



GRID INDEPENDENT AND SELF OPERATING HYBRID SYSTEM OF BLADELESS WIND TURBINE AND SOLAR PV MODULES

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Abstract: The development of eco-friendly power generation has substantially improved with new advancement in renewable energy sources. To meet the energy requirements and to produce a clean energy source, we have opted an unconventional idea of wind turbine that has no blades. A tremendous amount of research has been done on this technology which generally consists of coil and magnet which is used to convert vibrations into electricity but it costs much higher than piezoelectric transducers. In order to eliminate the cost factor, piezoelectric transducers are used. The idea is to convert vibration caused by tapping of the wind to electrical energy by means of a piezoelectric crystal. The present study is directed to a renewable power generation system using piezoelectric transducers and Solar PV modules. The system comprises a mast of polypropylene sheet which is further connected to a disc by using a PVC rod so that the weight of the system can be reduced. Furthermore, the disc is surrounded by piezoelectric transducers whose sole function is to produce electric energy when pressure is applied. When the wind strikes the mast, the produced vibrations are carried to the disc which applies pressure on piezoelectric transducers resulting in electricity generation. The power generation system is hybrid and grid independent which can be used for various applications.

Index Terms - Renewable, Hybrid, Wind, Solar, Bladeless Wind Turbine, Piezoelectric

I. INTRODUCTION

Since the mid-20th century, human influence has been the dominant cause of the observed global warming. The largest human influence has been the emission of greenhouse gases such as carbon dioxide, nitrous oxide and methane. These gases are caused by burning of fossil fuel and agricultural emissions. In this regard, measures have been taken to reduce carbon emissions by enhancing renewable energy deployment and encouraging technological innovations.

Many countries have started using renewable energy sources as a backup for power generation. Today, renewable energy sources make up 26% of the world's electricity and this renewable energy revolution could end the world's rising demand for oil and coal. Fatih Birol (Executive Director of the International Energy Agency) said that the technologies such as solar photovoltaic (PV) and wind are at the heart of transformations taking place across the global energy system. He also warned that the role of renewables in the global energy system would need to grow even faster if the world hopes to meet its climate targets. Bladeless wind turbine is a concept used over conventional windmills. This concept works on the principle of Vortex Shedding effect. The cost incurred for this system is 40% less as compared to conventional windmills. Conventional windmill consists of heavy parts, heavy blades and gearboxes which are difficult to transport. Also the installation of conventional windmills on huge mountains is difficult and costly. This makes the conventional windmills ineffective even if they have capacity of producing high electric energy. The paper studies the scope and feasibility of a hybrid power generation system using the wind and solar energy. The hybrid wind-solar integrated system for the combined power generation comprises of a solar unit including a plurality of solar panel photovoltaic power generation cells impregnated or mounted with Bladeless Wind Turbine for receiving the sun light.

II. BLOCK DIAGRAM

The Fig.1 represents the block diagram of bladeless power generation system through piezoelectric sensors.

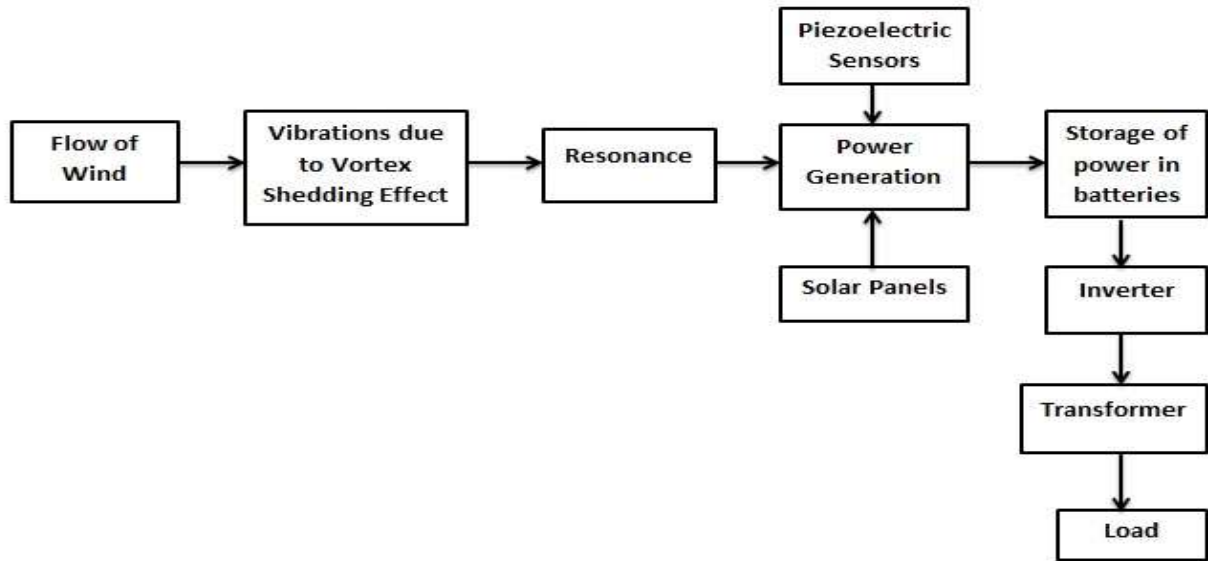


Figure 1 Block Diagram

III. COMPONENTS OF THE SYSTEM ARE AS FOLLOWS:

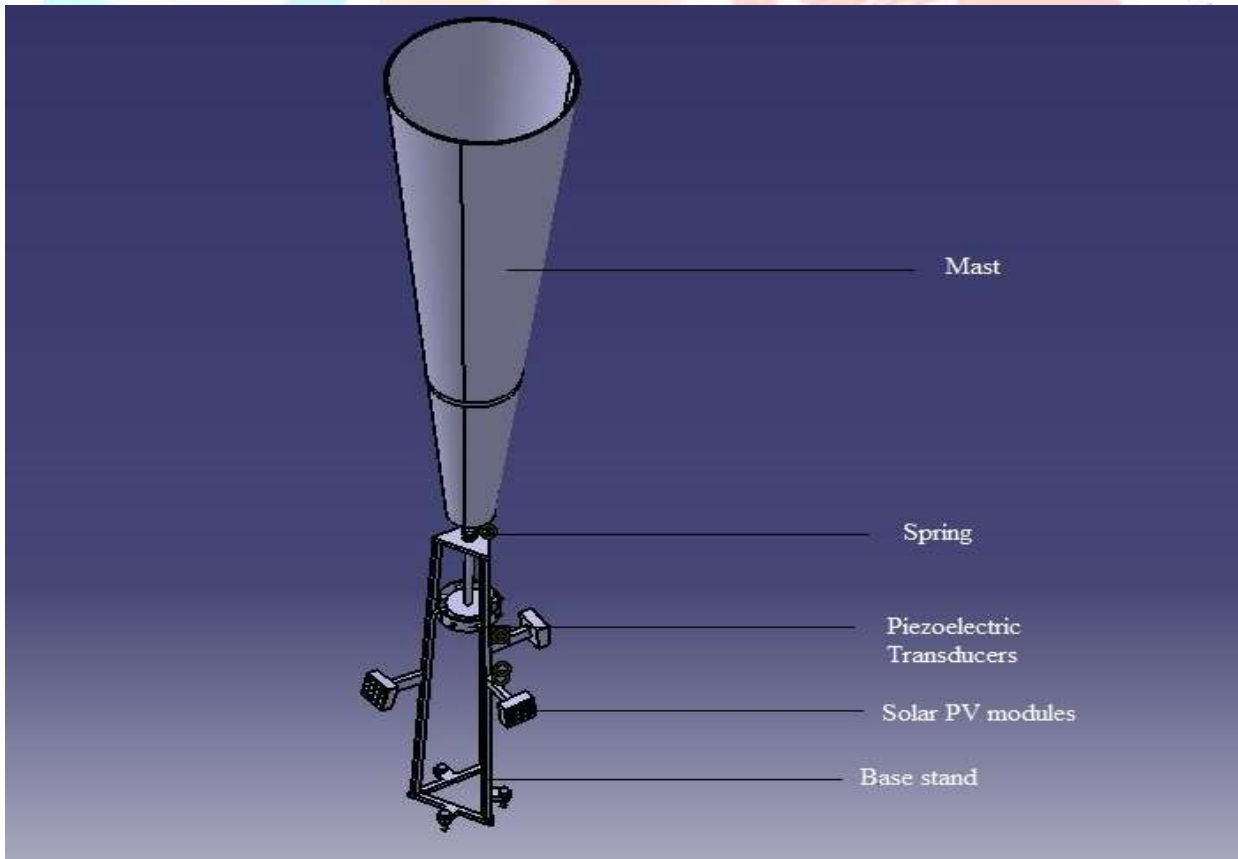


Figure 2 Assembly of BWT

1. Mast:

The mast is a light circular section. When subjected to wind, it oscillates due to the vortices formed by vortex shedding effect. The mast is made of polypropylene sheet. Polypropylene is known for its excellent chemical resistance in corrosive environments. Polypropylene sheet can be easily welded and machined. It has the ability to retain stiffness and flexibility.

2. Piezoelectric Transducers:

A piezoelectric sensor is a device that uses the piezoelectric effect to measure changes in pressure, acceleration, temperature, strain or force by converting them to an electrical charge. Piezoelectric effect is the ability of piezoelectric material to convert mechanical stress into electrical charge. This is reversible, an applied mechanical pressure will generate a voltage and an applied voltage will change the shape of the solid material. The piezoelectric sensor used in this system is made up of natural single-crystal material like quartz. Quartz crystals are less sensitive but have higher stability.

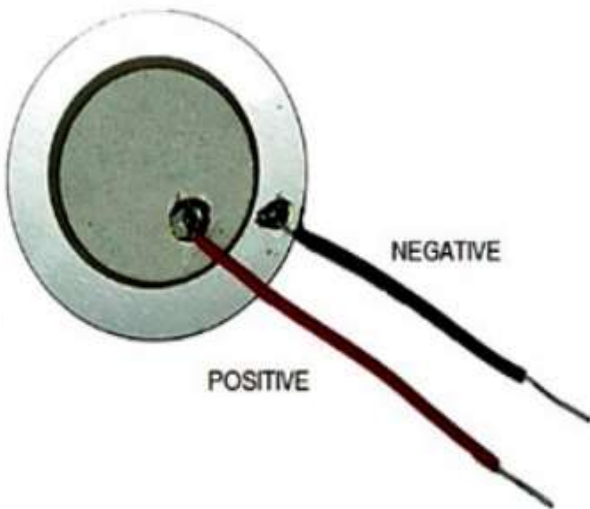


Figure 3 Piezoelectric transducers

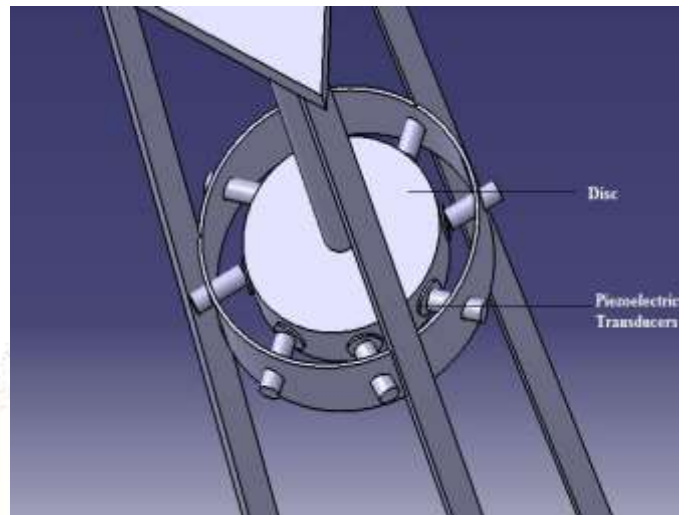
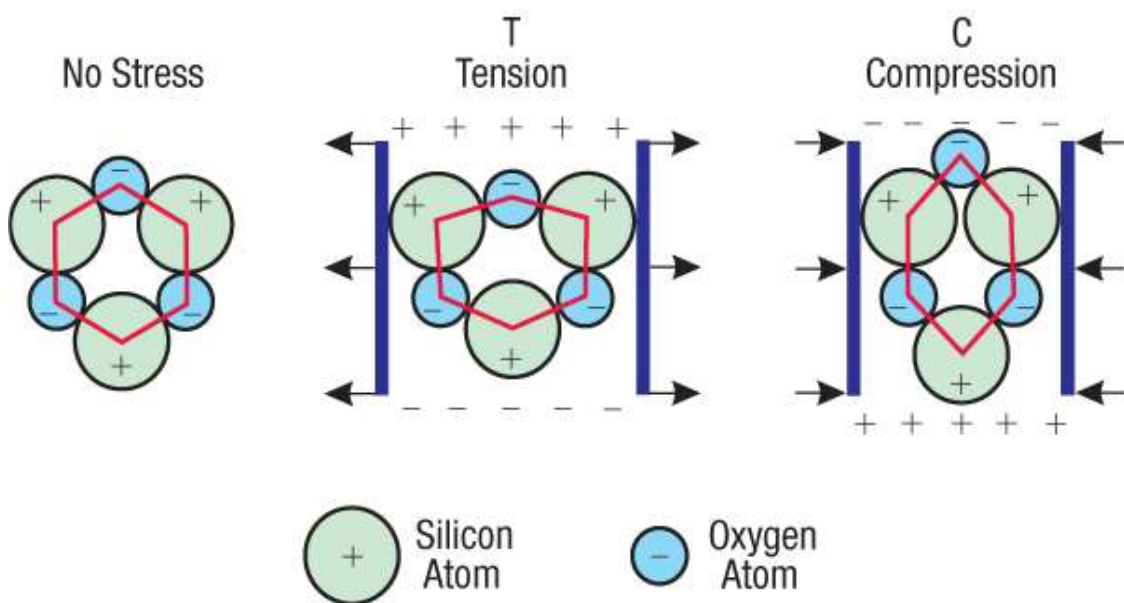


Figure 4 Position of piezoelectric transducers

When force is applied on these crystals, they change their polarity. Fig.5 illustrates the mechanism briefly.

Piezoelectric Effect in Quartz



3.

Figure 5 Piezoelectricity Mechanism

Spring:

The mast is connected to the disc containing piezoelectric sensors through a light weight PVC pipe. This PVC pipe is passed through a spring. This spring allows the mast to oscillate in any direction. It is also capable of withstanding the weight of the mast.

4. Base stand:

Base stand is a tripod stand made of iron rod. This stand supports the system and is capable of withstanding the mechanical stresses acting on it due to the oscillating mast. It provides a strong base to the bladeless wind turbine structure.

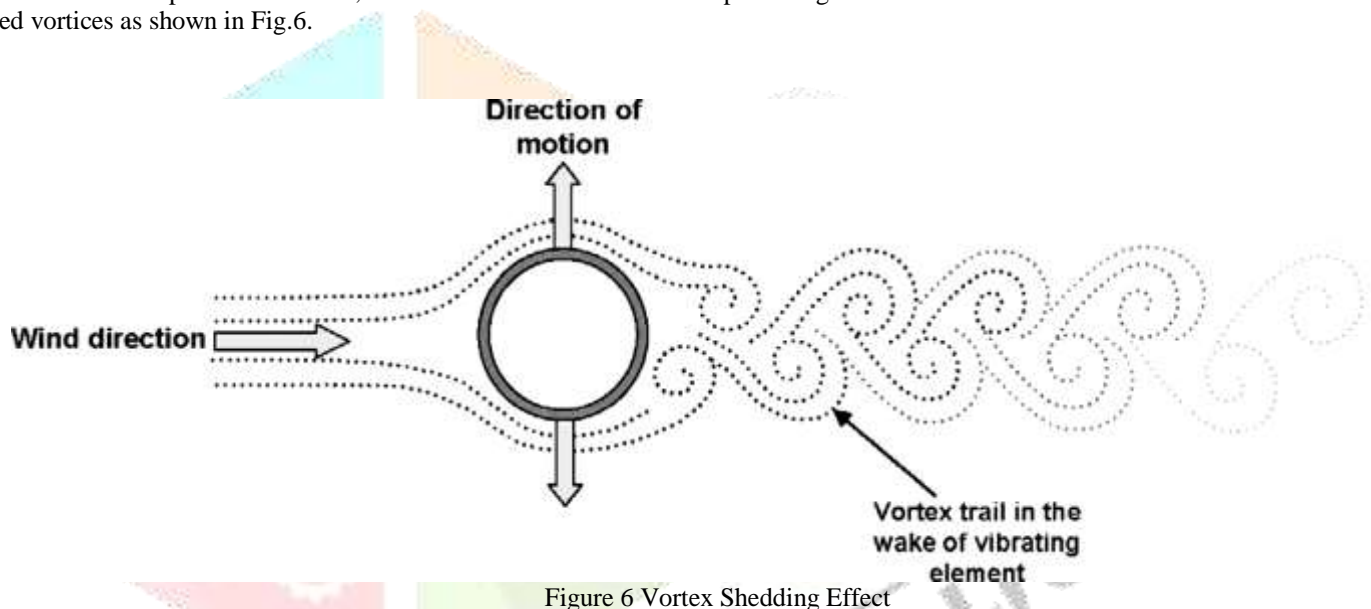
5. Solar Panels:

Solar panels are mounted on all the three legs of the tripod stand. Solar power adds up to the power generated by the piezoelectric sensors and thus increases the efficiency of the bladeless wind turbine.

IV. METHODOLOGY

In bladeless wind turbine, the conversion of energy is carried out in mast, where the wind flow strikes the mast and makes it to vibrate. This vibrational energy is further converted into electric energy. This phenomenon is called Vortex Shedding Effect. This effect was first described and mathematically formalized by Theodore von Karman, the genius of aeronautics, in 1911.

Vortex shedding is an oscillating flow that takes place when a fluid such as air or water flows past and bluffs (As opposed to streamlined body at curtailed velocities, depending on shape and size of the body). When the wind strikes on the projected surface area of the mast from one specified direction, stream lines of the wind tend to depart and get sheared off. This results into formation of wind current called vortices as shown in Fig.6.



This system is to be mounted in high flow wind field or open field where the wind does not meet with any obstacle. As soon as the wind hits the mast, it starts vibrating which actually enables the system. These vibrations are further carried to the disc which is surrounded by piezoelectric transducers. When these transducers are pressurized by the disc, the change in dimension or deformation of the material occurs which induces the EMF. This electrical energy is stored in a battery. Thus the stored dc current is used to charge a battery. This dc current can be converted into ac current using inverter. Furthermore, using a transformer it can also be connected to load.

Solar PV modules, in this case, play their role as it is. They are mounted on the stand with an inclination to get optimum results. They are also connected to a battery for storing the electric charge making this system a hybrid system which can work in any condition.

ADVANTAGES

1. The system occupies about 30% area as that of the conventional system.
2. The tapered shape of mast allows it to capture about 40% of the wind power present in the air.
3. The system is light weight, self-running and standalone with minimum need of raw materials.
4. Piezoelectric material can be utilized at its maximum because of its small dimensions.
5. Piezoelectric materials have very high frequency response; so give quick response to wind changes.
6. It is harmless to wildlife especially to birds due to its compactness and by any means does not create pollution.
7. The system is corrosion and cavitation free.
8. Absence of moving parts makes it cost effective and minimizes the maintenance cost.
9. This hybrid system is able to perform in any condition.
10. The bladeless wind turbine operates at lower wind speed than conventional windmill.

DISADVANTAGES

1. It undergoes large power fluctuations.
2. Energy conversion rate is low.
3. Absorption of wind is comparatively low as that of conventional system.

APPLICATIONS

1. Optimum result of this system can be made on highways by employing the high speed wind due to high speed vehicles at the mast. The output can be utilized almost everywhere like industries, houses mainly in rural area, farms and other public places.
2. In rural areas, hybrid systems like this can solve the issue of load-shedding. Moreover, pumps and other electric equipment can be run by this system to solve electricity problems in farms.
3. Sea shores is another place where this hybrid system can be optimized as wind speed is relatively high compared to other regions and solar PV modules can also work the best without any obstacle.

FUTURE SCOPE

1. Implementation of this system can help in solving electricity problems in every state of India.
2. It can create employment to literate as well as illiterate people as mass implementation will need large number of workers.
3. India will have large amount of eco-friendly and renewable energy to create impact on the world.
4. India is the best country to fulfill wind conditions needed for this system in every state.

CONCLUSION

This is an advanced method of generating electricity with the help of vortex shedding effect. The project is simple, cost-effective, eco-friendly and is capable of sharing the increasing load of electricity which can be used for wide range of applications. By implementing it on highways and coastal areas, optimum results can be generated. In addition, it is potential enough to solve load-shedding problems in rural areas of India. Further research on this project can lead to a new revolution in the modern world for renewable energy.

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