

Vortex Bladeless Wind Generator

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Abstract: Today, India is amongst the list of developing countries in terms of economic development. Hence the energy requirement is going to increase manifold in the coming decades. To meet these energy requirements, coal cannot be the primary source of energy. This is because coal is depleting very fast. So to meet these energy requirements non-renewable energy sources should be used excessively. In the world, India has fifth largest installed wind power capacity. As the area required for installation of conventional windmill is high, bladeless windmill based on vortex induced vibrations can provide the solution for these disadvantages of the conventional windmill. The Bladeless Windmill is a concept which works on the phenomenon of vortex shedding to capture the energy produced. Generally, the structures are designed to minimize vortex induced vibrations in order to minimize mechanical issues. But here, we try to increase the vibrations in order to convert vortex induced vibrations into electrical energy.

Keywords: Bladeless Windmill, Vortex Induced Vibrations, Vortex Shedding, Clean Energy.

I. Introduction

The efficiency of renewable energies has grown significantly in recent years and wind energy has been one of the most important parts. However, In today's world the photovoltaic cells are commonly used close to end customer point where energy generated is closed to that point. The lacking of mobile mechanical parts allows collecting energy from the sun with minimal maintenance and no environmental noise impact. The development of a new wind generator can be very useful if it is able to emulate the features that have made photovoltaic the main energy source in the distributed energy sector. With this new prototype of bladeless windmill power generator it is possible to harness wind energy without using blades which are used to rotate the alternator. In the process of wind power generation there are mainly two methods, Rotational wind harvesting and oscillation wind harvesting. In both of them mechanical energy is converted into electrical energy. This device works on the principle of vortex induced vibrations. This comes under the method of oscillation wind harvesting. It converts the vibration produced on the cylindrical body due to vorticity into electrical energy.

II. Problem Identification

The problems related to conventional windmills are:

1. The initial investment is huge.
2. It requires places where wind speed is more. Such places are limited.
3. The manufacturing cost of different parts of windmill is very high as compare to vortex wind generation.
4. Transportation is costly and risky.
5. Designing of windmill blades is also complex.
6. It requires lot of space (60 acres per MW), it is about 160meter high.
7. A typical windmill cost about per kilowatt is around (Rs. 2,00,000-Rs. 5,50,000).
8. Its harmful to birds.
9. It produces a low frequency sound which is not good for human health.
10. It has efficiency of about 60%.
11. Since it has moving parts, there is high wear and tear.

III. Possible solution

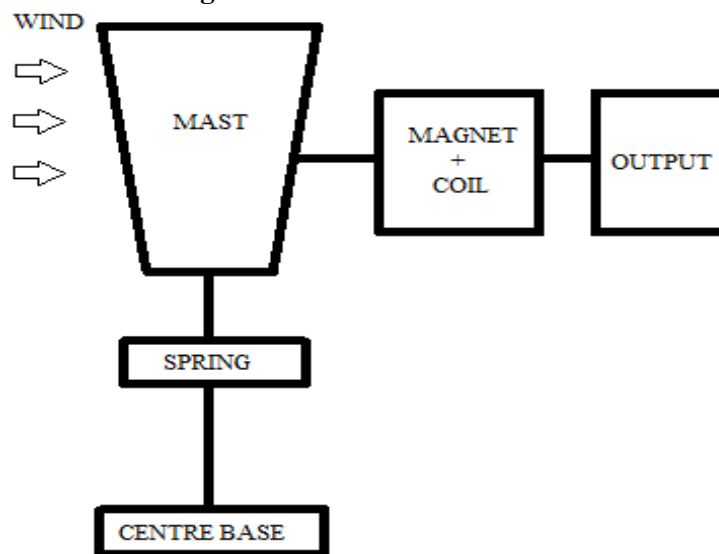
1. Bladeless windmill is far less costly and also required has less maintenance cost.
2. It requires lesser wind speed compared to traditional windmill.
3. It requires less space and is safe for birds.
4. It is based on the phenomenon based of vortex shedding effect.
5. 80% reduction in maintenance cost, because it is to easy maintain.
6. The design is study and there is minimal wear.
7. It captures wind energy using vorticity.

8. It is safer for birds, which often suffer from collision with blades.
9. Its operation is silent as it oscillate at a frequency that doesn't produce audible noise (below 20Hz)
10. It generates electrical power without blades.

IV. Working Principle

This device converts oscillating mechanical energy into electrical energy. This bladeless wind turbine captures the energy from the wind through resonance phenomenon produced by an aerodynamic effect called vortex shedding. In fluid mechanics, as the wind passes through hollow material body, the flow is modified and generates a cyclical pattern of vortices of wind. When the frequency of these forces is equals or near to body's structural frequency, the body starts to oscillate and enters into resonance with the wind. This phenomenon is called as Vortex Induced Vibration (VIV). Vortex shedding is an oscillating flow that takes place when a fluid such as air or water flows past a body at particular velocities, depending on the size and shape of the body. Instead of capturing energy through the rotational motion of a turbine, this windmill takes advantage of this Vortex induced vibration (VIV), an aerodynamic effect that occurs when wind breaks against a solid structure. The structure starts oscillating and capturing the energy that is produced and this can be done by placing cylindrical bodies such that wind flow normal to cylindrical bodies. Flow over this cylinder will generate an irregular vortex pattern which creates alternating high lift force on the body and pushing it up and down perpendicular to fluid flow. This alternating movement of this body will produce fluctuating kinetic motion which can be converted into electricity. As the cylinder oscillates forward and backward, the magnets attached to it moves around the conducting coils fixed on the base. The motion of the magnetic field through the coils generates current, causing voltage, which is then harnessed as electrical energy. This process varies greatly in efficiency based on device scale, spring tension, and the strength of magnetic field along with the no. of turns in the coil being used to generate electricity.

V. Block Diagram Of Vortex Bladeless Wind Generator



As shown in the block diagram, when wind strike to the mast then according to the vortex principle the mast start oscillating in forward and backward direction. The magnets which are connected to the mast also start oscillating. Due to this oscillation of magnets change in magnetic field produce and flux are cut by the stationary coil conductors according to the faraday's law of electromagnetic induction.

VI. Design Parameters

Resonance

$$f = \frac{St.v}{\phi} \dots (1)$$

F = frequency of vorticity

St = constant

V = velocity of wind flow

$$\phi = D + a.X \dots (2)$$

D = Diameter of mast

X = Amplitude of Oscillations

ϕ = Height of the mast

Design of mast:

Height = 50cm

Diameter = 17cm

VI. Conclusion

Vortex bladeless wind generations application in generating alternative energy is a viable solution of the current energy crisis. Vortex bladeless wind generation requires less investment, less area than conventional wind. VIV (Vortex Induced Vibration) also has the potential to be integrated with the other renewable energy technologies such as solar, wind and tidal. The device produces renewable clean energy which will provide alternate option for exhausting non-renewable energy sources in future.

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