A Dynamic Performance of Vertical Axis Wind Turbine by using Magnetic Levitation

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Abstract— It is a natural power source that can be economically used to generate electricity. Wind turbines convert the kinetic energy in the wind into mechanical power. Magnetic levitation or maglev is a method by which an object is suspended with no support other than magnetic fields. The Magnetic force of magnet is eliminating the effects of the gravitational and other accelerations. The main advantage of maglev vertical axis wind turbine is to reduce mechanical friction. Maglev has more advantages from other conventional wind turbines. It can be work on low speed of air i.e1.5 m A single large maglev turbine can output more than Conventional horizontal wind turbines.

Key words: Spiral Blade, Magnetic Levitation, Magnets, Wind Energy, Highway Medians, Involute, Power Generation, Vertical axis Wind Turbine

I. INTRODUCTION

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 vast departure from conventional propeller designs. Its main advantages are that it uses frictionless bearings and a magnetic levitation design and it does not need to vast spaces required by more conventional wind turbines. It also requires little if any maintenance.

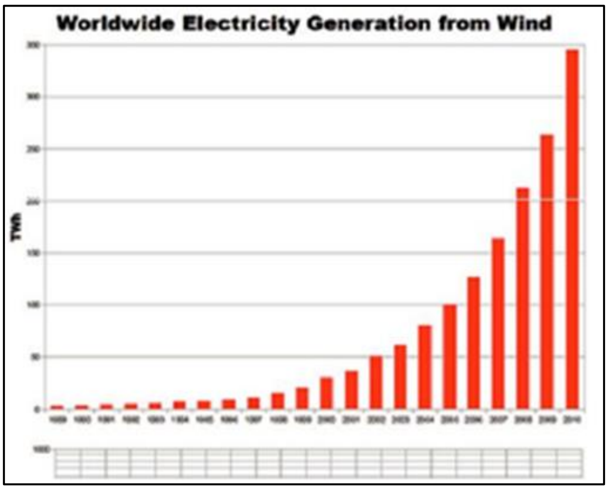

Fig. 1: Electricity Generation Graph

The Maglev wind turbine was first unveiled 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. The vertically oriented blades of the wind turbine are suspended in the air re-placing any need for ball bearings.

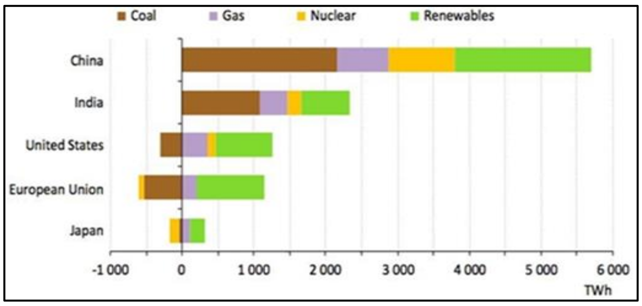

Fig. 2: Power Generation 2010 - 2013

II. MAGNETIC LEVITATION

The Method by which an object is suspended with no support other than magnetic fields. The Magnetic pressure is used to counteract the effects of gravitational and any other Accelerations.

The vertical axis concept for the wind turbine that is implemented as the power generation portion of this project, 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 centre 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.

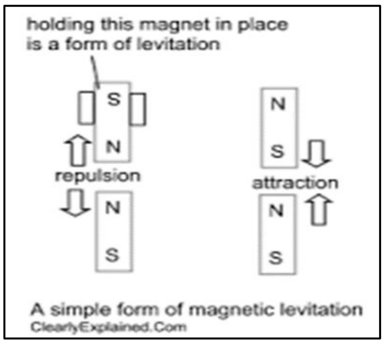

Fig. 3: Magnetic Levitation

III. WIND POWER TERMINOLOGY

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,

$$\text{Kinetic energy (K.E)} = \frac{1}{2} mv^2$$

Amount of Air passing is given by,

$$m = \rho\, AV$$

Substituting this value of the mass in expression of K.E,

$$K.E = \rho A v^3 \text{ Watts}$$

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 $\rho A v^3 \times 10^{-3}$

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

IV. TYPES OF WIND TURBINES

There are two 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. 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 servomotor 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.

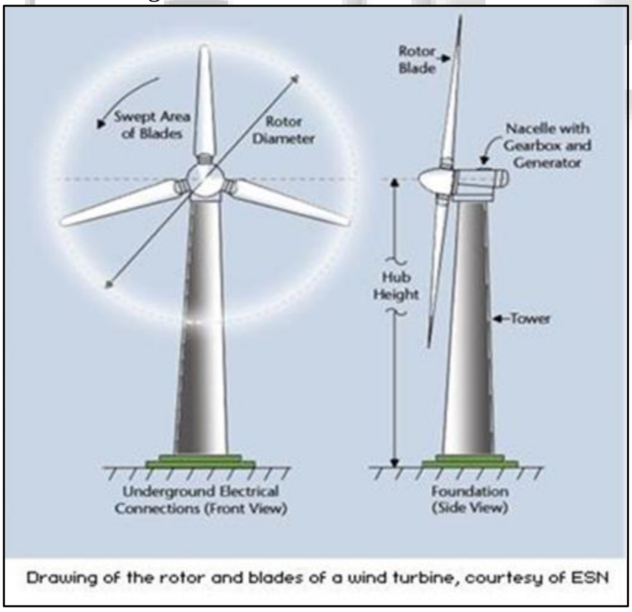

Fig. 4: Comparison of VAVT and HAWT

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

V. MAJOR COMPONENTS OF MAGLEV VERTICAL AXIS WIND TURBINE

1) Blades
2) Neodymium magnet
3) Generator

A. Blades

Aluminium 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 aluminium extrusion to achieve the same deflection as a steel profile.

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 aluminium for blade material. Aluminium is a metal like steel, brass, copper, zinc, lead or titanium. Aluminium is a very light metal with a specific weight of 2.7 g/cm^2, about a third that of steel. Its strength can be adapted to the application required by modifying the composition of its alloys.

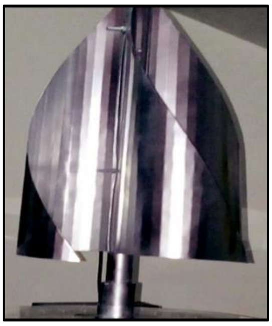

Fig. 5: Wind Rotors side view

Aluminium naturally generates a protective oxide coating and is highly corrosion resistant. Aluminium 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.

B. Neodymium Magnet

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

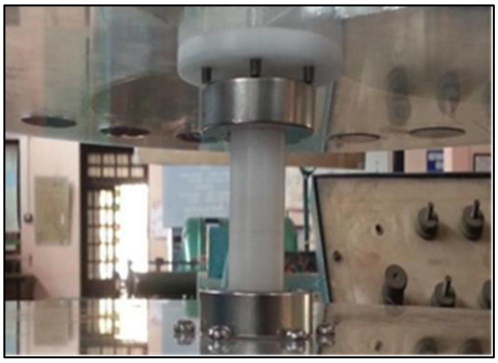

Fig. 6: Disk Type Neodymium Magnet

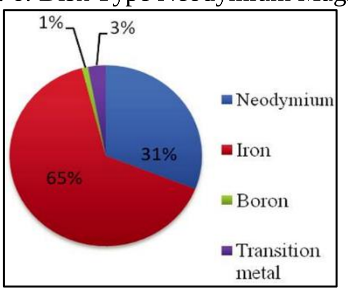

Fig. 7: Composition of Neodymium Magnet

C. 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 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

VI. Levitation between Stator & Rotor

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.

VII. Conclusion

At the end of the project, the vertical axis maglev wind turbine was a success. 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.

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