MAGLEV WINDMILL

S.T.B.S. COLLEGE OF DIPLOMA ENGINEERING, SURAT

Diploma in Electrical Engineering
Project Report

Project (Phase-II): <u>Maglev Windmill</u>

<u>Project Group: - E-8</u>

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ABSTRACT:-

Magnetic levitation, maglev, or magnetic suspension is a method by which an object is suspended with no support other than magnetic fields. Magnetic pressure is used to counteract the effects of the gravitational and any other accelerations. The principal advantage of a maglev windmill from a conventional one is, as the rotor is floating in the air due to levitation, mechanical friction is totally eliminated. That makes the rotation possible in very low wind speeds. Maglev wind turbines have several advantages over conventional wind turbines. For instance, they're able to use winds with starting speeds as low as 1.5 meters per second (m/s). Also, they are able to with stand the speed of about 40 m/s.

INDEX

CHAPTER-1

1.1 NEED FOR THE PROJECT:

Renewable energy is generally electricity supplied from sources, such as wind power, solar power, geothermal energy, hydropower and various forms of biomass. These sources have been coined renewable due to their continuous replenishment and availability for use over and over again. The popularity of renewable energy has experienced a significant upsurge in recent times due to the exhaustion of conventional power generation methods and increasing realization of its adverse effects on the environment. It is estimated that renewable sources might contribute about 20%-50% to energy consumption in the later part of the 21stcentury.Facts from the World Wind Energy Association estimates that by 2010, 160GW of wind power capacity is expected to be installed worldwide which implies an anticipated net growth rate of more than 21% per year.

Maglev wind turbines have several advantages over conventional wind turbines. For instance, they're able to use winds with starting speeds as low as 1.5 meters per second (m/s). Also, they could operate in winds exceeding 40 m/s. Currently, the largest conventional wind turbines in the world produce only five megawatts of power. However, one large maglev wind turbine could generate one GW of clean power, enough to supply energy to 750,000 homes.

1.2 INTRODUCTION :-

This project focuses on the utilization of wind energy as a renewable source. In the United States alone, wind capacity has grown about 45% to 16.7GW and it continues to grow with the facilitation of new wind projects . The aim of this major qualifying project is to design and Implement a magnetically levitated vertical axis wind turbine system that has the ability to operate in both high and low wind speed conditions. Our choice for this model is to showcase its efficiency in varying wind conditions as compared to the traditional horizontal axis wind turbine and contribute to its steady growing popularity for the purpose of mass utilization in the near future as are liable source of power generation. Unlike the traditional horizontal axis wind turbine, this design is levitated via maglev (magnetic levitation) vertically on a rotor shaft. This maglev technology, which will be looked at in great detail, serves as an efficient replacement for ball bearings used on the conventional wind turbine and is usually implemented with permanent magnets.

This levitation will be used between the rotating shaft of the turbine blades and the base of the whole wind turbine system. The conceptual design also entails the usage of spiral shaped blades and with continuing effective research into the functioning of sails in varying wind speeds and other factors, an efficient shape and size will be determined for a suitable turbine blade for the project. With the appropriate mechanisms in place, we expect to harness enough wind for power generation by way of an axial flux generator built from permanent magnets and copper coils. The arrangement of the magnets will cultivate an effective magnetic field and the copper coils will facilitate voltage capture due to the changing magnetic field.

CHAPTER 2

2.1 Overview:-

This section introduces and provides a brief description of the major components and factors that will contribute to an efficiently functioning wind turbine. These factors are wind power, the generator and magnetic levitation. Later sections will provide an in-depth look into the essence of each factor and its function and importance to the overall operation of the vertical axis wind turbine.

2.1(A). Wind Power:-

Undoubtedly, the project's ability to function is solely dependent on the power of wind and its availability. Wind is known to be another form of solar energy because it comes about as a result of uneven heating of the atmosphere by the sun coupled with the abstract topography of the earth's surface . With wind turbines, two categories of winds are relevant to their applications, namely local winds and planetary winds. The latter is the most dominant and itis usually a major factor in deciding sites for very effective wind turbines especially with the horizontal axis types. These winds are usually found along shore lines, mountain tops, valleys and open plains. The former is the type you will find in regular environments like the city or rural areas, basically where settlements are present. This type of wind is not conducive for effective power generation; it only has a lot of worth when it accompanies moving planetary winds. In later chapters, more focus will be placed on the power of wind and effective ways to design wind turbines for optimal wind power production.

2.1(B). Generator :-

The basic understanding of a generator is that it converts mechanical energy to electrical energy. Generators are utilized extensively in various applications and for the most part have similarities that exist between these applications. However the few differences present is what really distinguishes a system operating on an AC motor from another on the same principle of operation and likewise with DC motors. With the axial flux generator design, its operability is based on permanent magnet alternators where the concept of magnets and magnetic fields are the dominant factors in this form of generator functioning. These generators have air gap surface perpendicular to the rotating axis and the air gap generates magnetic fluxes parallel to the axis. In further chapters we will take a detailed look into their basic operation and the configuration of our design.

2.3(C). Magnetic Levitation :-

Also known as maglev, this phenomenon operates on the repulsion characteristics of permanent magnets. This technology has been predominantly utilized in the rail industry in the Far East to provide very fast and reliable transportation on maglev trains and with ongoing research its popularity is increasingly attaining new heights. Using a pair of permanent magnets like neodymium magnets and substantial support magnetic levitation can easily be experienced. By placing these two magnets on top of each other with like polarities facing each other, the magnetic repulsion will be strong enough to keep both magnets at a distance away from each other. The force created as a result of this repulsion can be used for suspension purposes and is strong enough to balance the weight of an object depending on the threshold of the magnets . In this project, we expect to implement this technology for the purpose of achieving vertical orientation with our rotors as well as the axial flux generator.

CHAPTER 3

3.1 WIND POWER AND WIND TURBINES

3.1(A) Wind Power Technology:-

Wind power technology is the various infrastructure and process that promote the harnessing of wind generation for mechanical power and electricity. This basically entails the wind and characteristics related to its strength and direction, as well as the functioning of both internal and external components of a wind turbine with respect to wind behavior.

1. The Power of Wind:-

As mentioned earlier the effective functioning of a wind turbine is dictated by the wind availability in an area and if the amount of power it has is sufficient enough to keep the blades in constant rotation. The wind power increases as a function of the cube of the velocity of the wind and this power is calculable with respect to the area in which the wind is present as well as the wind velocity [4.1]. When wind is blowing the energy available is kinetic due to the motion of the wind so the power of the wind is related to the kinetic energy.

2. Types of wind turbines:-

Many types of turbines exist today and their designs are usually inclined towards one of the two categories: horizontal-axis wind turbines (HAWTs) and vertical axis wind turbines (VAWTs). As the name pertains, each turbine is distinguished by the orientation of their rotor shafts. The former is the more conventional and common type everyone has come to know, while the latter due to its seldom usage and exploitation, is quiet unpopular. The HAWTs usually consist of two or three propeller-like blades attached to a horizontal and mounted on bearings the top of a support tower as seen in Figure.

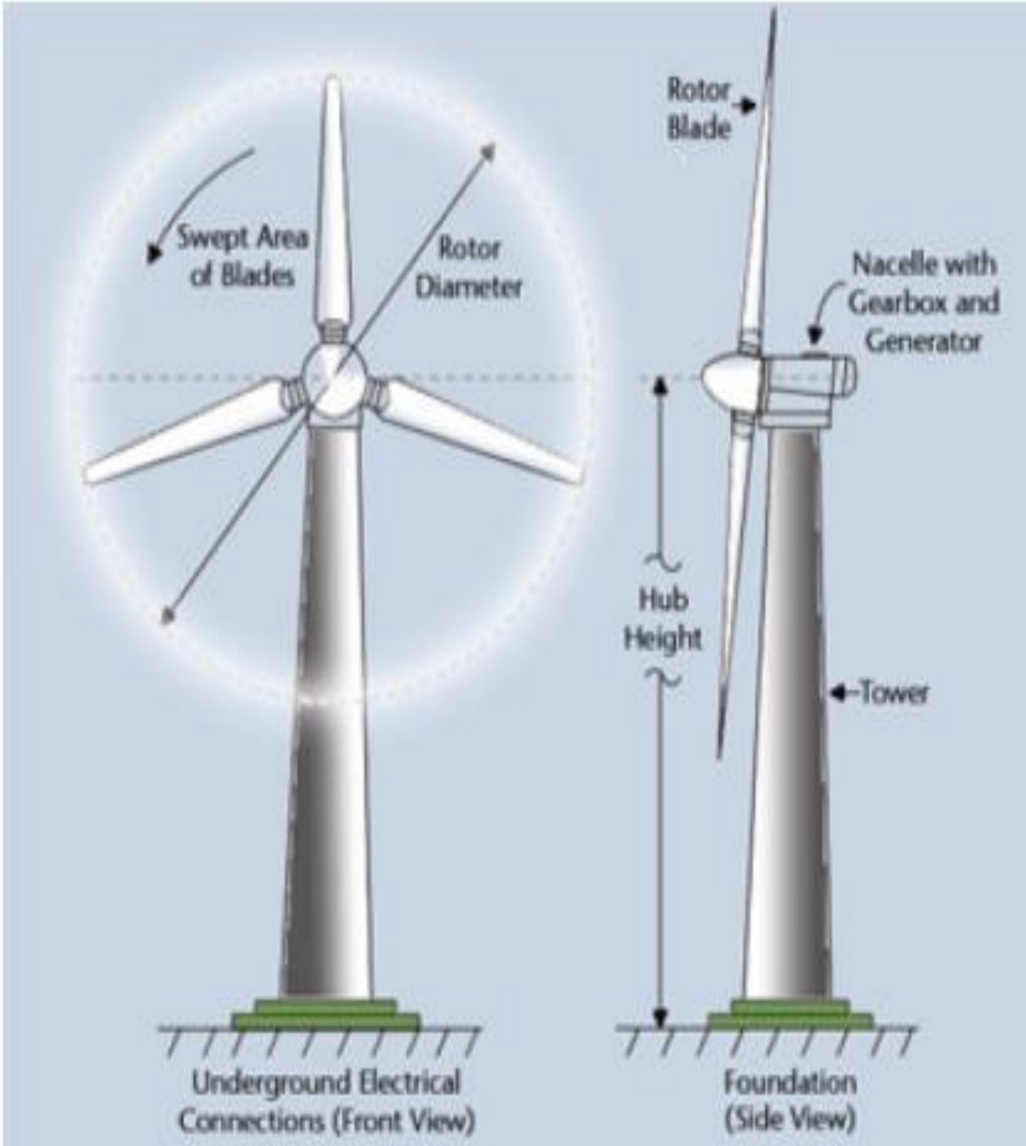


Fig.1 Horizontal Axis Wind Turbine

When the wind blows, the blades of the turbine are set in motion which drives a generator that produces AC electricity. For optimal efficiency, these horizontal turbines are usually made to point into the wind with the aid of a sensor and a servo motor or a wind vane for smaller wind turbine applications. With the vertical axis wind turbines, the concept behind their operation is similar to that of the horizontal designs. The major difference is the orientation of the rotors and generator which are all vertically arranged and usually on a shaft for support and stability. This also results in a different response of the turbine blades to the wind in relation to that of the horizontal configurations. A typical vertical axis design is shown in Figure.

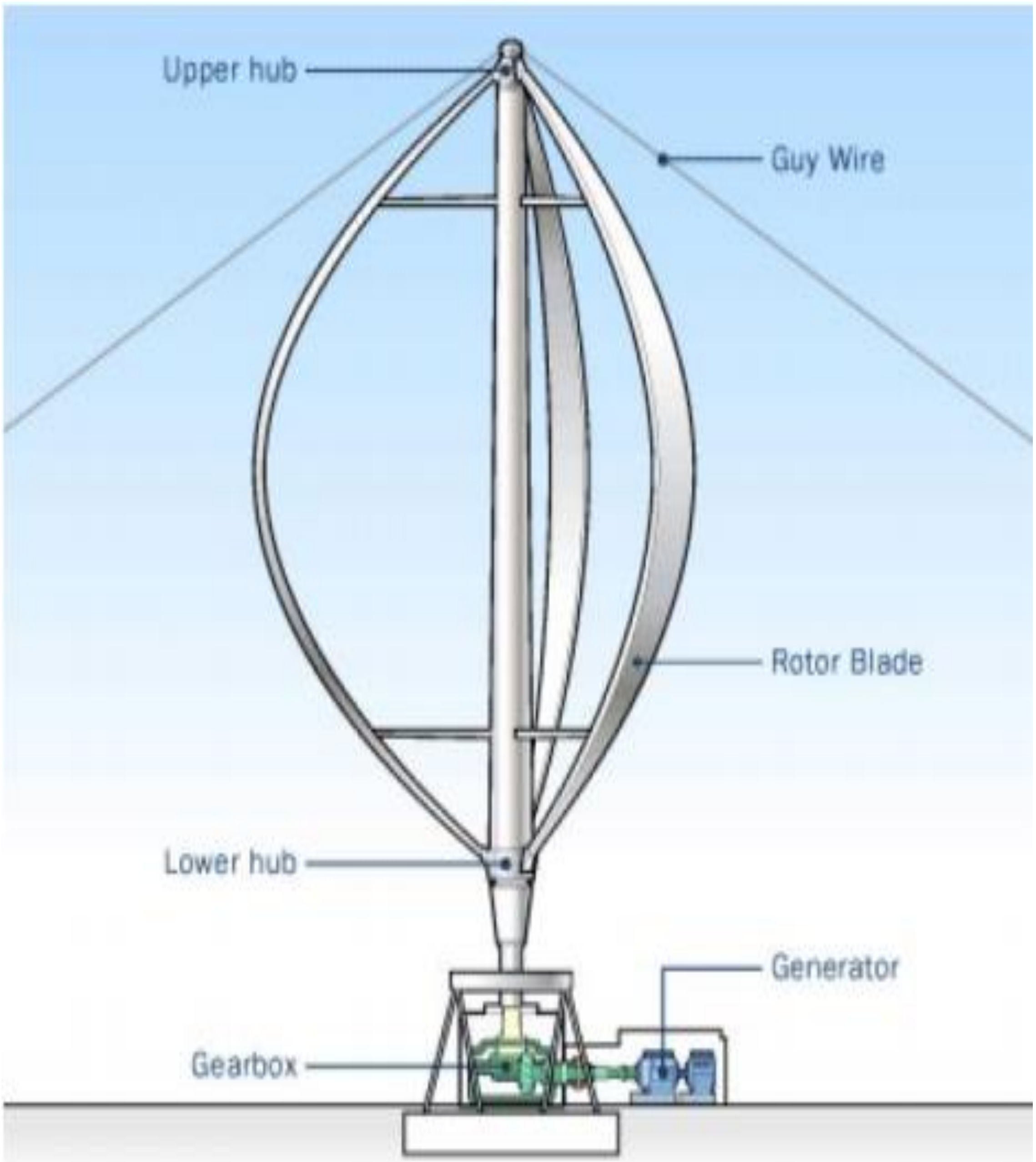


Fig.2 Vertical Axis Wind Turbine

Their design makes it possible for them to utilize the wind power from every direction unlike the HAWTs that depend on lift forces from the wind similar to the lift off concept of an airplane. Vertical axis wind turbines are further subdivided into two major types namely the Darrius model and the Savonius model. Pictured above in figure 3.3 is an example of the Darrius Model which was named after designer and French aeronautical engineer, Georges Darrieus . This form of this design is best described as an eggbeater with the blades, two or three of them bent into a c-shape on the shaft. The Savonius model was invented by Finnish engineer Sigurd Savonius and an example is shown in Figure.

Fig.3 Savonius Model Vertical Axis Wind Turbine

The functioning of this model is dependent on drag forces from the wind. This drag force produced is a differential of the wind hitting by the inner part of the scoops and the wind blowing against the back of the scoops. Like the Darrieus model, the Savonius turbines will work with winds approaching in any direction and also work well with lower wind speeds due to their very low clearance off the ground.

3.1(B)Major components and operation of a wind turbine:-

A wind turbine basically draws the kinetic energy from the wind and converts this power to electrical energy by means of a generator. Its operability is dependent on key components of the turbine and its response to the wind based on how it is built. Figure shows an illustration of a conventional wind turbine and its parts.

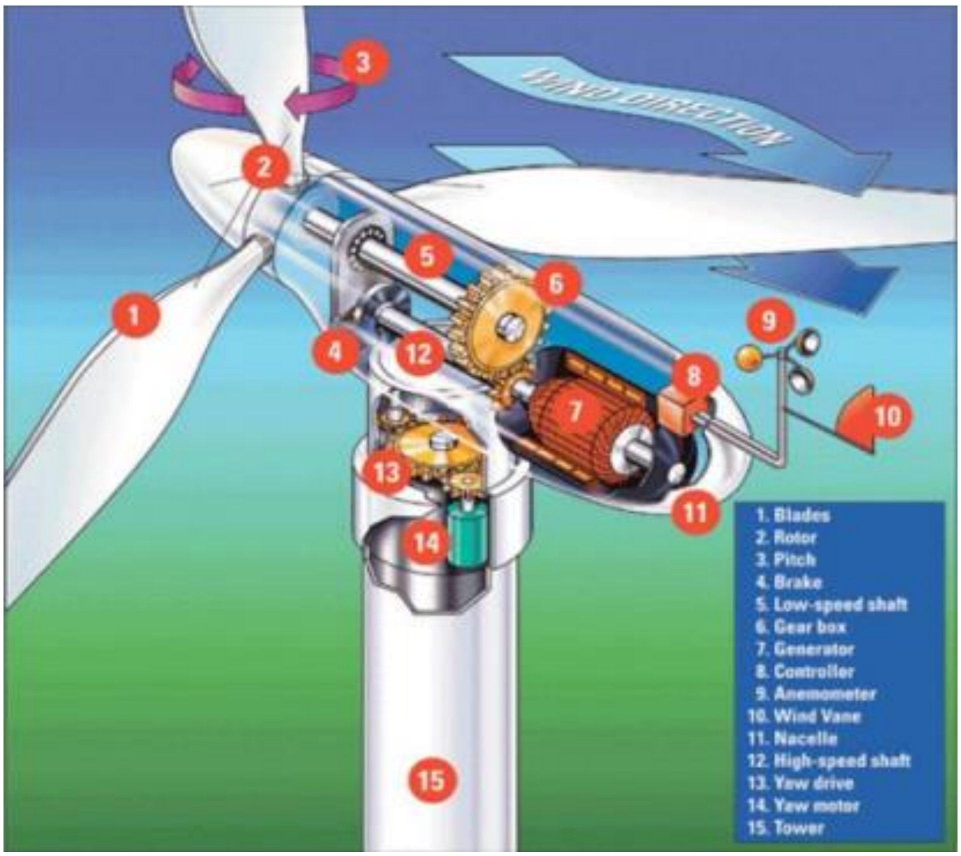


Fig.4 Components of Wind Turbine

With this turbine, the blades receive the wind and are caused to lift and rotate. Depending on the wind speed the controller will start up or shut off the turbine. If wind speeds are right between 8 to 16 miles per hour, the turbine would start to operate but will shut down if speeds exceed about 55 miles per hour. This is a preventative measure because at very high winds the turbine could be damaged. The anemometer on the turbine calculates this wind speed and sends the information to the controller. The VAWTs usually do not have anemometers because they are usually used for low speed and small scale applications.

The high speed shaft drives the generator to produce electricity and they are connected to the low speed shaft by gears to increase their rotational speed during operation. Most generators usually require a rotational speed of about 1000 to 1800 rotations per minute so the gears increases them significantly from 30 to 60 rotations per minute to the electricity producing threshold. All these components sit on a tower usually made out of steel or concrete. The height of the tower is dependent on the size of the rotors and the desired amount of electricity generation. Taller towers serve as an advantage because wind speed is abundant with height so the rotors will work well with increased tower height and promote more and efficient electricity generation.

3.1(C)Wind sails design selection:-

After a thorough research into both sub types of vertical axis wind turbine rotors configurations, we decided to base the foundation of our design on the Savonius model and the final design is pictured in Figure.

Fig.5 Wind Rotors side view

As compared to the standard design model of the Savonius, we took a bit of a different approach in our design by modifying it with a curvature design from the top of the sails to the bottom. This design was attained with four triangular shapes cut out from aluminum sheet metal and due to the flexibility of the sheet metal, we were able to spiral the sail from the top of the shaft to the base.

The main factor for our design is due to its attachment to the stator of our generator and to some extent the magnetic levitation. From Figure 3.6, it is observed that our streamlined design eliminates the scoop on the upper half of the Savonius model and winds down from the top of the shaft to the circumference of the circular base thus providing a scooping characteristic towards the bottom. This therefore concentrates the mass momentum of the wind to the bottom of the sails and allows for smoother torque during rotation. A standard Savonius model for this design would have created a lot of instability around the shaft and on the base which could eventually lead to top heaviness and causing the turbine to tip over.

Fig.6 Rotor Side Top view

The presence of the twenty eight permanent magnets on the stator contributes some weight to the base of the sail thus the expectance of a little resistance in starting off the turbine and during operation as well. With our design we expect a smoother torque during rotation since the wind energy shoots for the base of the sails and will set the rotors spinning easily and freely around the shaft.

CHAPTER 4

POWER GENERATION:-

When designing a generator it is important to have a firm grasp of the basic laws that govern its performance. In order to induce a voltage in a wire a nearby changing magnetic field must exist. The voltage induced not only depends on the magnitude of the field density but also on the coil area. The relationship between the area and field density is known as flux (Φ). The way in which this flux varies in time depends on the generator design. The axial flux generator uses the changing magnetic flux to produce a voltage. The voltage produced by each coil can be calculated using Faraday's law of induction:

$$V = -N\, d\emptyset/dt$$

4.1 INDUCED EMF:-

In order to explain how an axial flux generator is designed the elements that produce an electromotive force or voltage must be described. An induced EMF is produced by a time varying magnetic field. Michael Faraday performed experiments with steady currents and a simple transformer in hopes of producing a voltage from a magnetic field. He discovered that a constant magnetic field would not induce a voltage but a time varying field could This was an important discovery in what is known as electromagnetic induction, a discovery that is fundamental in the design of a generator. It is this relative motion of a magnetic field producing a voltage that allows us to be creative in the ways we produce electricity.

4.2 FLUX:-

Electricity is not generated solely as a function of the field density. In order to fully describe the electromotive force the area in which the field is applied must be considered. Flux Φ (Vs) takes into consideration both the field density B (Vs/m2)and the area A(m2) of the field.

4.2(A) Ways to induce voltage:-

There are three ways to induce a voltage. The first way is to change the magnetic field. The axial flux generator, which we are designing, utilizes the changing magnetic field produced by the magnets to induce a voltage. The rotating magnets pass over a number of coils each producing their own voltage. The second way is to change the area of an individual coil in a magnetic field. The third and final way is to change the angle between the coil and the magnetic field. Many generators today use this method to induce a voltage. Some of these generators rotate the coils in a field and others rotate the field around stationary coils.

4.2(B) Time varying magnetic flux:-

An important factor to note in generators is that the greater the change in magnetic field the greater the induced voltage. Translating this to the construction of a wind turbine is that the greater the velocity of the wind the greater the rate of change in the magnetic field and hence more voltage will be produced. Faraday discovered that the induced voltage was not only proportional to the rate of change in the magnetic field but it is also proportional to the area of the magnetic field. This area directly relates to the size of each coil in a generator or the area of a coil. Increasing the size of each coil will proportionally increase the voltage output. A term known as the magnetic flux is formulated from the dot product of the area and the magnetic field density in a uniform field.

$$\text{Flux} = \emptyset B = BA\cos\theta$$

In most cases a uniform magnetic field cannot be produced so the flux is calculated by the integral of the magnetic field with respect to the area.

$$\emptyset B = \int B \, dA$$

A close approximation of the induced voltage can be taken using the dot product.

4.2(C) Flux:-

The magnitude of the magnetic flux is greatest when the coil in a magnetic field is perpendicular to the field. In the design of an axial flux generator it is best to keep the coils perpendicular to the field produced by the permanent magnets. In many conventional motors a winding rotates inside a magnetic field. The number of windings is increased so that each winding is positioned close to 90 degrees to the field. *Figure illustrates* this concept. In our design the angle between the coils and the field does not change, instead the field itself varies with time.

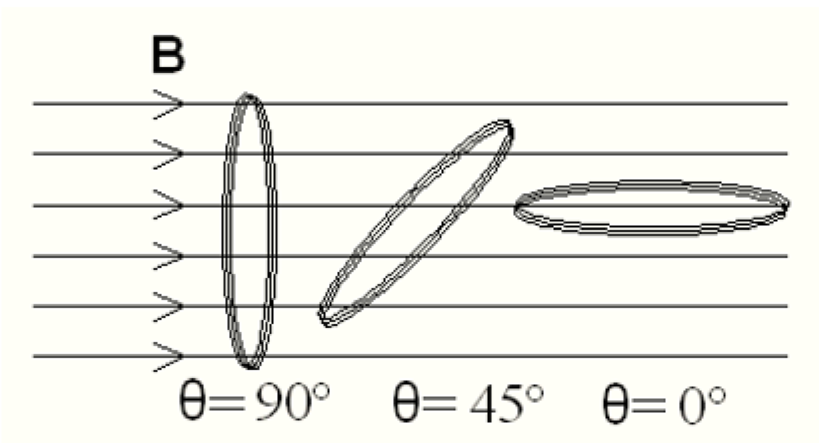


Fig.7 Field lines through coils

Faraday's law of induction states that the induced electromotive force is equal to the change in magnetic flux over the change in time.

$$v = -d\emptyset/dt$$

Generally the coils, which pass through this field, contain more than one winding. The number of turns adds to produce a greater voltage. In order to take advantage of the property of Faraday's law, we wound our coils with 5000 turns. This design choice will increase the voltage each coil will produce. The coils we built are shown in the Figure below.

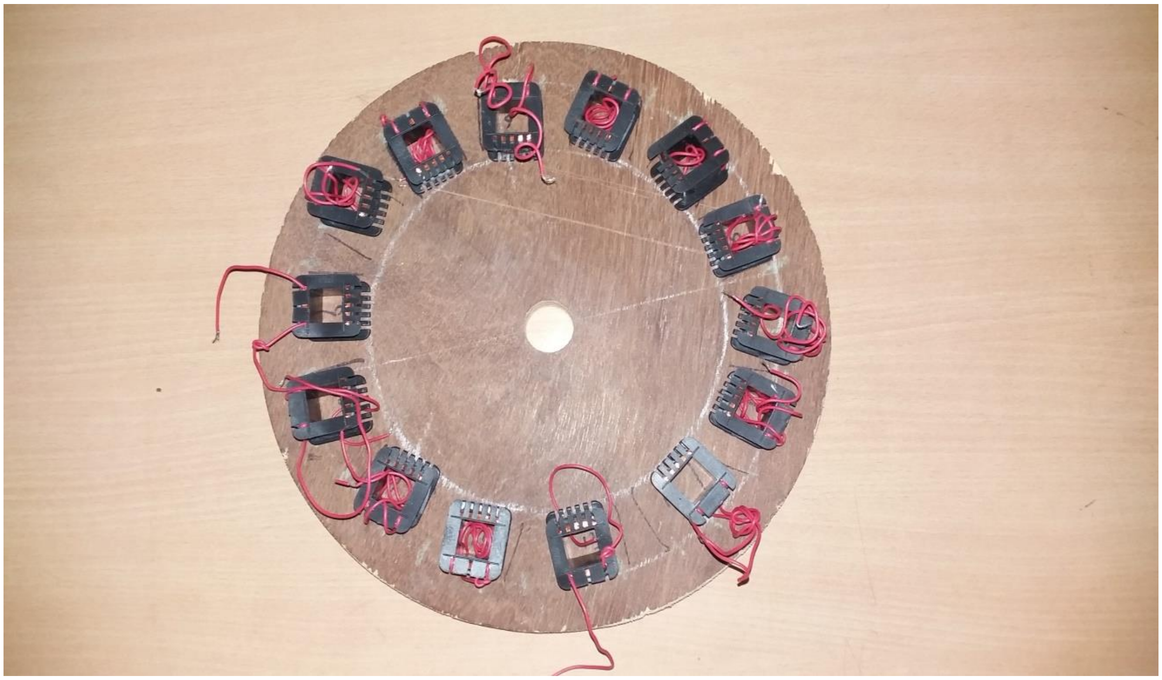


Fig.8 Coils Placement

4.2(D) Coil Design:-

The number of windings per coil produces a design challenge. The more windings will increase the voltage produced by each coil but in turn it will also increase the size of each coil. In order to reduce the size of each coil a wire with a greater size gauge can be utilized. Again another challenge is presented, the smaller the wire becomes the less current will flow before the wire begins to heat up due to the increased resistance of a small wire. Each one of our coils has a measured resistance of 40 Ω; a smaller gage wire would further reduce this resistance.

When designing a generator the application, which it will be used for, must be kept in mind. The question must be answered, which property, the current or the voltage, is of greater importance? The problem that is produced by a larger coil is the field density is decreased over the thickness of the coil. The thickness of the coil is what reduces the flux magnitude. In our design we have chosen to sandwich the coils between two attracting magnets.

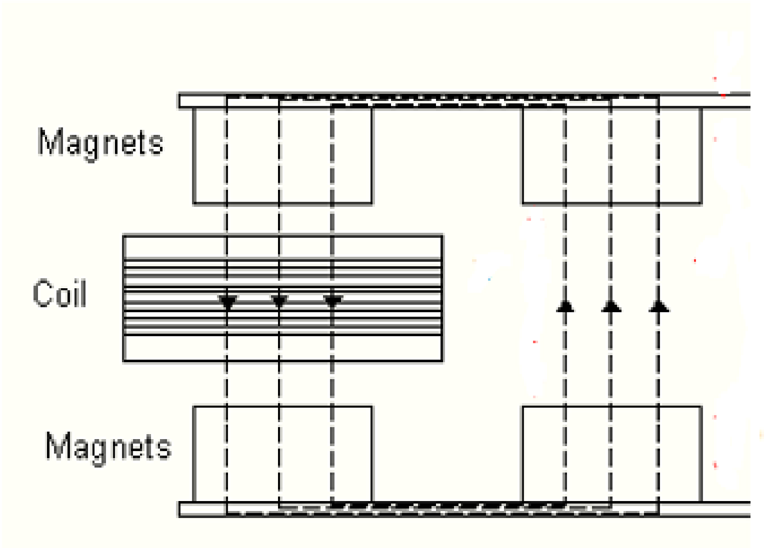


Fig.9 Coil and Design

This design will increase the field density greatly improving the voltage output. The increased thickness of a coil would therefore increase the distance between the two magnets reducing the flux. A balance must be found between the amount of voltage required and the amount of current required. We have chosen to use a very high gage wire to increase the amount of voltage the generator can provide. If the generator is required to produce more current the coils can be replaced with those of a smaller gage wire. The permanent magnets we have chosen to use provide a very strong magnetic field.

4.2(E) Coil Polarity:-

Lenz's law states that the induced EMF is always opposing the original change in flux. This law will help explain the direction of current flow in each coil. In an axial flux generator the magnets flow over each coil producing a changing magnetic field. As an individual magnet enters the area of a coil, the coil produce s a magnetic field opposing the magnets; in turn a current flows in a direction according to the right hand rule.

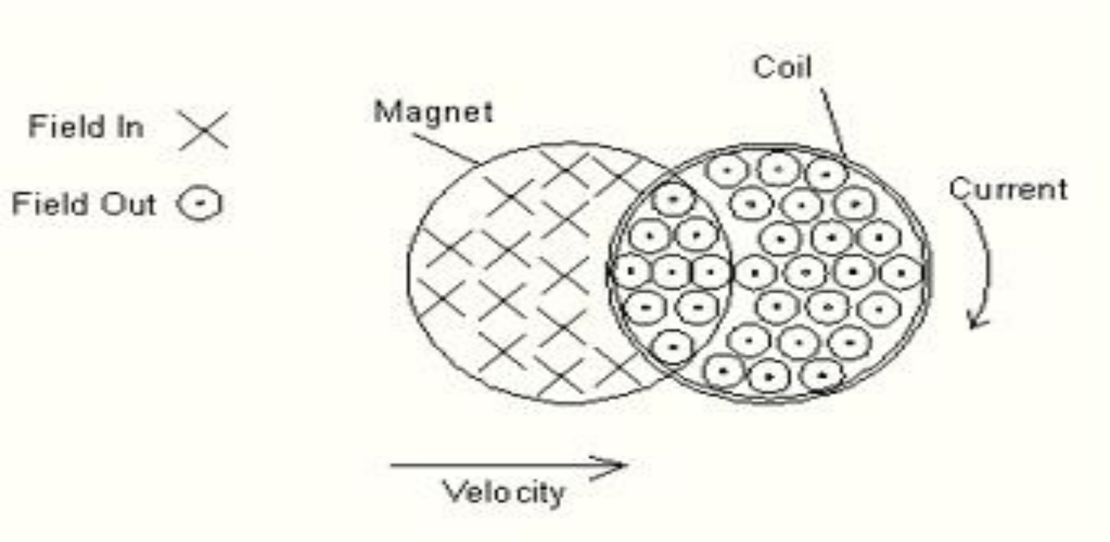


Fig.10 Magnet Entering Coil Region

When a magnet is positioned directly over a coil the magnetic field produced by the coil equals the magnetic field produced by the magnet, therefore the voltage will go to zero and no current flows at this instant.

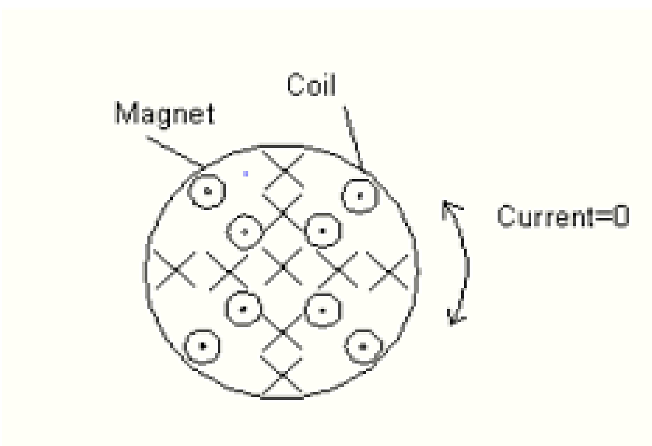


Fig.11 Magnet directly Above Coil Region

When the magnet finally exits the area of the coil, the coil now produces a field that coincides with the direction of the magnet. This in turn produces a current that flows in the opposite direction that it was originally flowing when the magnet entered the region.

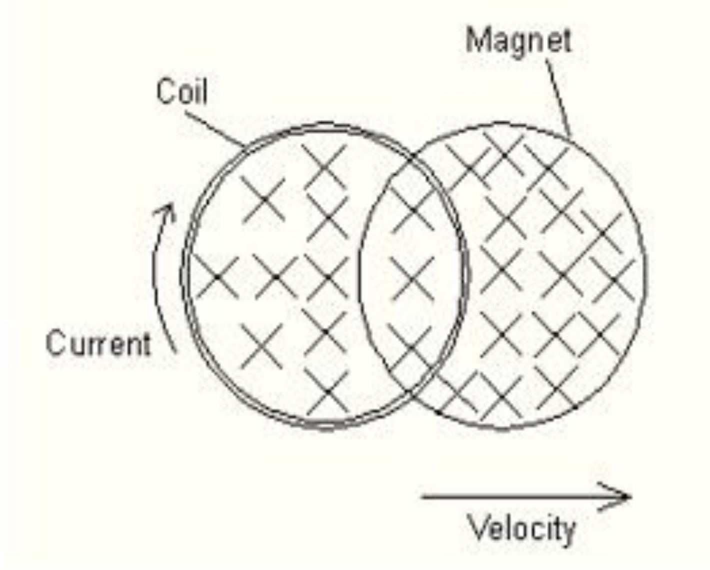


Fig.12 Magnet exiting coil region

Lenz's law helps us explain the voltage and current waveforms, which are produced as the magnets pass over the coils. This law conforms to the conservation of energy because the magnetic field produced by the current in a coil tries to maintain the original state of flux.

It is best to design a generator that alternates the direction of the magnetic poles around the circumference of the rotor. The alternation of poles allows the current to continue to flow in one direction as one magnet exits the area of a coil and another enters. If the permanent magnet poles were not alternated the output waveform would not produce a nice sinusoid. This alternation ultimately leads to increased power output from the generator. It is important to notice the symmetry of the generator when interconnecting the coils. Coils may be connected in series when they are 180 degrees apart. Two coils connected in series will produce a voltage twice that of one coil. If two coils are connected in series that are 90 degrees out of phase the currents will cancel each other producing no output.

CHAPTER 5

MAGNETIC LEVITATION

In selecting the vertical axis concept for the wind turbine that is implemented as the power generation portion of this project, a certain uniqueness corresponded to it that did not pertain to the other wind turbine designs. The characteristic that set this wind generator apart from the others is that it is fully supported and rotates about a vertical axis. This axis is vertically oriented through the center of the wind sails which allows for a different type of rotational support rather than the conventional ball bearing system found in horizontal wind turbines. This support is called maglev which is based on magnetic levitation. Maglev offers a near frictionless substitute for ball bearings with little to no maintenance.

5.2 MAGNETIC SELECTION:-

Some factors need to be assessed in choosing the permanent magnet selection that would be best to implement the maglev portion of the design. Understanding the characteristics of magnet materials and the different assortment of sizes, shapes and materials is critical. There are four classes of commercialized magnets used today which are based on their material composition each having their own magnetic properties.

5.2(A)B-H Curves of different Materials

The four different classes are Alnico, Ceramic, Samarium Cobalt and Neodymium Iron Boron also known Nd- Fe-B. Nd-Fe-B is the most recent addition to this commercial list of materials and at room temperature exhibits the highest properties of all of the magnetic materials. It can be seen in the B-H graph *shown in Figure that Nd-Fe*-B has a very attractive magnetic characteristic which offers high flux density operation and the ability to resist demagnetization. This attribute will be very important because the load that will be levitated will be heavy and rotating a high speeds which will exhibit a large downward force on the axis.

The next factor that needs to be considered is the shape and size of the magnet which is directly related to the placement of the magnets. It seems that levitation would be most effective directly on the central axis line where, under an evenly distributed load, the wind turbine center of mass will be found as shown I figure. This figure shows a basic rendition of how the maglev will be integrated into the de sign. If the magnets where ring shaped then they could easily be slid tandem down the shaft with the like poles facing toward each other. This would enable the repelling force required to support the weight and force of the wind turbine and minimize the amount of magnets needed to complete the concept.

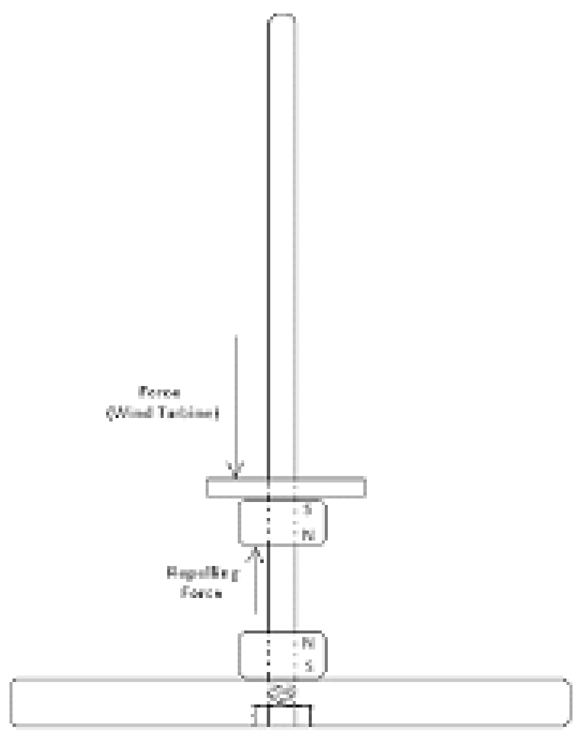


Fig.13 Basic Magnet Placement(Diagram)

The permanent magnets that were chosen for this application were the N35 magnets from Magnatronix. These are Nd-Fe-B ring shaped permanent magnets that are nickel plated to strengthen and protect the magnet itself. The dimensions for the magnets are reasonable with a outside diameter of 40mm, inside diameter of 20mm and height of 10mm.

5.3 B-H CURVE:-

All of the following information explains the importance of the B-H curve corresponding to magnet design. The hysteresis loop also known as the B-H curve, where B is the flux density and H the magnetizing force, is the foundation to magnet design and can be seen in Figure 5.3. Each type of material has its own B-H characteristic which describes the cycling of the magnet in a closed circuit as it is brought to saturation, demagnetized, saturated in the opposite direction, and then demagnetized again under the influence of an external magnetic field.

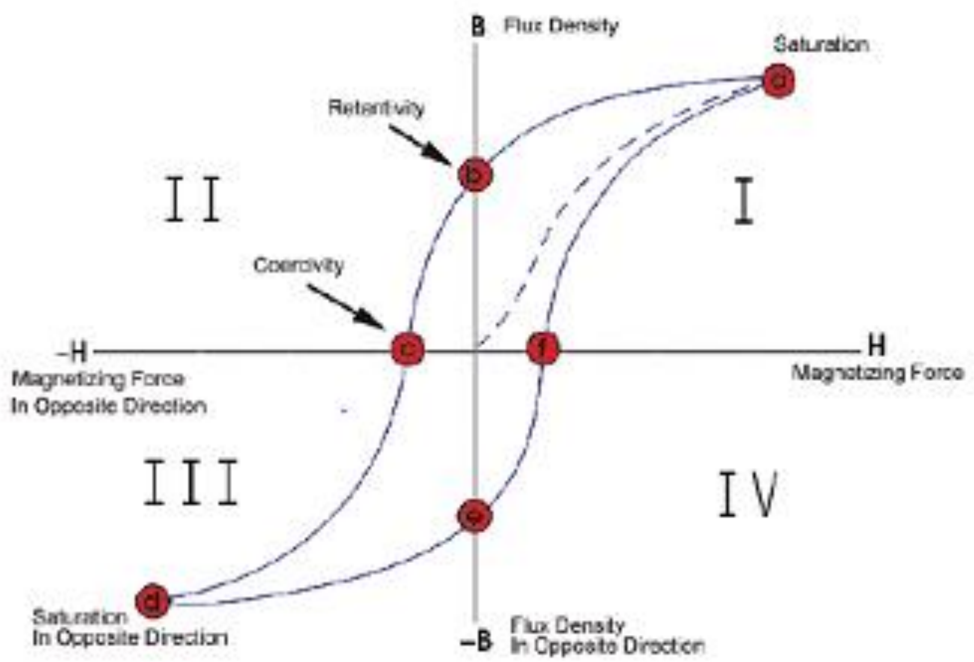


Fig.14 General Hysteresis loop

Of the four quadrants that the hysteresis loop passes through on the B-H graph, the most important is the second. This quadrant commonly known as the demagnetization curve, will give the operating point of a permanent magnet at a given air gap. In the case of maglev for the wind turbine, the air gap corresponds to the space in between the two opposing magnets and should stay moderately constant as long as the wind is not too violent. If the air gap where to change, the operating point of the magnets on the B-H curve will change respectively.

The most important points of the hysteresis loop are when it intersects with the B-H. The point where the curve intersects the B axis in the second quadrant is known as the magnets retentively, which is the point where a material will stay magnetized after an external magnetizing field is removed. This is also known as the residual induction point which is denoted by BR(MAX) and is where the flux density is at its maximum for a specific material as *shown in Figure The next point* that is relevant to magnet design is the point at which the curve intersects the H axis. This point is known as the materials coercively which is the intensity of the applied magnetic field required to reduce the magnetization of that material to zero after the magnetization of that material has been driven to saturation.

This point is also known as the coercive force which is denoted by Hc as seen in *Figure* The last point that is important to the maglev design is the resultant product of B and H which is denoted by BH(MAX). This point represents when the energy density of the magnetic field into the air gap surrounding the magnet is at its maximum.

Outer Diameter D_O	Inner Diameter D_I	Thickness h
40 mm	20 mm	5 mm

5.3(A)Permanent Magnet Specification

Again the force that is desired is the permanent magnet repelling force in the air gap of the magnet. This force will be obtained from equation but the flux ф is unknown at this point. Φ is going to be difficult to find in this situation because of the absence of finite analysis tools but approximations can be made to get a close estimate. Under normal operating conditions with no outside influence, it can be assumed that the flux distribution is proportional around a magnet as seen in Figure below,

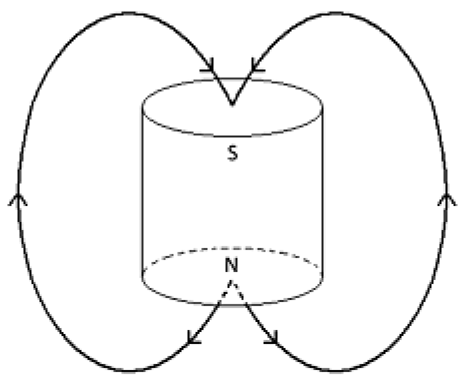


Fig.15 Flux Distribution Around Permanent Magnet

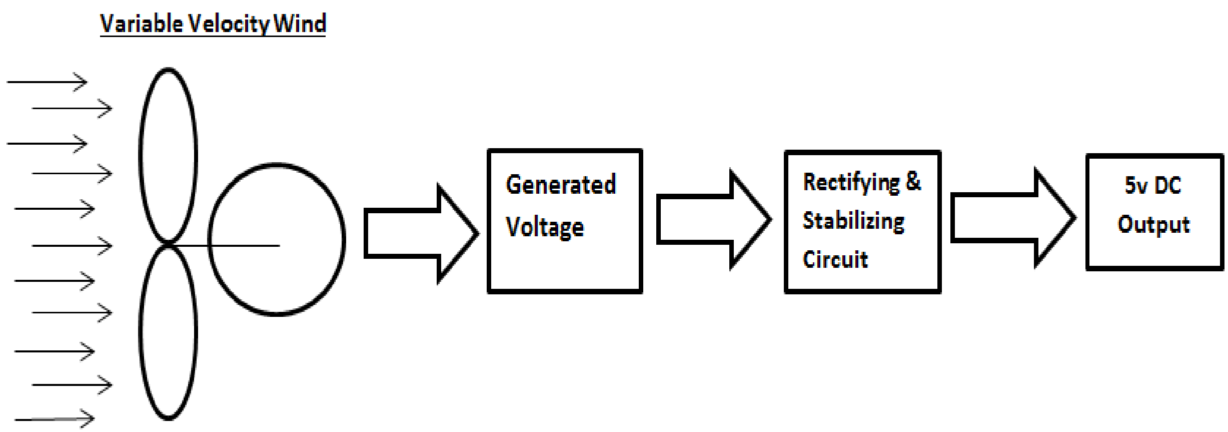
The magnets used in this design is N-35 grade NdFeB magnets. The flux density of such magnet is 2100 Gauss and that is indicated by the green glow of light in the figure below. The values of flux densities varies as distance changes from the magnet. The change in flux density is shown as color changes in the figure. The concentric flux lines are directed outwards as shown in the figure.

CHAPTER- 6

PROTOTYPE

Some modifications are made in order to overcome the limitations of theoretical design of magnetically levitated vertical axis wind turbine and a prototype is constructed. This section include details of modifications made.

6.1 Block Diagram:-



6.1(A) MAGNET PLACEMENT:-

Two ring type neodymium (NdFeB) magnets of grade N-35 of outer diameter 40 mm, inner diameter 20 mm and thickness 10 mm are placed at the center of the shaft by which the required levitation between the stator and the rotor is obtained. Similar Disc type magnets of 25 mm diameter are arranged as alternate poles one after the other, along the periphery of the rotor made of plywood of 30 mm diameter as in figure.

These magnets are responsible for the useful flux that is going to be utilized by the power generation system.

Fig.16 Magnet Arrangement

6.2 COIL ARRANGEMENT:-

46 gauge wires of 5000 turns each are used as coils for power generation. 14 sets of such coils are used in the prototype. These coils are arranged in the periphery of the stator exactly in a line to the arranged disc magnets. The coils are raised to a certain height for maximum utilization of the magnetic flux. Each set of such coils are connected in series to obtain maximum output voltage. The series connection of the coils are preferred over the parallel connection for

optimizing a level between the output current and voltage. The coil arrangement is shown in figure.

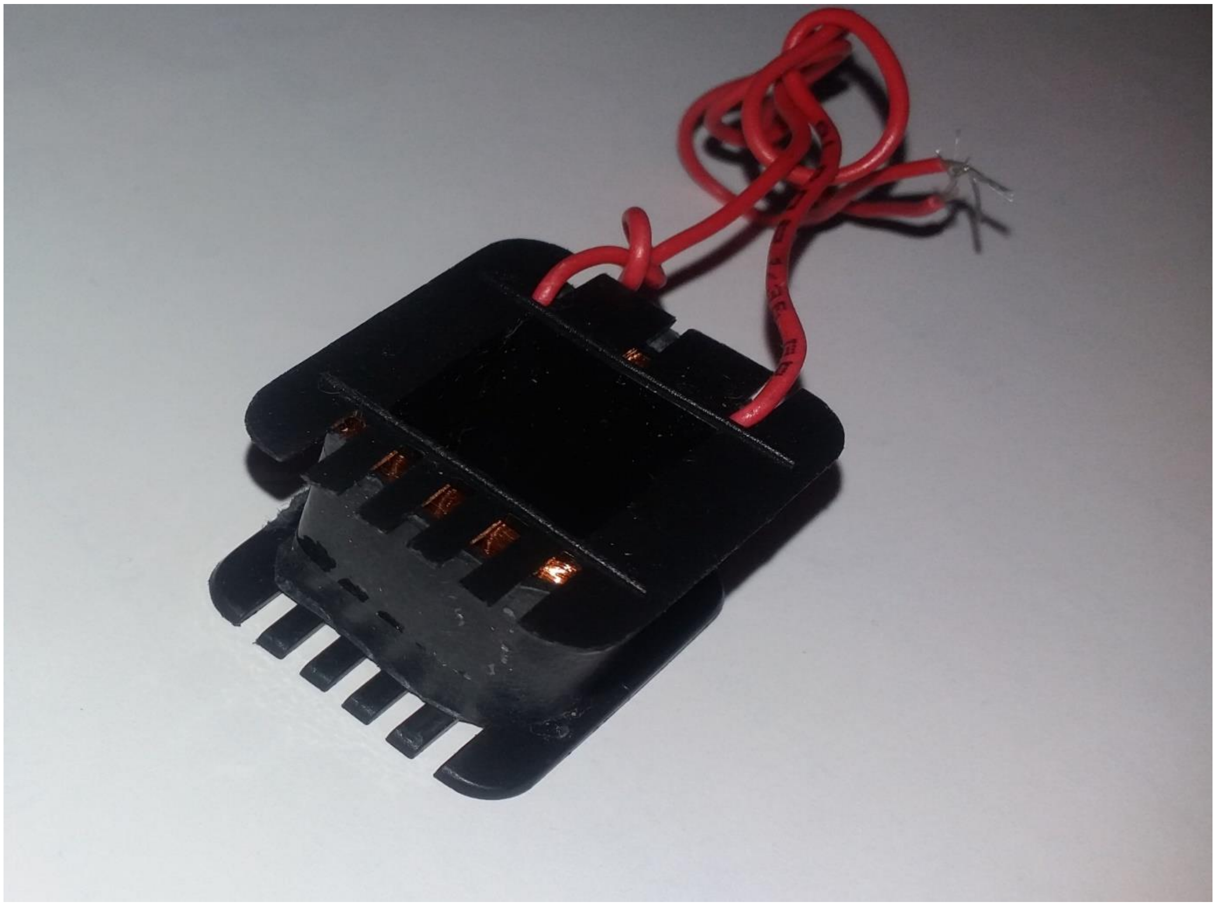


Fig.17 Coil (single set)

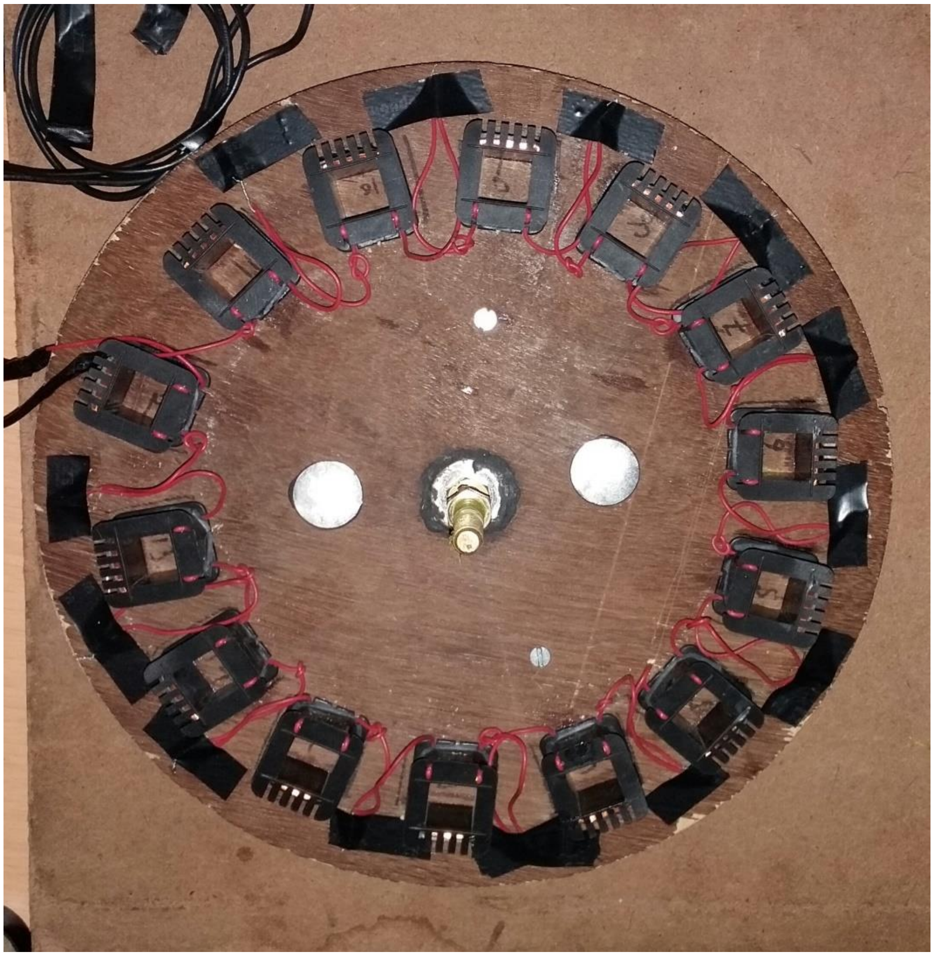


Fig.18 Coil Assembly

If the amount of current was more important in the output of the system, neglecting the voltage, the coils could have been replaced with lesser gauge and they could have been connected in parallel.

6.3 LEVITATION BETWEEN STATOR AND ROTOR:-

In the designed prototype, the stator and rotor are separated in the air using the principle of magnetic levitation. The rotor is lifted by a certain centimeters in the air by the magnetic pull forces created by the ring type Neodymium magnets. This is the principal advantage of a maglev windmill from a conventional one. That is, as the rotor is floating in the air due to levitation, mechanical friction is totally eliminated. That makes the rotation possible in very low wind speeds. Figure illustrates the magnetic levitation in our prototype.

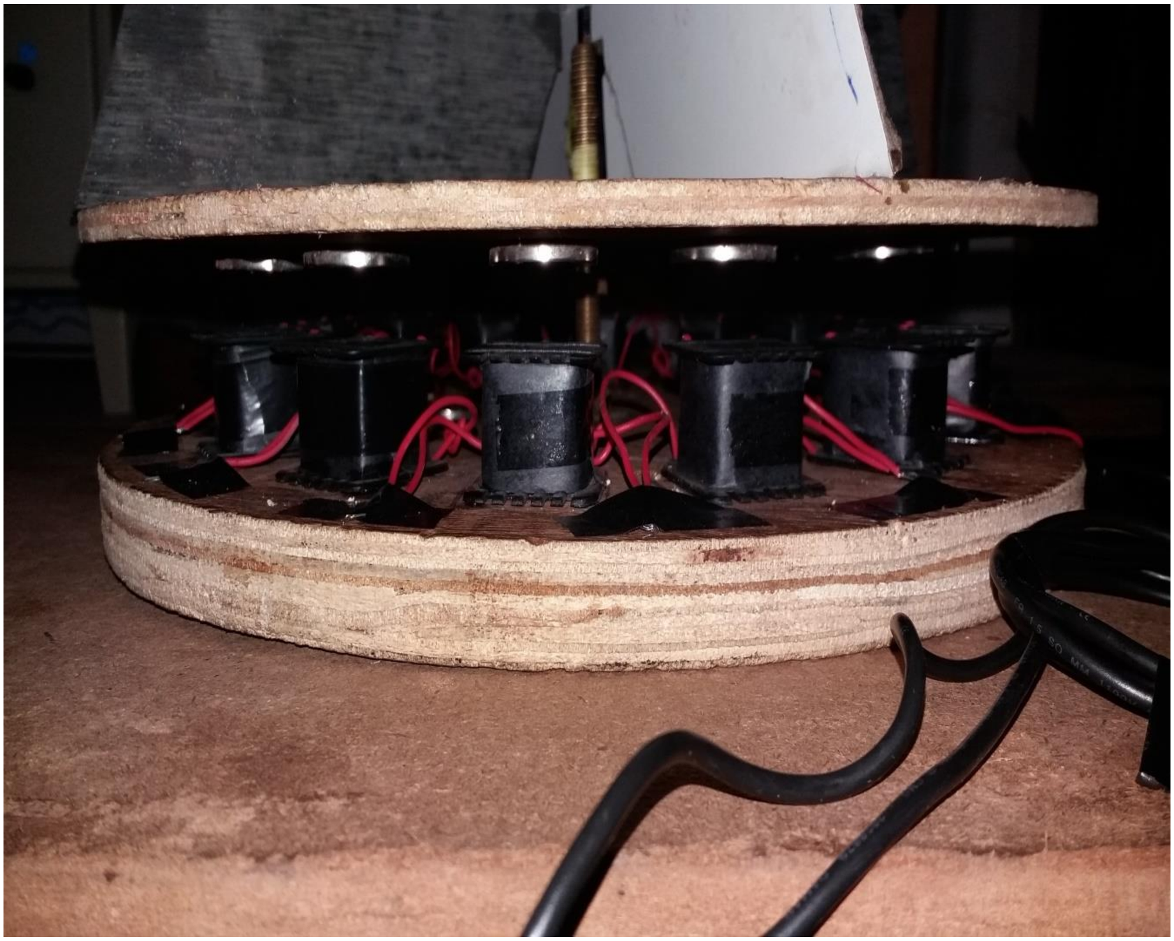


Fig.19 Magnetic Levitation

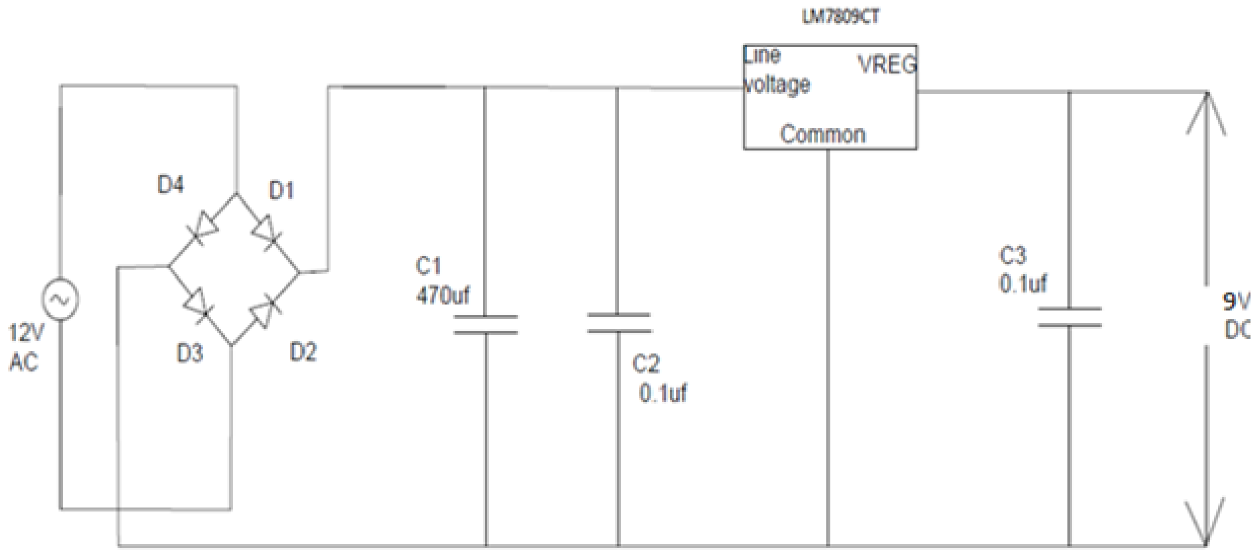
6.4 BLADE DESIGN:-

The blades used in this prototype are not of the conventional type. In this prototype, we have followed a blade structure known as Savonius type of wind blade. The main peculiarity of this type of blade is that its lower portion have an increased width and upper portion is narrow. This helps for the wind density to be increased in the bottom side and this in turn increases the total system stability. The blades in our prototype is shown in figure.

Fig.20 Savonius Type Blades

CHAPTER 7

7.1 Rectifier Circuit:-



7.2 Working Of Circuit:-

From the above diagram, when the minimum 12V (ac input) is applied to the circuit through windmill which will rectified by the rectifier and it will filter through smoothing reactor i.e. capacitor(C1 470uf) and it will regulated through IC7809CT and we get the constant +9V DC converted.

Bridge Rectifier: - We used bridge rectifier of 4*1N4001 it will convert the ac input into pulsating dc.

Capacitor (C1): - It is electrostatic type capacitor. Capacitor rated at 470uf is used usually it works as smoothing reactor which will filter out the pulsating dc.

Capacitor (C2&C3): - It is ceramic type capacitor. Capacitor rated at 0.1uf is used which works as regulated circuit.

IC7809CT: - To regulate the dc voltage IC7809CT is used which will regulate the voltage into +9V DC.

7.3 FINAL MODEL:-

The overall structure of the prototype designed is shown in the figure. The output voltage obtained from this prototype is measured using a multi-meter and it is found to be some value around 40 volts.

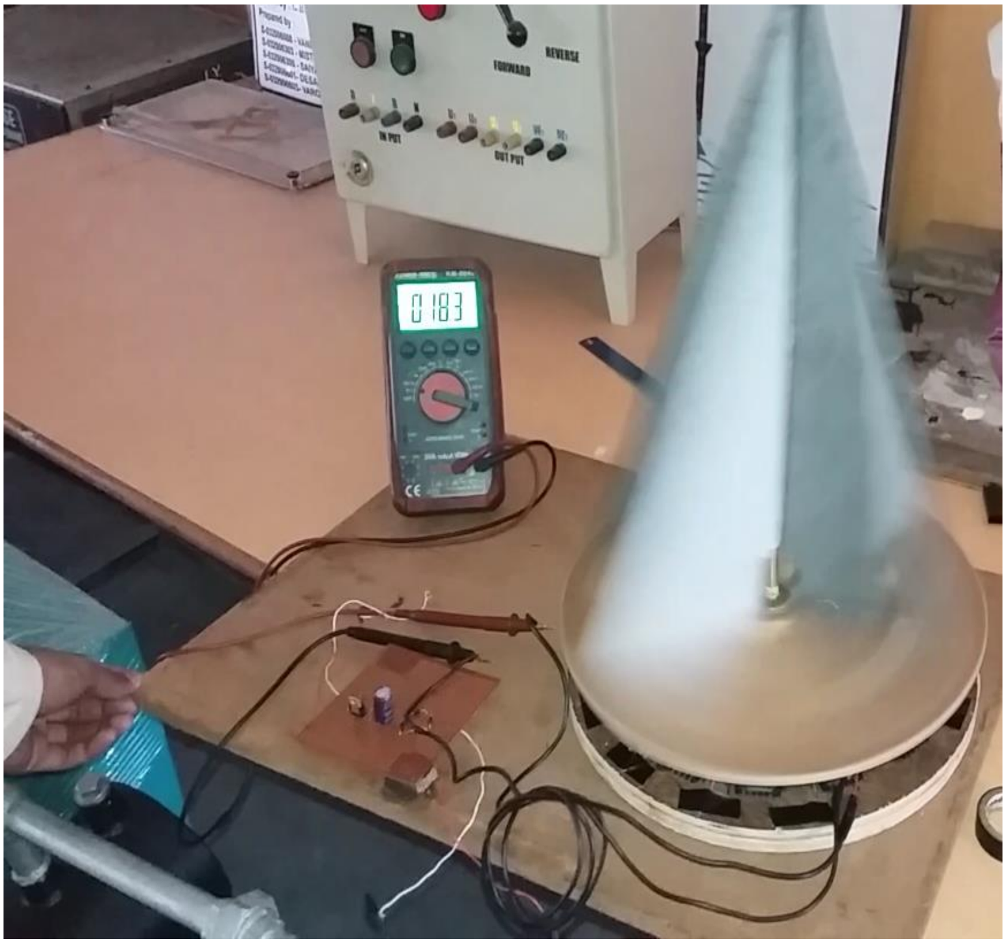


Fig.21 Final Structure

Observation Table: -

Serial No.	Speed of wind(m/s)	Voltage(AC Volt)
1	5	16.3
2	7.2	19.8
3	9	22.1

Work Allocation Matrix

Activity No.	Description of Activity	Who will Perform?	Planned Date		Actual Date		Who Has/Have Performed ?	Reason For Any Delay/Deviation from Planning
			Starting	Ending	Starting	Ending		
1.	Finalization of Project	All	28/12/2015	10/3/2016	28/12/2015	10/4/2016	All	-
2.	Block Diagram	Nikunj Rana	19/6/2015	22/4/2016	19/6/2015	22/4/2016	NikunjRana	-
3	Preparation of PPT	Rutvij Chitroda, Harsh Chauhan, SurajRana , Abdulkadir bundiwala	5/1/2016	1/2/2016	5/1/2016	1/2/2016	Rutvij Chitroda, Harsh Chauhan, SurajRana , abdulkadir bundiwala	-
4	Design of circuit Diagram (Autocad)	All	5/3/2016	15/3/2016	5/3/2016	22/3/2016	All	Due to the Failure of circuit
5.	Preparation of Report	Harsh Chauhan, SurajRana , Abdulkadir bundiwala	5/1/2016	1/2/2016	5/1/2016	1/2/2016	Harsh Chauhan, SurajRana , Abdulkadir bundiwala	-
6.	Working/Project Photography	Suraj Rana, Nikunj Rana	1/1/2016	20/2/2016	1/1/2016	20/2/2016	Suraj Rana, Nikunj Rana	-
7.	Estimating Costing of Project	Harsh Chauhan, Rutvij Chitroda, Abdulkadir Bundiwala	28/12/2015	10/2/2016	28/12/2015	10/2/2016	Harsh Chauhan, Rutvij Chitroda, Abdulkadir Bundiwala	-

Notes on Individual Achievements

Abdul

- Got the knowledge about magnetic levitation, and also got the knowledge about estimating and costing.
- Got the knowledge about the model work.
- Also done the market survey & gained the knowledge about it.

Harsh

- learned, what is Magnetic Levitation, how it works and also understand how it can be implemented.
- Also learned about the concept of permanent Magnet, And getting the knowledge about the estimating & costing.
- Concluded that magnetic levitation can be implemented on only Vertical Axis Wind Turbine and it is very difficult for the Horizontal Axis Wind Turbine.

Rutvij

- learned about the magnetic levitation, also understand the use of repulsion principle of the magnets and how it is implemented on the project.
- Also got the knowledge about the estimating & Costing.
- Concluded that, the magnetic levitation is only possible for Vertical axis wind turbine.

Nikunj

- Got the knowledge about magnetic levitation, also got the knowledge about windmill & wind turbine.
- Learned, how to face problems and solve them.
- Learned about the estimating and costing of our project.

Suraj

- Learned about the difference between Horizontal Axis Wind Turbine & Vertical Axis Wind Turbine.
  Also got the knowledge about the estimating & Costing.
- Also learned the difference between Windmill & Turbine.

CHAPTER 8

8.1 Advantages: -

- They are able to with stand the speed of about 25-30m/s as compare to conventional windmill.
- It's rotation is freely due to magnetic levitation.
- Due to magnetic levitation it's efficiency is improved.
- There is no problem of friction due to magnetic levitation.

8.2 Disadvantages: -

- It cannot be used for Horizontal axis wind turbine.
- Initial cost is high.

8.3 Applications: -

- The place at where the wind velocity is less there this Maglev Windmill is best option for the power generation.
- It is operated on low speed, hence its also installed at the terrace and we get the output.

CONCLUSION

At the end of project, the Maglev Windmill is a useful project. The principle of magnetic levitation is implemented to eliminate friction and utilize the maximum output at its sufficient speed. A modified design of savonius model wind turbine blade was used in the construction of the model.

FUTURE SCOPE

The home for the magnetically levitated vertical axis wind turbine would be in residential areas. 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. The maglev windmill can be designed for using in a moderate scale power generation ranging from 400 Watts to 1 KW. Also it is suitable for integrating with the hybrid power generation units consisting of solar and other natural resources.

References

www.maglevwindmill.com

www.google.com

www.youtube.com

Moment Of Work Photographs