the conversion efficiency to the maximum extent.

The shaft driven by the sprockets arrangement rotates only in clockwise direction and restricts the rotation of the shaft in the opposite direction which otherwise may cause the threads to be pulled which may disrupt the oscillation of the mast and bring it to a halt. This shaft is welded with two bicycle pedal at the end spaced 180 degrees apart and the flywheel is provided with four counter weights 90 degrees apart, the arrangement of the pedal and the counterweight helps to increase the rotation of the flywheel.

As the power is generated in the half cycle of the oscillation of the mast the shaft is subjected to a jerk motion rather than a smooth motion. Such arrangement of pedal and the counterweight helps in the smooth rotation of the flywheel trying to achieve perpetual motion. The power wheel is connected to the alternator via belt drive which increases the rotation of the alternator with a ratio of 1:10 when the shaft is in the motion. The belt drive eliminates the gear system thereby reducing the maintenance. The maximum oscillation on one side is reached with the thread pulled to maximum extent, at which the maximum energy is absorbed from the wind. After which the mast returns to initial position and continues the oscillation at other end where in the other arrangement of the threads and sprocket drives the shaft hence providing the continues movement of the shaft. Since the power output of the alternator is AC. It is rectified using a rectifier circuit, filtered and regulated using a regulating circuit to 12V. The output DC Voltage obtained via the dual output of the regulation circuit charges the batter.

Block Diagram

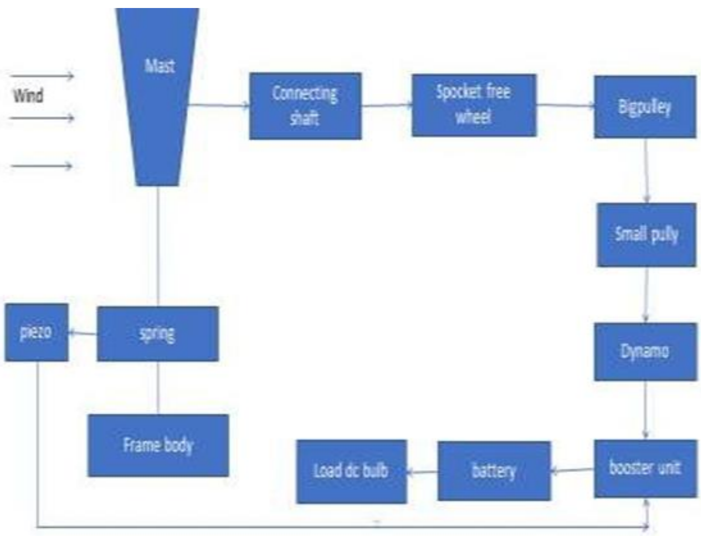


Fig 2.2 Pictorial representation of Block diagram

3. DESIGN AND FABRICATION OF BLADELESS WIND TURBINE

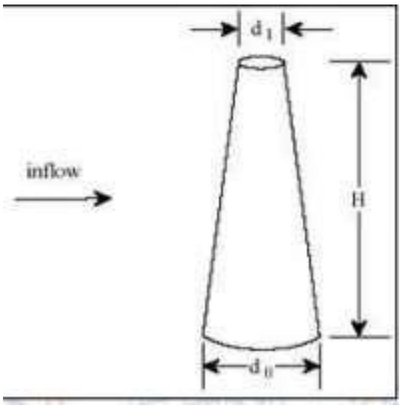


Fig.4.1: Vortex Induced Vibration

Considering the notations as, d0= Dmax,d1= Dmin,

H= L,

U= Air velocity,

ν= Kinematic viscosity, fa= Oscillation frequency

Now, we know Reynolds Number(Re)

Re= (UD)/ν

And Strouhal Number (St)

St= $(f_s D)/L$ Area

of tapered cylinder,

$A_p = (\pi/2)*(Dmax + D_{min})*L$

R_t *= Taper Ratio =L/ $(D_{max} + D_{min})$*

Reynolds Number distinguishes the flow of fluid as Laminar or turbulent. So we are targeting Re values 300<Re<3*105 for better frequency of vibration. Now for Reynolds number to be 300<Re<3*105,

Strophe Number should be 0.2 or 0.198 (from graph)

St = 0.198

Now all the parameters are known except Mean diameter(D).To find mean diameter, we have to do trial and error. By comparing our value of D with L/D ratio of other such Experiment.

Let's fix length as L=2m total length so from previous research paper and past study we takeL/D=10 Now,

2000/D=10

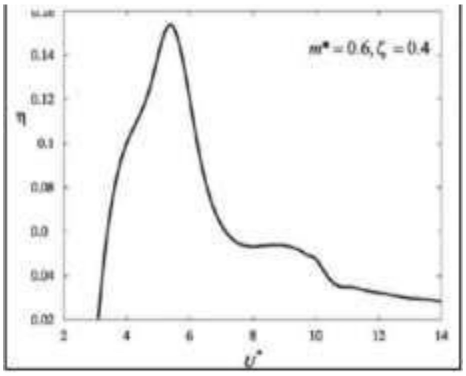
Dmax=200mm

Now from diffrentReserch paper we found the taper ratio lies between 14-19 so selecting 16 as a taper ratio r=16

r=L/Dmax- Dmin

16=2000/200-Dmin

Dmin=75mm = 80 mm Approx for smooth taper



4. DISCUSSION, PERFORMANCE ANALYSIS

Fig 4.1 Model view

We have built and assembled the circuit in the model as shown above in the figure above. When the wind above 20 m/s speed comes to the mast is to swing energy is converted into kinetic energy to rotating the wheel is connected to the dynamo shaft to rating is generating the electric power .

The generated power is to store in the battery because the wind is continuously varies the power output is not a constant that way to store the power in the battery to utilized to small applications of street light.

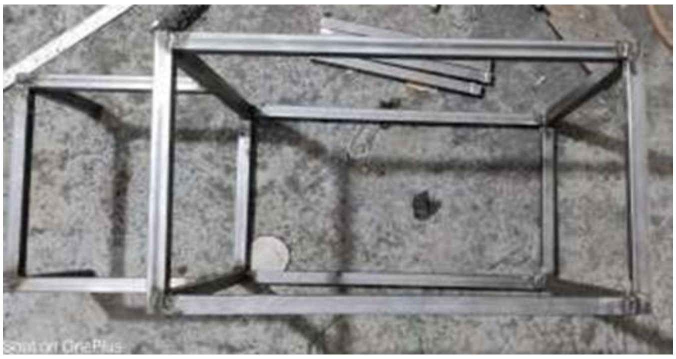


Fig 4.2 Base of the model

Fig 4.3 mast of the model 3M Height

5. RESULT

The frequency of oscillation of mast is 1 cycle per second. For each cycle of oscillation of mast voltage is between 4V-8V. The revolution of flywheel at 20 RPM gives 700RPM at the rotation of the generator. The energy is stored in the battery via the booster circuit.

Wind speed in m/s	Speed inrpm	Generatedvoltage
40	1000	8
35	800	6
25	600	4
10	450	3

6. CONCLUSION

Wind energy holds the potential to be the world's primary source of energy. The papers conclude that the vortex windmill is one of the greatest wind energy generation system .The generation system is useful for each and every individuals as well as residential, small scale industries. The problems with cost efficiency and the negative side effects that the modern wind turbine has an attempt to compensate for these problems, Vortex bladeless wind turbine is less expensive. In summary, the generation of electricity is made possible by the small structure of bladeless turbine. Efficient power is generated. This project will satisfy the need of continuous generation of electricity. The overall project uses less space area . The purpose of this project is to provide some fundamental results on the bladeless wind system and serve as stepping stones for the future development of bladeless wind power generating system. The forces that is beneficial or useful to generate power in bladeless are different from those in conventional horizontal axial wind turbines.

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