Scientific Journal of Impact Factor (SJIF): 4.72

e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 4, Issue 4, April -2017

MAGLEV WIND TURBINE BASED POWER GENERATION

Vivek G. Metkar, Mo. Shahnawaz R. Shaikh, Milton M. Kamle, Jagdish S. Lahane

Manav School of Engineering and Technology, Akola, vyala

Abstract: *This paper gives information about wind turbine for power generation. Magnetic levitation, maglev is a method by which an object is suspended with no support other than magnetic fields. Magnetic pressure is used to counteract the effect of the gravitational and any other acceleration. Magnetic repulsion gives advantages of no use of ball bearing hence turbine gives universal rotation. Power is generated by vertical axis flux generator with use of permanent magnets and set of coils. Hence this technology provide an extreme efficient, versatile and elegant method of power generation from wind with nearly zero pollution and green energy is possible using this model on higher scale.*

Keywords: *Magnetic Levitation, Neodymium magnet, Clean Green Power, Vertical Axis Wind Turbine and Generator.*

1. Introduction

Now a day, we will ultimately need to search for renewable or virtually inexhaustible energy sources for the human development to continue. Renewable energy is generally electricity supplied from sources, such as wind power, solar power, geothermal energy, hydropower and some others. The need for the renewable energy is high from last few decades due to the consumption of conventional power generation methods. The use of renewable energy is the only thing that decreases the dependency of human on fossil fuels. Among all the other renewable energy sources Wind Energy is one of the rapidly growing energy sources which is growing at the rate of 30% annual graph. The wind speeds in Asian countries is very low, especially in the cities, and this much amount of wind speed is not enough to start the wind mill. This project introduces structure and principle of the proposed magnetic levitation wind turbine for better utilization of wind energy. In Maglev Wind turbine there is no friction, and therefore it can work on low speed. The Maglev wind turbine design is a huge departure from conventional propeller designs. Its main merits are that it uses frictionless bearings and a magnetic levitation design and it does not need to huge spaces required by more conventional wind turbines. It also requires little if any maintenance. The Maglev wind turbine was first presented at the Wind Power Asia exhibition in Beijing 2007. The unique operating principle behind this design is through magnetic levitation. Magnetic levitation is supposedly an extremely efficient system for wind energy

It is a natural power source that can be economically used to generate electricity. The way in which wind is created is from the atmosphere of the sun causing areas of uneven heating. In conjunction with the uneven heating of the sun, rotation of the earth and the rockiness of the earth's surface winds are formed. The terms wind energy or wind power describes the process by which the wind is used to produce mechanical power or electricity. Wind turbines convert the kinetic energy in the wind into mechanical power. This mechanical power can be used for particular tasks or a generator can convert this mechanical power into electricity. The wind turbine is used for conversion of kinetic energy of wind into electrical energy. The wind turns the blades, which spin a shaft, which connects to a generator and produces electricity. A wind turbine is used to generate electricity in bulk. Several wind turbines, bunched together, form a wind farm. The electrical power that is generated from the turbines is distributed to customers from a utility grid. The utility grid works similar as a conventional power plant. The cost of generating wind power comes from the cost of machinery, installation and site preparation. These three factors make up over eighty percent of the initial startup cost. The cost of wind energy used over the course of a lifetime though, is lower than using fossil-fueled systems. This is because there are less operating expenses and there is no fuel to purchase. So in the long run wind power is cheaper than other forms of energy. The renewable energy produced from wind has gathered much attention in recent years but is often criticized for its low output and lack of reliability. The maglev wind turbine is expected take wind power technology to the next level with magnetic levitation.

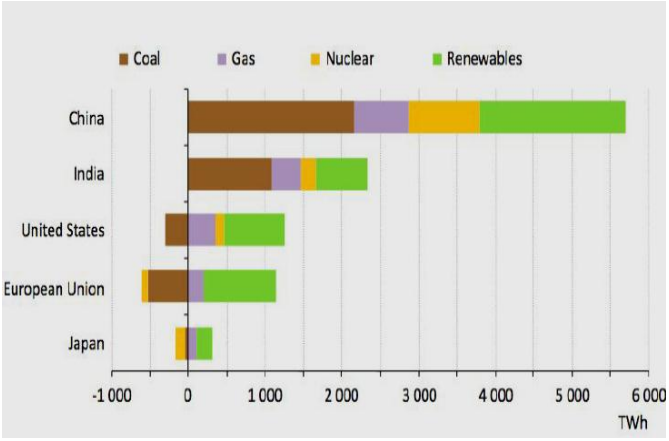

Fig.1: Comparison in energy sources

2. Basic Principle of Magnetic Levitation Wind Turbine

Magnetic levitation is a technique by which an object is suspended in air so effect of gravity on that object reduces significantly with no support other than magnetic fields. Here magnetic pressure is used to mainly counteract the effects of the gravitational forces. Magnetic levitation is an extremely effective system for wind energy. Here how it works:- At the bottom one magnet is placed. It repels the other magnet which is welded to the shaft of generator. The shaft contains the vertically oriented blades of the wind turbine. Now due to this repulsion power between the magnets the upper magnet attached to shaft is suspends is air suspended,. For this levitation full permanent rare earth magnets made from neodymium are used. Due to this no energy loss through friction occurs in generator. This also helps in decrease the maintenance cost and increases the life span of the wind generator.

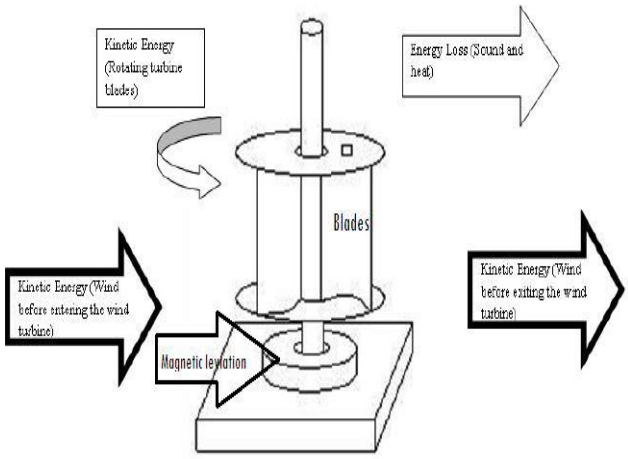

Fig. 2: Working model of maglev wind turbine

The energy that can be collected from the wind is directly proportional to the cube of the wind speed. We can then calculate the power converted from the wind into rotational energy in the turbine using equation.

$P_{avail} = 0.5\ \rho\ A v^3\ Cp$

Where,
P_{avail} is output power available in watts.
ρ is density of air in kg/m^3.
A is area swept by blades.
V is velocity of wind.
Cp is the power coefficient called Betz limit
Cp max= 0.59

3. Test System

Entire construction of this magnetic levitation wind power generation can be divided into following part:-

3.1 Neodymium magnet

The full-permanent magnets consist of neodymium magnets which are rare earth metals, which lose no energy through friction. This combination of magnetic components and reduction of moving parts should reduce maintenance costs and increase the life of the turbine. Neodymium magnet is the composition of neodymium, iron, boron & few transition metals. Thus magnets are extremely strong for their small size, metallic in appearance and found in simple shape such as rings, blocks and disk. Neodymium magnets are develop rapidly and applied widely due to their perfect characteristics

Fig. 3: Neodymium magnet

3.2 Wind turbine

The problem the traditional structure of VAWT of is the weight from the VAWT makes bearings bear larger axial force makes bearings frayed largely and shorten the life. At the same time, due to the increase in friction, the system loss mechanical energy and reduce the efficiency. Maglev VAWT use the attracted gather of disc stator and permanent magnetic rotor, in other words, use the attracted gather of magnetic core and the permanent magnet, which makes the bearing overcome axial force and reduce bearings attrition and lengthen bearings service life. At the same time, reduce bearings frictional force, improve the mechanical efficiency.

A wide range of materials can be select as a turbine blade in wind turbines. Depending on a size of our project here we use aluminum for blade material. Aluminum is a metal like steel, brass, copper, zinc, lead or titanium. Aluminum is a very light metal with a specific weight of 2.7 g/cm2, about a third that of steel. Its strength can be adapted to the application required by modifying the composition of its alloys. Aluminum naturally generates a protective oxide coating and is highly corrosion resistant. Aluminum is a good reflector of visible light as well as heat, and that together with its low weight makes it an ideal material for reflectors in, for example, light fittings or rescue blankets. Aluminum is strong with a tensile strength of 70 to 700 MP depending on the alloy and manufacturing process. Extrusions of the right alloy and design are as strong as structural steel. This means that the moment of inertia has to be three times as great for an aluminum extrusion to achieve the same deflection as a steel profile.

The efficiency of the wind turbine is dependent on wind availability, if the amount of wind is sufficient wind turbine blades are rotating continuously. The wind is hits the blades of the turbine, the power generation by the blades can be calculated as:

Kinetic energy (K.E) = ½ mv^2 (1)

Amount of Air passing is given by,
$m = \rho AV$ (2)
Substituting this value of the mass in expression of K.E,
$K.E = \rho Av^3$ Watts (3)

To convert power to kilo watt a non-dimensional proportionality constant k is introduced where,
$k = 2.14 \times 10^{-3}$
Therefore,
Power in KW (P) = $2.14\ \rho Av3\ x10^{-3}$ (4)

Where,
m = Mass of air traversing
A = Area Air Density
(ρ) = 1.2 kg/m^3
Swept by the blades of the turbine Velocity
(V) = wind speed

With above equation, the power being generated can be calculated, however one should note that's not possible to convert all the power of the wind into power. The turbine absorbs the wind energy with their individual blade will moves slower that the wind velocity. The different speed generates a drag force to drive the blades. The drag force Fw acting on one blade is calculated as:

$$Fw = Cd^2A \frac{Uw - Ub}{2} \quad (5)$$

Where,
A - Swept area of the blade
ρ - Air density (about 1.225 kg/m^3 at sea level)
Uw - Wind speed
Cd - The drag coefficient (1.9 for rectangular form)
Ub - The speed on the blade surface.

Fig. 4: Structure of maglev wind turbine Blade

3.3 Generator

The basic function 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 some differences present is what really distinguishes a system operating on an 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.

4. Performance of Test System

Voltage: 9 volts
Frequency: 23.63Hz
Rotation Speed of turbine: 320 rpm
Current: 16.8 mA

Fig. 5: Coil Structure of maglev wind turbine

5. Advantages

- These have a lower noise signature.
- They don't require yaw mechanisms
- Eliminates need of long distance transmission line.
- Cost is less compare to solar plant.

6. Disadvantages

- The capital cost of wind power is third higher than Conventional thermal power
- Because of their low height they cannot capture the wind energy stored in higher altitudes.
- Efficiency affect by replacing magnet.

7. Applications

This paper demonstrates the utilization of the renewable resource (wind energy) in an efficient way. This type of generation can be used in remote places where conventional power supply is uneconomic. The methodology can be used for hybrid power generation. Generated power by this method can be used ON and OFF grid.

The technology is expected to create new opportunities in low-wind-speed areas worldwide such as mountain regions, islands, observatories and television transfer stations. In addition, the Maglev generator will be able to provide roadside lighting along highways by utilizing the airflow generated from vehicles.

Table: I **System Parameter**

Sr. No.	Parameters	Details
1	Blade Material	PVC
2	Supporting Material	Acrylic
3	Blade Quantity	6
4	Diameter	30 cm (base)/ 45 cm (bottom)
5	Height	45 cm
6	Turbine Weight	< 1 Kg
7	No. of Magnet	4
8	Maglev Magnet	Ferranti Magnet
9	Design of Blades	45 degree, 30 cm

8. Conclusion

The important concept of magnetic levitation explained in this paper. The frictional losses which can assume to be negligible, so Maglev wind turbine helps in achieving greater efficiency. If we use more numbers of coils in stator and more numbers of magnets in rotor the emf generated in coils will be more. To get more output another way is to reduce turbines own inertia by using lighter weight materials for turbine. So that for the same wind speed it will rotate faster, hence it will generate more power.

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