ISSN (Online) 2395-2717

International Journal of Engineering Research in Electrical and Electronic Engineering (IJEREEE)
Vol 3, Issue 2, February 2017

"Review & Study Paper of Vortex Windmill"

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***Abstract*— Wind energy has become a genuine source of energy over the past few years as larger, more efficient turbine designs have produced increasing amount of power. Transportation is increasingly challenging because of the size of the components: individual blades and tower requires specialized trucks and straight wide roads. Today's wind turbines are also incredibly top heavy. As the weight and height increase, the material cost of wider, stronger support towers, as well as the cost of maintaining components attached so far from the ground, are cutting into the efficiency benefits for larger turbines.**

***Key Words*:- Vortex Windmill; Conceptional design; working principal; Effects and results.**

I. INTRODUCTION

Wind is a form of solar energy. Winds are caused by the heating of the atmosphere by the sun, the irregularities of the earth's surface, and rotation of the earth. Wind flow patterns are modified by the earth's terrain, bodies of water, and vegetative cover. This wind flow, or motion energy, can be used to generate electricity. The term" wind energy" describe the process by which the wind is used to generate electricity. Wind turbines convert the kinetic energy in the wind into mechanical power. This mechanical power can be used for generate the power.
Wind turbines, like aircraft propeller blades, turn in the moving air and power an electric generator that supplies an electric current. Simply stated, a wind turbine is the opposite of a fan. Instead of using electricity to make wind, like a fan, wind turbines use wind to make electricity. The wind turns the blades, which spin a shaft, which connects to a generator and makes electricity.

II. WIND ENERGY GENERATON:

Wind power converts the kinetic energy in wind to generate electricity or mechanical power. This is done by using a large wind turbine usually consisting of propellers; the turbine can be connected to a generator to generate electricity, or the wind used as mechanical power to perform tasks such as pumping water or grinding grain. As the wind passes the turbines it moves the blades, which spins the shaft. There are currently two different kinds of wind turbines in use, the Horizontal Axis Wind Turbines (HAWT) or the Vertical Axis Wind Turbines (VAWT). HAWT are the most common wind turbines.[1]

Horizontal axis wind turbine:

Horizontal axis means the rotating axis of the wind turbine is horizontal, or parallel with the ground. In big wind application, horizontal axis wind turbines are almost be there. The horizontal-axis turbine typically has a three-blade vertical propeller that catches the wind face-on. The advantage of horizontal wind is that it is able to produce more electricity from a lesser amount of wind. The disadvantage of horizontal axis still is that it is generally heavier and it does not produce well in unstable winds.

FIG-1 Horizontal axis windmill [11]

Vertical axis wind turbine:

Vertical axis wind turbines the rotational axis of the turbine stands vertical or perpendicular to the ground. In small wind and residential wind applications, vertical axis turbines are used. Vertical axis wind turbines are considered to be ideal for installations where wind conditions are not

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consistent, or due to public ordinances the turbine cannot be placed high enough to benefit from steady wind.[2]

FIG-2 Vertical axis windmill [3]

The development of wind power in India began in the 1986 with first wind farm being set up in coastal areas of Maharashtra (Ratnagiri), Gujarat (Okha). And Tamil Nadu (Tuticorin) with 55 kW wind turbines. Wind power accounts nearly 8.6% of India's total installed power generation capacity and generated 28,604 million Kwh in the economic year 2015-16 which is nearly 2.5% of total electricity generation.

The worldwide installed capacity of Wind power reached 435 GW by the end of 2015. China (148,000 MW), US (74,347 MW) and Germany (45,192 MW) are ahead of India in fourth position.

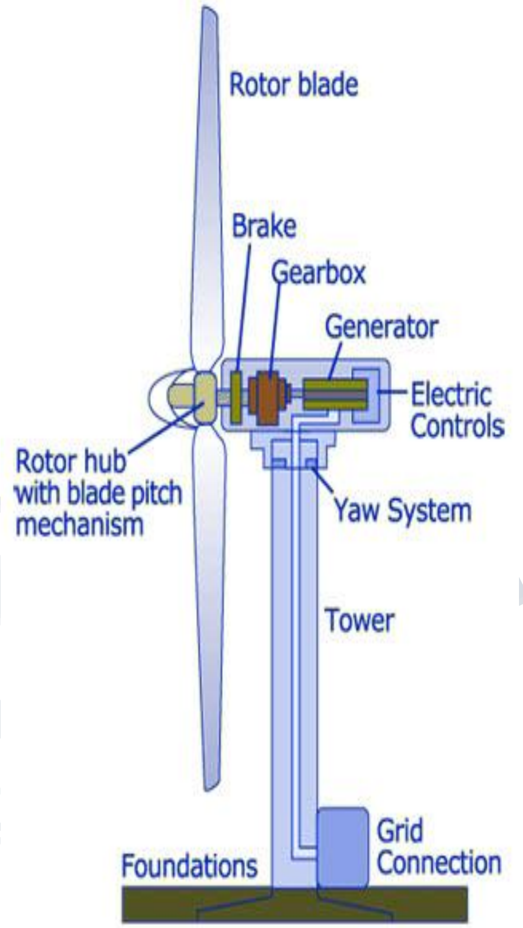

FIG-3 Working of windmill [4]

- Wind energy is friendly to the surrounding environment, as no fossil fuels are burnt to generate electricity from wind energy. But also Wind turbines generally produce allots less electricity than the average fossil fuelled power station.

- Wind turbines take up less space than the average power station. But its construction can be very expensive and costly to surrounding wildlife during the build process.

- Wind turbines are a great resource to generate energy in remote locations, such as mountain communities and remote areas. It's difficult to transport parts of windmill from manufacturer to wind generation area.

● The wind is free, and we are able to cash in on this free source of energy. The noise pollution from commercial wind turbines is sometimes similar to a small jet engine.

III. EQUATIONS:

Michel faraday is generally credited with the discovery of induction in 1831, and mathematically described it as Faraday's law of induction. Faraday's experiment showing induction between coils of wire: The liquid battery provides a current that flows through the small coil (A), creating a magnetic field. When the coils are stationary, no current is induced. But when the small coil is moved in or out of the large coil (B), the magnetic flux through the large coil changes, inducing a current which is detected by the galvanometer. Lenz' law describes the direction of the induced field. [6]

Electromagnetic induction has found many applications in technology, inducing electrical components such as inductors and transformers, and device such as electric motors and generators. Faraday's law of induction makes use of the magnetic flux ΦB through a region of space enclosed by a wire loop. The magnetic flux is defined by a surface integral [6]

$$\emptyset B = \int_{\Sigma} B \cdot dA$$

Where **dA** is an element of the surface **Σ** enclosed by the wire loop, **B** is the magnetic field. The dot product **B·dA** corresponds to an infinitesimal amount of magnetic flux. In more visual terms, the magnetic flux through the wire loop is proportional to the number of magnetic flux lines that pass through the loop.

When the flux through the surface changes, Faraday's law of induction says that the wire loop acquires an electromotive force (EMF). The most widespread version of this law states that the induced electromotive force in any closed circuit is equal to the rate of change of the magnetic flux enclosed by the circuit.

$$\mathbf{E} = -\frac{\mathbf{d\emptyset B}}{\mathbf{dt}}$$

Where **E** is the EMF and **ΦB** is the magnetic flux. The direction of the electromotive force is given by Lenz's law which states that an induced current will flow in the direction that will oppose the change which produced it. This is due to the negative sign in the previous equation. To increase the generated EMF, a common approach is to exploit flux linkage by create a tightly wound coil of wire, composed of N identical turns, each with the same magnetic flux going through them. The resulting EMF is then N times that of one single wire. [6]

$$\mathbf{E} = -\mathbf{N}\frac{\mathbf{d\emptyset B}}{\mathbf{dt}}$$

Generating an EMF through a variation of the magnetic flux through the surface of a wire loop can be achieved in several ways:

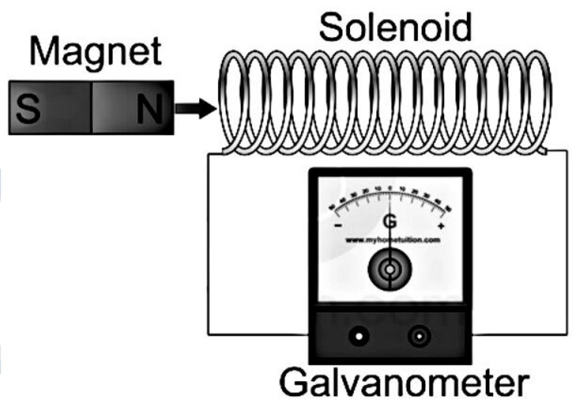

FIG-4 Electromagnetic Induction [6]

1. The magnetic field B changes (e.g. an alternating magnetic field, or moving a wire loop towards a bar magnet where the B field is stronger),
2. The wire loop is deformed and the surface **Σ** changes,
3. The orientation of the surface **dA** changes (e.g. spinning a wire loop into a fixed magnetic field),
4. Any combination of the above.

IV. MODERN DESIGN OF WINDMILL:

Nearly all modern wind turbines use rotors with three blades. [7]

The Vortex turbine sounds promising, but like any radical new alternative energy design . Vortex. The device captures the energy of velocity. As the wind bypasses a fixed structure, its flow changes and generates a cylindrical pattern of vortices. Once these force are strong enough, the

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Vol 3, Issue 2, February 2017

fixed structure starts oscillating. There is classic academic example of the Tacoma Narrows Bridge, which collapse three months after its inauguration because of the vortex shedding effect as well as effect of flattering and galloping. [8]

Instead of avoiding these aerodynamic instabilities, this technology maximizes the resulting oscillation and captures that energy. Naturally, the design of such a 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 wind generator does not have any moving parts in contact, which eliminates the need for lubrication and reduces the wear and tear. Also, it's known that a structure can only have a certain frequency of oscillation, which limits the number of working hours. However, Vortex can operate in a wider range of wind speeds. This system allows maximizing the oscillation amplitudes: when wind intensifies, the magnetic force of repulsion goes up, which reduces the distance between the rod and the magnet. As a result, the oscillation and the potential of generated energy increases to the maximum. With that, Vortex can automatically vary rigidity and "synchronize" with the incoming wind speed, in order to stay in resonance without any mechanical or manual interference.

In addition to capturing less energy, oscillating cylinders can't convert as much of that energy into electricity. A conventional wind turbine typically converts 80 to 90 percent of the kinetic energy of its spinning rotor into electricity. The oscillating turbine design will remove a smaller area and have lower conversion efficiency, but says significant reductions in manufacturing and maintenance costs will be more important than the losses. The Vortex, which stands at around 41 feet tall, can capture up to 40 percent of the wind's power during ideal conditions (this is when the wind is blowing at around 26 miles per hour). The vortex ultimately captures 30 percent less than conventional wind turbines, but that shortcoming is compensated by the fact that you can put double the Vortex turbines into the same space as a propeller turbine. Its design can be reduce manufacturing costs by 53%, cut maintenance costs by 80%, when compared to conventional bladed wind turbines.[9]

V. HOW A BLADLESS TURBINE WORKS

Instead of capturing energy as a result of the circular motion of a propeller, the bladeless wind turbine "takes advantage of what's known as vortices, an aerodynamic effect that produces a pattern of spinning vortices". The spinning winds it creates can lead to oscillating motions, or vibrations in structures. However, instead of trying to avoid this energy, the Vortex Bladeless is attempting to capitalize on it. The mast, which is made from a composite of fiberglass and carbon fiber and zero moving parts, is designed to ensure that spinning winds, or vorticities, occur synchronously along the totality of the rod as naturally occurring wind passes by. The spinning winds that result cause the pole to oscillate, or vibrate, as much as possible. The wind turbine is then able to harness the kinetic energy created by the oscillations and convert it into electricity. Vortex Bladeless are clearly taking a completely different standpoint into generating wind energy. It's "oscillating rod" harnesses almost the same amount of wind energy as a modern windmill would. The modern windmill can convert around 80%-90% of kinetic wind energy into whereas the bladeless wind turbine at this stage can only convert around 70% of wind energy into electricity. [10]

FIG-5 Vortex wind farm [14]

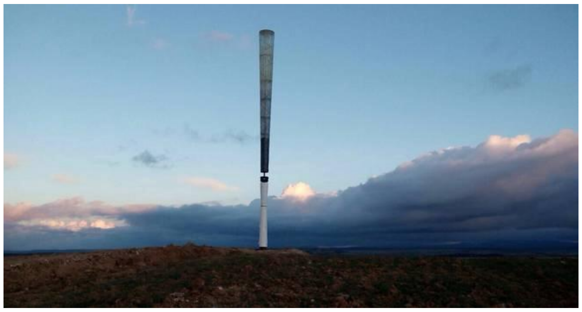

FIG-6 Vortex Windmill [13]

Advantages:

- One of the main advantages of Vortex is its significantly low cost. Including capital costs, operation and maintenance, performance, land leases, insurance, and other administrative expenses.

- It's less expensive to manufacture, totally silent, and safer for birds since there are no blades to fly into.
- We can build it close to ground and it does not need to be pointed towards the wind to be effective.
- Keeping workers from climbing tall turbine towers also makes vortex a safer option. Plus it's pretty cool-looking.

V. 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 a lot less expensive and has a lot less problems in its design while generating almost as much energy as the modern windmill. The vortex windmill is most effective new technology in wind energy generation system. The ordinary wind turbines has a complicated design, difficult to set up, tough to transport, requires huge area. But the vortex is most effective because of its simple and attractive design, less moving parts and its eco-friendly.

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