

BLADELESS WIND MILL POWER GENERATION

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Abstract - The bladeless windmills use a radically new approach for capturing both intermittent wind energy pulses and constant wind flow under specified wind velocity and pressure. The windmill utilizes the energy of vortices, an aerodynamic effect (vortex shedding). As wind strikes a fixed structure, its flow changes and a cyclical pattern of eddies or vortices are formed in the vicinity of the structure. As these forces go strong, the structure starts vibrating. Consequently, these aerodynamic instabilities can be utilized to run. The natural frequency of the structure should not match with the frequency of vibration, which is one of the design criteria, our design takes care of this major criteria. The design of our windmill is entirely different from a traditional windmill. Instead of the huge tower, nacelle and blades, this device has a conical frustum mast made up of polypropylene sheet (pivoted at one-third length from bottom), a connecting rod and hinge joint. The hollow and light weight mast makes this device portable and user-friendly. Also, this low-cost component opens a way for low cost renewable source of energy.

Key Words: Bladeless windmill, Vortex, Spring, Polypropylene sheet, Birds

1. INTRODUCTION

The Bladeless Windmill is such a concept 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. This study focuses on identifying the effect of governing parameters on the energy extraction efficiency by VIV. The parameters investigated were the mass ratio, the mechanical damping coefficient, and the Reynolds number. 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.

1.1 HISTORY OF BLADELESS POWER GENERATION

The Vortex Street effect was first described and mathematically formalized by Theodore von Kármán, the genius of aeronautics, in 1911. This effect is produced by lateral forces of the wind on any fixed object immersed in a laminar flow. The wind flow bypasses the object, generating a cyclical pattern of vortices, which can become an engineering challenge for any vertical cylindrical structures, such as towers, masts and chimneys. The issue is that they may start vibrating, enter into resonance with the lateral forces of the wind, and ultimately, collapse. One of such examples is the collapse of three cooling towers of the power station Ferrybridge in 1965. However, it is possible that the same forces can be captured to produce energy - the idea behind Vortex.

1.2 PIEZOELECTRIC TRANSDUCER

A transducer can be anything which converts one form of energy to another. Piezoelectric material is one kind of transducers. We squeeze this material or we apply force or pressure on this material it converts it into electric voltage and this voltage is function of the force or pressure applied to it. The material which behaves in such a way is also known as piezoelectric sensor. The electric voltage produced by piezoelectric transducer can be easily measured by voltage measuring instruments, which can be used to measure stresses or forces. The physical quantity like mechanical stress or force cannot be measured directly. There for piezoelectric transducer can be used.

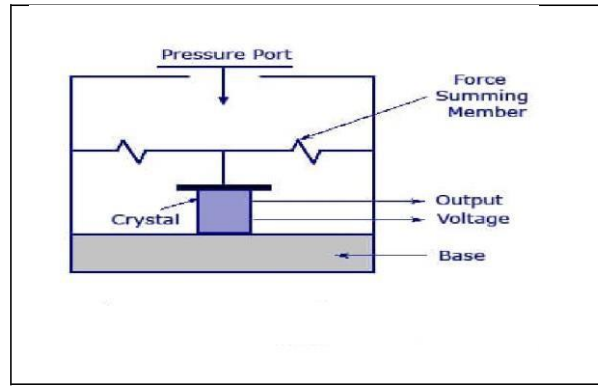


Fig.1 Piezoelectric Transducer

Piezoelectric transducer consists of quartz crystal which is made from silicon and oxygen arranged in crystalline structure (SiO₂). Generally, unit cell (basic repeating unit) of all crystal is symmetrical but in piezoelectric quartz crystal it is not. Piezoelectric crystals are electrically neutral. The atoms inside them may not be symmetrically arranged but their electrical charges are balanced means positive charges cancel out negative charge.

2. VORTICITY AND VORTEX SHEDDING EFFECT

Vortex shedding is an oscillating flow that takes place when a fluid such as air or water flows past a bluff body at certain velocities, depending on the size and shape of the body. In this flow, vortices are created at the back of the body and detach periodically from either side of the body. Vortex shedding behind a circular cylinder. In this animation, the flow on the two sides of the cylinder is shown in different colors, to show that the vortices from the two sides alternate.

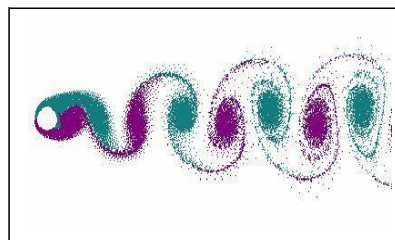


Fig.2 Eddies form

3. POLYPROPYLENE SHEET (MATERIAL)

Polypropylene is known for its excellent chemical resistance in a corrosive environment. Polypropylene sheet is easily welded and machined. Homopolymer and copolymer grades are used in various applications throughout the chemical and semiconductor industries. Polypropylene (PP) is a thermoplastic "addition polymer" made from the combination of propylene monomers. It is used in a variety of applications to include packaging for consumer products, plastic parts for various industries including the automotive industry, special devices like living hinges, and textiles.

4. WORKING:

When the wind impinges on the projected surface area of the mast from one specified direction, streamlines of the wind tend to depart and get sheared off.

Further passage results into the formation of wind currents called vortices or eddies. When they are strong enough to overcome the internal resistance offered by the mechanism (Piezoelectric Transducer), the mast vibrates due to a spring connected at the outside surface of the mast. The spring is connected to the foundation seat. The connecting rod is bound to transmit this vibration to the piezoelectric transducer. The Piezoelectric Transducer connection can be connected to a generator further. We can also connect the lower end of the mast with the linear alternator directly. Obviously, we can use a rectifier circuit to transform this A.C. current to D.C. current and charge a battery or connect it to the load.

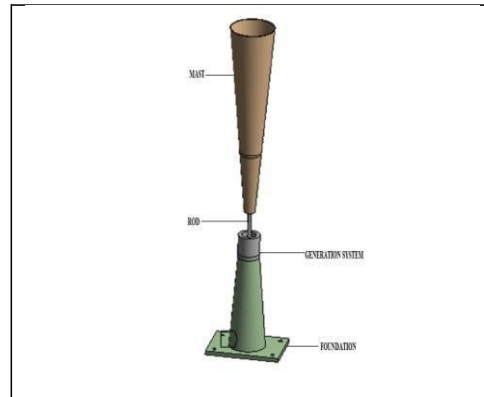


Fig. 3 Bladeless windmill

ADVANTAGES

- The bladeless windmill reducing wear and tear.
- It is more portable and cost effective with durability.
- Installation cost and maintenance cost low compared to blade wind mill.
- It produces less noise compared to blade wind mill.
- It occupies less area.
- It will not kill the birds.

DISADVANTAGES

- The efficiency of the energy extraction for bladeless windmill from the wind is 40% while that of convectional windmill is 59.3%.
- The output power depends directly on the height of the mast.

APPLICATIONS

- Industries
- Remote telemetry
- Schools
- Farms
- Houses
- Off-grid power for rail signaling
- Off-grid lighting

3. CONCLUSIONS

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 hence highly economical for the rural electrification of India.

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