Vertical Axis Bladeless Windmill.

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Abstract

Today India is having fifth largest installed wind power capacity in the world. As the regions with high wind speed are limited, the installation of conventional windmill is limited. Windmills that would provide safe, quite, simple, affordable and work on lesser wind speeds are need of the hour. Vortex-Bladeless is a new concept of wind turbine without blades called Vortex wind turbine. The Bladeless Windmill which works on the phenomenon of vortex shedding to capture the energy produced. Generally, structures are designed to minimize vortex induced vibrations in order to minimize mechanical failures. But here, we try to increase the vibrations in order to convert vortex induced vibrations into electricity. The paper studies the scope and feasibility of the bladeless windmill. The device is composed of a single structural component, simplicity, its manufacturing, transport, storage and installation has clear advantages.

It is clear that the proposed device is of prime interest, and that scientific investigation of the response of this wind energy generator under different operation scenarios is highly desirable. Thus, the objective of this SHAPE project is to develop the needed tools to simulate Fluid-Structure Interaction (FSI) problems and to reproduce the experimental results for scaled models of the Vortex-Bladeless device. In order to do so the Alya code, developed at the Barcelona Supercomputing Center, is adapted to perform the Fluid-Structure Interaction (FSI) problem simulation. The obtained numerical results match satisfactorily with the experimental results reported.

Keywords – Rack and Pinion,*Bladeless Windmill, Vortex Induced Vibrations, Vortex Shedding*

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% 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 vorticity, 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 and/or glass fiber, materials used in conventional wind turbine blades.

The inner cylindrical rod, which will penetrate into the mast for 10% - 20% of it's 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 non existent, opening the possibility to make the future wind farms completely silent.

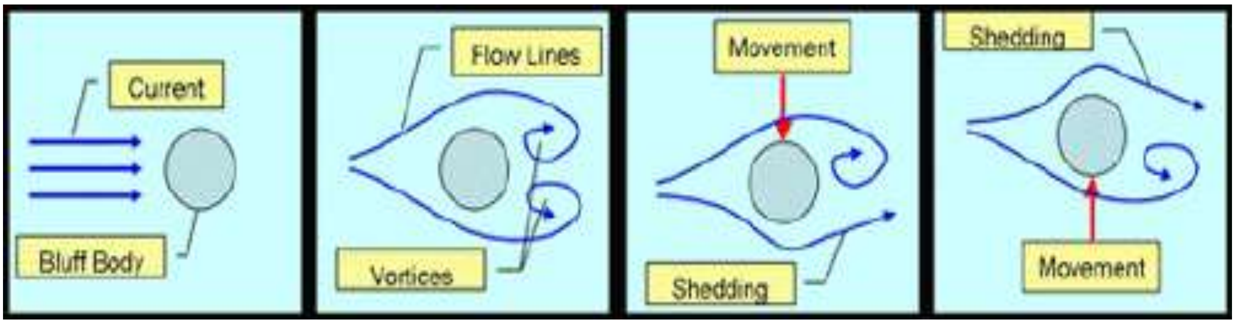
2. Problem Statement –

In But utilization of wind energy with the help of conventional windmills is very costly. To find the answer to the above question
survey of established literature was done. The problems related to conventional windmills were studied.
- It was found that huge investment is the most significant problem for erection of windmills.
- Conventional windmill requires places where wind speed is more. Such places are limited. Hence windmills working on lesser wind speeds are need of the hour.
- The cost of manufacturing different parts of windmill is very high. A typical windmill will cost $3000-$8000 per kilowatt .
- So also the transportation of such huge parts is very costly and risky. If during transportation components get damaged then again cost increases.
- Designing of windmill blades is also a big task.
- The size of the assembled windmill is also very large. The conventional windmills occupy lots of space. The commercial turbines can be 160m high .
- Area of installation is 60 acres per megawatt of capacity of wind farms .
- Also they prove fatal to birds.
- They produce low frequency sound which is not good for human health System .

3. General Information –

3.1. Vortex Shedding –

Vortex shedding is a widely occurring phenomenon applicable to nearly any bluff (non streamlined) body submerged in a fluid flow. Since any real fluid flow is viscous, there will be a significant boundary layer on the bodies' surface for all but the lowest Reynolds number flows. At some point along the bodies' surface, separation of the boundary layer will occur, depending on the exact surface geometry. This separated layer, which bounds the wake and free stream, will tend to cause fluid rotation, since its outer side, in contact with the free stream, moves faster than its inner side, in contact with the wake. It is this rotation which then results in the formation of individual vortices, which are then shed from the rear of the body and travel down the wake. Typically, a pattern of periodic, alternating vortex shedding will occur in the flow behind the body, which is referred to as a vortex street. Depending on the characteristics of the flow, mainly the Reynolds number, different types of vortex streets may form, which will be discussed later in more detail. When the pattern of shed vortices is not symmetrical about the body, which is the case in any vortex street, an irregular pressure distribution is formed on the upper and lower sides of the body, which results in a net lift force perpendicular to the flow direction. Since the vortices are shed in a periodic manner, the resulting lift forces on the body also vary periodically with time, and there for can induce oscillatory motion of the body. This occurrence alone would qualify as vortex induced vibration; however, there is a more interesting and important phenomenon, similar to linear resonance, which can occur when the frequency of vortex shedding (fs) is close to the natural frequency of the body in motion, (fn). In this phenomenon, referred to as “lock in”, the vortex shedding frequency actually shifts to match the bodies’ natural frequency, and as a result, much larger amplitudes of vibration can occur.



3.2 Scope –

The From above information it is clear that the Bladeless turbine wind generator is the best option for electricity generation using wind power due to its various advantages.
The country like India which having more rural population and condition suitable for wind generation through bladeless wind turbine is the best solution. It will help to increase percentage of renewable energy for electrical power generation and provides electrically as well as economically efficient power to the consumers.
Here it can be mounted to a roof and be very efficient and practical. A home owner would be able to extract free clean energy thus experiencing a reduction in their utility cost and also contribute to the “Green Energy” awareness that is increasingly gaining popularity. Problem with bladeless wind turbine is that it’s initial cost is high but once it get implemented then it’s operational cost is very less since it compensates initial cost. Another problem is, awareness about this concept. This concept having very less awareness among the world hence research and development of this concept is very slow.
Hence have to spread this concept because only renewable energy can survive the world in coming future and in that wind energy is efficient option .

4. Working –

The main principle behind bladeless wind mill is the conversion of 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 motion to generate electricity. In the bladeless wind system configuration, the mast is connected to the centre base and to the ground by using high tension nylon rod and the rack and pinion mechanism connected at the bottom of the mast. Energy is obtained by continuously oscillation of the mast. The oscillation vibrations from the wind forced mast is given to rack and pinion. Rack and pinion converts linear motion into rotational motion and these rotations are given to dc generator. As per function of generator, it converts mechanical rotation into electrical voltage. Further this electricity is stored in storage device like batteries. Thus the power generated is used for number of application.

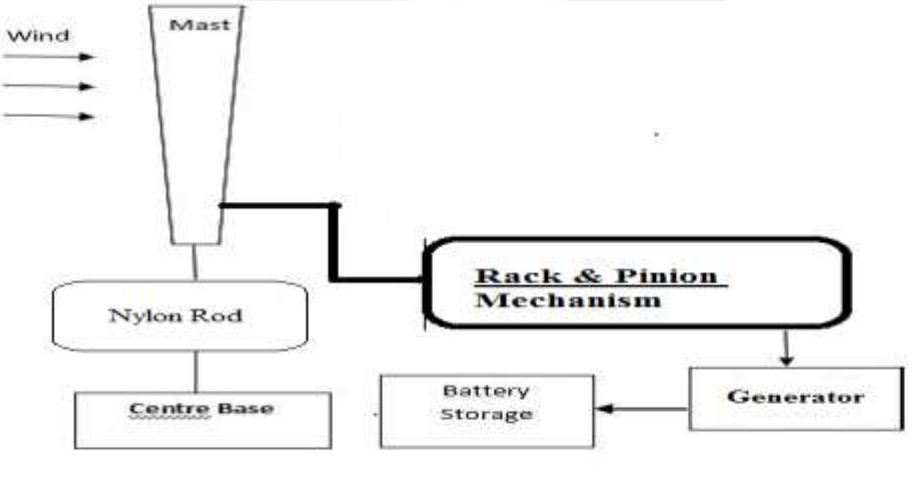


Fig-Setup

5. Methodology –

Fig- Methodology

6. Application –

1. Industries.
2. Remote telemetry
3. School
4. Farms
5. Houses
6. Off-Grid for Rail Signaling
7. Off-grid Lighting

7. Advantages-

8. Simple and low cost.
9. Compact size and light weight.
10. Pollution free.
11. Corrosion and cavitation is less.

8. Disadvantages –

1. Large power fluctuations.
2. Low energy conversion.
3. High mechanical stresses
4. Electrical power generation affected by environmental changes.

9. Conclusion –

Solar From above information it is clear that the Bladeless turbine wind generator is the best option for electricity generation using wind power due to its various advantages. The country like India which having more rural population and condition suitable for wind generation through bladeless wind turbine is the best solution. It will help to increase percentage of renewable energy for electrical power generation and provides electrically as well as economically efficient power to the consumers. Hence we have to spread this concept because only renewable energy can survive the world in coming future and in that wind energy is efficient option.

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