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Experimental Investigation of Windmill to Generate Electric Power using Magnetic Levitation : A Review

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ABSTRACT

The present scenario indicates that the demand for electricity is increasing day by day and to meet it many research are going on. Electricity generation through renewable energy sources has gained attention in the last few decades due to depleting conventional energy sources and can help in reducing dependency on fossil fuels. One of the fastest growing renewable energy sources in the world is wind energy source. With the use of magnetic levitation the efficiency of the wind turbine can be increased and losses minimized. It also increases the life span of the generator. Magnetic Suspension Wind Power Generators, represent a very promising future for wind power generation.

Keywords: Wind Power Generators, Solar Energy, Kinetic Energy

I. INTRODUCTION

Energy is important for the development of human civilization. As conventional energy exhausts, the development of clean and renewable energy, such as wind and solar becomes ever important to people's live. Humankind has harnessed the wind power for a long time and the associated technology is more advanced than other clean energies. Nowadays wind power increasingly attracts interests and its utilization has entered a rapid development stage. The wind speeds in most of Asian zone is much lower than 7 m/s, especially in the cities, but the mechanical frictional resistance of existing wind turbines is too big, usually it can't start up when the wind speed is not big enough. This project introduces structure and principle of the proposed magnetic levitation wind turbine for better utilization of wind energy. Maglev Wind turbine has the features of no mechanical contact, no friction etc. minimizing the damping in the magnetic levitation wind turbine, which enables the wind turbine start up with low speed wind and work with breeze.

1. 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 it is usually a major factor in deciding sites for very effective wind turbines especially with the horizontal axis types.

These winds are usually found along shorelines, 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. 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. 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.

We know:

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

Amount of Air passing is given by

m = ρ AV …………………..(1)

Where

m = mass of air transversing

A=area swept by the rotating blades of wind mill type generator

ρ = Density of air

V= velocity of air

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

K.E= ½ ρ AV.V^2 watts

K.E= ½ ρ AV^3 watts ………………….. (2)

To convert the energy to kilowatts, 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
Air Density (ρ) = 1.2 kg/m^3
Area (A) = area swept by the blades of the turbine
Velocity (V) = wind speed

II. METHODS AND MATERIAL

2. 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 AC 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.

B. 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. 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. 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.

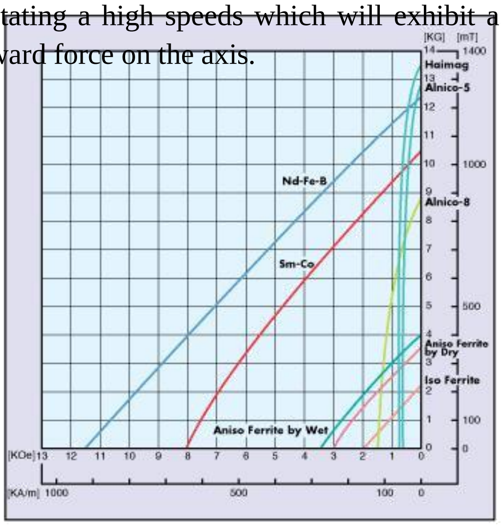

Figure 1 : B-H Curve of Various Magnetic Materials
The pro-e model of the project is as shown in the figure.

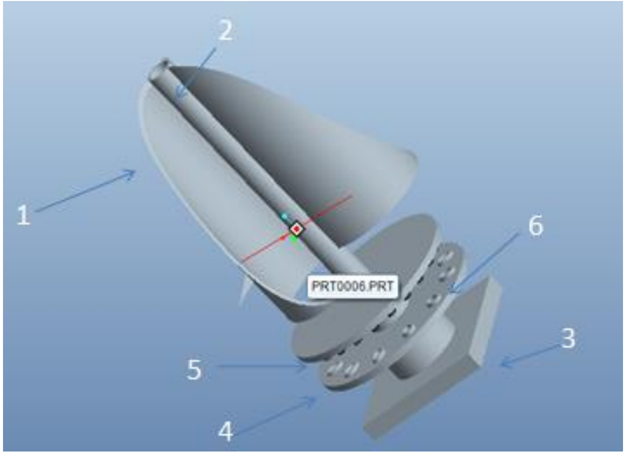

Figure 2 : Pro-e model of setup

1. Turbine. 2.Shaft. 3. Base. 4. Stator. 5. Magnets. 6. Coil.

Figure 3: Setup of the project

III. RESULTS AND DISCUSSION

Experimentation:

1] The turbine was rotated freely. Voltage was measured using multimeter and speed of the turbine was measured using digital tachometer. The turbine was rotated at different speeds (RPM) and voltage (V) at that speed was recorded. The different voltage at different RPM is tabulated below.

RPM	230	565	1122	1172	1514	1874	2150
Voltage (V)	0.9	2.0	3.0	3.5	4.5	5.2	7.6

The graph obtained between speed(rpm) and voltage(V) is as shown.

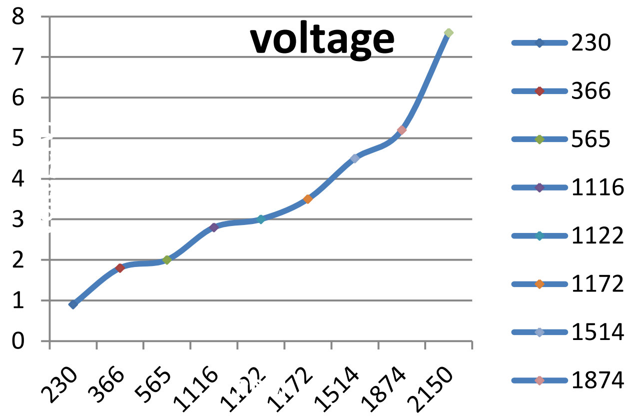

Figure 4 : Graph of Voltage and RPM

2] For the above readings, power is calculated as,

$$P = VI = \frac{V^2}{R}$$

The graph obtained between power and rpm is as shown.

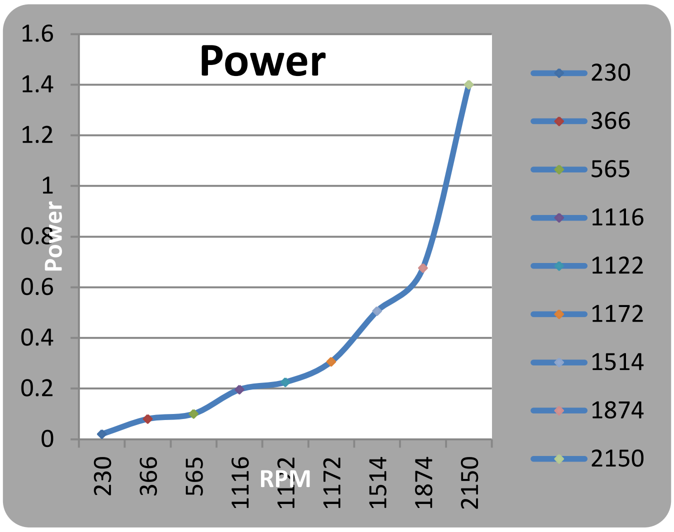

Figure 5 : Graph between Power and RPM

IV. CONCLUSION

Over all, the magnetically levitated vertical axis wind turbine was a success. The wind turbine rotors and stator levitated properly using permanent magnets which allowed for a smooth rotation with negligible friction. At moderate speeds the power output of the generator is satisfactory. The turbine gave maximum voltage of 7.6 V which can be further increased by using wire of higher gauge.

V. RECOMMENDATION FOR FUTURE WORK

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 range 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.

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