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FRICTIONLESS WIND TURBINE USING MAGNETIC LEVITATION

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Abstract-

The paper describes the implementation of different type of a wind turbine for purpose of power generation. A vertical axis wind turbine (VAWT) with use of magnetic levitation technology for optimal performance of wind turbine has been discussed. With the merits of conventional VAWT, the merits of starting at low wind-speed, higher efficiency, low noise emission, etc. are also discussed. The major consequence in front of conventional wind turbine is loss of energy during rotation. By using nature of permanent magnet as a perfect replacement for ball bearings levitation of the turbine is intended thus reducing energy losses while rotation. Using this effect wind turbine blades are placed on a rod for obtaining stability during rotation. Power is then generated by using an axial flux generator, which has incorporated the utilization of permanent magnets and a set of coils.

Keywords—VAWT, Magnet, Magnetic Levitation, Wind Turbine, Energy, Wind Power.

INTRODUCTION

An important factor in development of human resource is the Energy. While fossil fuels will be the main fuels for thermal power, there is a fear that they will get exhausted eventually in the next century. Therefore other systems based on non-conventional and renewable sources are being tried by many countries. These are solar, wind, sea, geothermal, and biomass. The wind power been utilized by human being for a greater time period and the technology linked with it is more modified compared to other non-polluting energies. Today wind power is attracting the benefits of power sector and their application is entering into quicker development.

The merits for vertical-axis wind turbine (VAWT) can be noted such as requirement of minimum cost, easy installation, easy maintenance, and the capability to accept wind from all directions. Compared with the traditional horizontal axis wind turbine, this type is levitated or suspended with the help of magnetic levitation directing vertical on a rotor shaft. This technology is utilized as an efficient replacement for ball bearings having its application on the traditional wind turbine. This technology is usually implemented with permanent magnets and is used in between the rotating shaft of turbine blades and base of wind turbine system. The entire rotor weight of wind turbine is balanced by magnetic bearings. The friction of the bearings is eliminated and hence need for bearing lubrication is also eliminated with decrease in the maintenance cost.

LITERATURE REVIEW

Vishal D Dhareppagol, Maheshwari M Konagutti, the objective of this thesis work is to design and implement a magnetically levitated vertical axis wind turbine system that has the ability to operate in both low and high (1.5m/s to 40m/s) wind speed conditions. The no of blades used for this turbine is 6 which are placed such that the angle between two adjacent blades is 60 degree. Each blade is fixed between the two discs with 30degree deviated. The length to diameter ratio is kept as 1 for better performance of turbine. Producing 20% more energy than a conventional turbine, at the same time decreasing operational costs by 50% over the traditional wind turbine. [1]

Pravesh K. Sahare, Tanveer A. Hussain, Sangita N. Kakde, Sujata R. Ingle, Ambikaprasad O. Chaubey, the objective of this paper is to write a review on all the parameters important for designing of Maglev Vertical axis wing turbine. Disc type Neodymium magnets are considered which are developed rapidly and applied widely due to their perfect characteristics. The author concluded that the design of the blades and rotors are capable enough to rotate at low wind speed and give the output. The magnets are levitated properly while working which gives smooth rotation and hence there is negligible friction. [2]

Chinnu Sara Thomas, Dhanya Varghese, Jayalakshmi S, Sonu Savy Thomas George, Rini Varghese P, the aim of this project work is to design a Vertical axis magnetic levitated wing turbine as an alternative for conventional wind turbine. Author has considered Two ring type neodymium (Nd-Fe-B) magnets of grade N52 of outer diameter 28 mm, inner diameter 10 mm and thickness 12.5 mm are placed at the shaft, by which the required levitation between the rotor and the base is obtained. The Experimental result shows that maglev wind turbine rotate at minimum wind energy of 1.45m/s as compared to conventional turbine which required 4.475m/s. [3]

Shubham Patil, Pratik Kumbhar, Oslaniya Siddhartha, Patil Rohit, C.S.Wagle, the objective is to compare the experimental testing of the Vertical wind turbine with bearing and magnetic assistance at the supports. Neodymium magnet with dimensions 15*8*3mm having capacity to repel 9.81 force can be used for levitation between stator and rotor to maintain air gap. The Magnetic bearing will produce 29.7% more RPM than conventional Design. The experimental Results shows that the Magnetic Vertical Axis Wind Turbine has lower starting speed and the arrangement of magnets so proposed assists the turbine in lowering the starting speed. [4]

Wind power

Wind is considered as another form of solar energy because of its origination from difference in heating of atmosphere by sun. The winds relevant to applications of wind turbines are local winds and planetary winds. The second one is most available. Hence it constitutes as important consideration in locating the sites for proper working of wind turbines. The locations of these winds are generally along sea shore, mountain, valleys and open plains. Electricity generated from the wind does not produce Carbon Dioxide emissions and therefore does not contribute to the greenhouse effect.

Types of Wind Turbine

Wind Turbines are divided into two classes: horizontal axis wind turbines (HAWTs) and vertical axis wind turbines (VAWTs).

1. *Horizontal axis Wind Turbines*

Horizontal axis wind turbine can be visualized as conventional box fan, a set of blades connected to a shaft that is parallel to the ground; however, function of turbine is the opposite of a box fan. It normally consists of two to three blades connected to a shaft that is connected to a generator which will produce energy from shaft work. There are two main types of HAWTs, ones that face into wind and ones that face away from wind. Turbines that face into wind require a rudder or some other type of mechanism to be able to self-orientate to face incoming wind. Those that face away from the wind do not need this rudder to self-orientate, however they suffer from a vibration due to support tower blocking part of wind flow.

2. *Vertical axis Wind Turbines*

Vertical axis wind turbines operate on same principle of converting rotational movement due to wind into shaft work, which is then converted into electricity through the use of a generator. VAWTs contain a shaft that is perpendicular to ground. Unlike the HAWTs, the VAWTs can catch the wind regardless of the position that they are facing, which can lead to them being more versatile. Also, VAWTs are able to function in more irregular wind patterns than HAWTs are
able to. There are two primary blade designs that are used for VAWTs that operate on different principles: The Savonius type and The Darrieus type

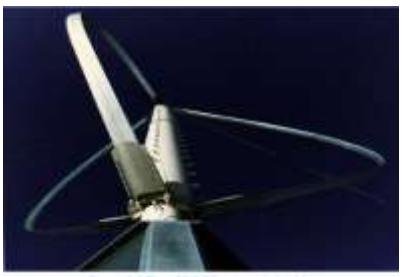

Fig. 1. Savonios type wind turbine

PROBLEM DEFINITION

The conversion efficiency of wind energy to electrical energy from the available conventional wind turbines is less than 30 % and the minimum wind velocity required to run these turbines is 20 km/h. Also they are noisy at high speed, requires regular maintenance, friction leads wear and tear.

IV. METHODOLOGY

- Design a Vertical axis magnetically levitated wing turbine for low wind application.
- study the Performance of the turbine in terms of Electric Power Generated.
- harness wind energy in more efficient way by elimination friction.
- analyze rotor in different pressure condition.
- fabricate the prototype.

It is found that to improve the performance of the wind turbines most of the work is carried out on the wind turbine blade profile modification. Therefore increasing the efficiency of the wind turbines is the present need. This can be achieved by reducing the contact friction of the rotor at its supports by providing the contact free frictionless magnetic bearings. It is the new direction to improve the performance of wind turbines. Also magnetic levitation increases life of rotor.

POWER GENERATION

When the air strike the blade of the turbine, due to the action of repulsive force of the magnet the rotation of the blade increase resulting in rotation of the shaft. Hence induced emf is generated in the generator. Output of turbine is AC
power. The bearing arrangement is totally replaced by the neodymium magnet which gives high repulsive force. With
the help of this force small amount of air pressure gives maximum rotation which results in large power generation

Power from Wind Turbine

The power rises as cube of the wind velocity and can be calculated with respect to area in which the wind and wind velocity is available.
When wind is in motion the energy produced is kinetic energy. Hence the power from turbine is related to the kinetic energy produced.

$$\text{Kinetic Energy} = \tfrac{1}{2} MV^2$$

The volume V' flowing in unit time through an area A, with wind speed V is denoted by AV and mass M is the product
of Volume V' and density ρ so: $M = \rho AV$
Putting the M in equation of kinetic energy we get:

$$\text{Kinetic Energy} = \tfrac{1}{2} (\rho AV)V^2 = \tfrac{1}{2} (\rho AV^3)$$

But Power is nothing but the kinetic energy generated by the turbine.
Hence,

$$\text{Power} = \tfrac{1}{2} (\rho AV)V^2 = \tfrac{1}{2} (\rho AV^3)$$

Where: Air Density (ρ) = 1.225 kg/m^3
Area (A) = Swept Area of turbine blades
Velocity (V) = wind speed in m/s

Generator

The generator converts mechanical energy of the shaft into electrical energy output. While designing the axial flux generator observation can be noted that the operating capacity of generator depends on permanent magnet alternators. For these generators air gap is arranged in perpendicular direction to rotating axis and hence produces magnetic fluxes in parallel direction to rotating axis.

How Power is Generated

Wind turbines serve as a means to transform the kinetic energy of wind into power. This process begins when wind contacts the turbine blades and transfers some of its kinetic energy to them, forcing them to rotate. Since the blades are connected to the main shaft through the rotor, the shaft rotates as well, creating mechanical energy. The main shaft is usually connected to a gear box which rotates a parallel shaft at about 30 times the rate of the main shaft. At high enough wind speeds, this amplification creates sufficient rotational speeds for the generator electrical output. Generators generally used in turbines are off-the-shelf and use electromagnetic induction to produce an electrical current. In these generators permanent magnets are arranged surrounding a coil. The shaft connects to the magnet assembly, spinning it around the stationary coil of wire and creating a voltage in the wire. The voltage is what drives the electrical current out of the wire and into power lines to be distributed.

MAGNETIC SUSPENSION (LEVITATION)

Principle

Magnetic levitation can be explained as technology which suspends or levitates an object with the help of magnetic forces for getting support without any contact and low friction during motion. Due to absence of mechanical contact in the magnetic bearing, advantages of no wear and tear, suitability for long-term use in any environment, absence of mechanical friction, low noise, less amount of power loss and absence of lubrication or sealing can be achieved. Therefore, this technology is beneficial for high speed applications to satisfy the objective of eliminating mechanical problems power loss.

Use of Magnetic Levitation in Wind Turbine

In recent years, due to rapid growth in the use of material for designing permanent magnet, the magnetic suspension using
permanent magnets are approaching towards wind turbine application leading to reduction in the cost as well as stringency of wind power. Due to use of magnetic levitation concept the advantages marked below has obtained:
1. Reduction in starting wind speed Due to elimination of friction the power output is increased for the same value of wind speed. Hence reduction in starting speed is obtained.
2. Due to utilization of magnetic levitation, design of the conventional wind turbine rotor has largely been affected. The use of conventional bearings is based upon careful lubrication for greater service life and higher reliability. With the reduction in operational cost as well as maintenance cost of the bearings reduction in the downtime of turbine is achieved improving the overhaul efficiency.

CONCLUSION

Magnetic levitation for wind power generators, represent a very promising future for wind power generation. Maglev wind turbines will require lower wind velocity for start-up and also they show better performance at lower wind velocities.

The turbine efficiency could be improved by utilization of magnets helping to spin with fast speed with negligible friction as it cancels out the stress on the shaft of the turbine. This modern design of turbine gives more power output with higher efficiency compared to conventional wind turbine.

FUTURE SCOPE

Power generated from this turbine can be utilized in remote places where traditional method of supplying power is costlier. Power generated from turbine can be efficiently used for Street/domestic lighting and domestic appliances.

The vertical axis wind turbine with magnetic levitation may be mounted on residences. Here it can be erected on rooftop with very efficient and practical approach. House owner would be capable for extraction of free and clean energy with a minimized utility cost. For medium power generation this design can be used.

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