REGENEDYNE MAGLEV WIND POWER GENERATION

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Abstract— Since a decade the demand for electricity is increasing at alarming rate and the demand for power is running ahead of supply. The present day methods are not sufficient to keep pace with ever increasing demand. The recent severe energy crisis has forced to think & develop the power generation by renewable sources (mainly wind power).
This project dwells on the implementation of an alternate configuration of a wind turbine for power generation purposes. Regenedyne (magnetic levitation) has apparently moved to prototype stage. The floating blades spin with little resistance, and the power output is increased. They also can spin in light breezes. This provides efficient frictionless Power Generation with less maintenance, compared to Horizontal Axis Wind Turbine (HAWT).
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 low and high (1.5m/s to 40m/s) wind speed conditions. This new model of wind turbine uses magnetic levitation to reduce the internal friction of the rotor which is considered as a revolution in the field of wind technology, producing 20% more energy than a conventional turbine, at the same time decreasing operational costs by 50% over the traditional wind turbine.
Hence this technology provides an extreme efficient, versatile and elegant method of producing power from wind with nearly zero pollution. 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 a reliable source of power generation.
Hence the main objective of this project is to harness wind energy in more efficient way with frictionless magnetic levitated operation.

Keywords—Magnetic Levitation, Neodymium magnets, Clean Green Power, Regenedyne.

I. INTRODUCTION

Regenedyne Maglev Wind Power Generation (RMWPG) is the advanced method of harnessing the kinetic energy of wind. The word Regenedyne means generation by renewable source (wind) and in this type of generation the spinning turbine floats on the magnetic cushion, just as the high-speed train floats above the rail track hence the name REGENEDYNE MAGLEV WIND POWER GENERATION.
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.
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 replacing any need for ball bearings.

Fig.1.1: Maglev Turbine concept.

II. PRINCIPLE

The basic working principle of a wind turbine is when air moves quickly, in the form of wind, the kinetic energy is captured by the turbine blades. The blades start to rotate and spin a shaft that leads from the hub of the rotor to a generator and produce electricity.
The high speed shaft drives the generator to produce electricity. The low speed shaft of wind turbine is connected to shaft of high speed drives through gears to increase their rotational speed during operation.
Using the effects of magnetic repulsion, spiral shaped wind turbine blades will be fitted on a rod for stability during rotation and suspended on magnets as a replacement for ball bearings which are normally used on conventional wind turbines.
The energy that can be extracted 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.

\[ P_{\text{avail}} = 0.5 \rho A V^3 C_p \]

where
- \( P_{\text{avail}} \) is output power available in watts.
- \( \rho \) is density of air in kg/m\(^3\).
- \( A \) is area swept by blades.
- \( V \) is velocity of wind.
- \( C_p \) is the power coefficient called Betz limit

\[ C_p \text{ max} = 0.59 \]

III. WORKING
Above figure gives an idea of MAGLEV WIND TURBINE. 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.

Power will then be generated with an axial flux generator, which incorporates the use of permanent magnets and a set of coils. The generated power is in form of DC, stored in battery, this can be used to directly supply the DC loads and can also be converted to AC using inverter to supply AC loads.

It can be used as OFF grid and ON grid as shown in above figures. Wind power is a proven and highly effective way to generate electricity. Maglev technology is the most efficient means of transferring kinetic energy to generate electricity. The vertical axis wind turbine platform floats on a magnetic cushion with the aid of permanent- magnet suspension and a companion linear synchronous motor. This technology eliminates nearly all friction and delivers maximum wind energy to the downstream linear generator.

\[
P_w = \frac{1}{2} MAu^3 \quad \text{[1]}
\]

where

- \(P_w\): power of the wind (W)
- \(M\): air density (kg/m\(^3\))
- \(A\): area of a segment of the wind being considered (m\(^2\))
- \(u\): undisturbed wind speed (m/s)

\[
P_m = \frac{1}{2} M (16/27 A u^3) \quad \text{[2]}
\]

where

- \(P_m\): mechanical power (W)

The constant 16/27 = 0.593 from equation [2] is referred to as the Betz coefficient. The Betz coefficient tells us that 59.3% of the power in the wind can be extracted in the case of an ideal turbine. For a VAWT, this area depends on both the turbine diameter and turbine blade length.

\[
P_m = \frac{1}{2} \rho C_p A D^2 u^3 \quad \text{[5.1.1]}
\]

Where, \(\eta_e\) = efficiency of electrical generation

\[
\eta_m = \text{efficiency of mechanical transmission}
\]

In the absence of concrete data, the following empirical formulae can be used.

- \(P=0.15 V^3 D^2\), for slow rotors
- \(P=0.20 V^3 D^2\), for faster rotors.

The below figures 4.1 and 4.2 shows the design of turbine model.

Regenedyne Maglev Wind Power Generation

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Choice of number of blades.

The choice of the number of blades of a wind rotor is critical to its construction as well as operation. Greater number of blades is known to create turbulence in the system, and a lesser number wouldn’t be capable enough to capture the optimum amount of wind energy. Hence the number of blades should be determined by both these constraints. The no of blades used for this turbine is 6 which are placed such that the angle between two adjacent blades is 60°. Each blade is fixed between the two discs with 30° deviated as show in above fig 5.1.1. When blades are placed with the deviation of 30° to 45° the area of blades facing the wind will be more and help the turbine to rotate faster. The length to diameter ratio is kept as 1 for better performance of turbine. The whole turbine assembly is placed on the magnetic levitation as shown in figure 4.2.

V. DEVELOPMENTS IN MWT

Construction began on the world’s largest production site for maglev wind turbines in central China on November 5, 2007. Zhongke Hengyuan Energy Technology has invested 400 million yuan in building this facility, which will produce maglev wind turbines with capacities ranging from 400 to 5,000 Watts.

In the US, Arizona-based MagLev Wind Turbine Technologies will be manufacturing these turbines. Headed by long-time renewable energy researcher Ed Mazur, the company claims that it will be able to deliver clean power for less than one cent per kilowatt hour with this new technology.

Equatorial region countries – less wind speed. (Malaysia, Singapore.) Small Maglev Wind Turbine generate power at wind speed of 1.5 m/s.

VI. COMPARISON

<table>
<thead>
<tr>
<th>Sl. no</th>
<th>MVAWT (Maglev Vertical Axis Wind Turbine)</th>
<th>HAWT (Horizontal Wind Turbine)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Can spin in light breezes (1 m/s).</td>
<td>High wind speed (3 m/s).</td>
</tr>
<tr>
<td>2</td>
<td>No or less maintenance.</td>
<td>Need of replacement of bearings, lubrication etc.</td>
</tr>
<tr>
<td>3</td>
<td>Configured to capture winds from any direction without any external control.</td>
<td>Requires yaw mechanism to turn turbine blades in direction of wind.</td>
</tr>
<tr>
<td>4</td>
<td>Major components at ground level.</td>
<td>At a height on tall towers.</td>
</tr>
<tr>
<td>5</td>
<td>No massive tall tower construction.</td>
<td>Requires tall tower.</td>
</tr>
<tr>
<td>6</td>
<td>Cost/kWh is less.</td>
<td>Cost/kWh is more.</td>
</tr>
<tr>
<td>7</td>
<td>Long life span (500 years).</td>
<td>Less life span.</td>
</tr>
</tbody>
</table>

The comparative analysis can be easily made with the following graphs 6.1, 6.2 & 6.3.
VII. OUTCOME OF PROJECT

The technology is expected to create new opportunities in low-speed areas, with starting speed as low as 1.5 m/s & cut in speed of 3 m/s. It is configured to capture wind from any direction and convert wind to energy at very high efficiency. Magnetic levitation reduces the friction & eliminates need of bearings. Major components are located at ground level. It requires less maintenance as no lubrication is required. Maglev wind turbines have long life span. Able to deliver clean green-power for less than one cent per kilowatt hour. This new technology is remarkably cheap with low operating cost. Less noise compared to existing conventional wind turbines. Today wind turbines are considered to be the most developed form of renewable energy technology.

VIII. APPLICATION OF PROJECT

This project 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 power so generated can be effectively used for Street/domestic lighting and domestic appliances. With the inclusion of inverter the power generated can be used for both AC as well as DC loads.

IX. ADVANTAGES

A massive tower structure is not required, as VAWTs’ are mounted closer to the ground. These are located closer to the ground and hence easier to maintain. These have lower startup speeds than their horizontal counterparts. These can start at speeds as low as 10Kmph. These have a lower noise signature. They don’t require yaw mechanisms. Requires no lubrication. Capable of generating power from wind speeds as low as 1.5 m/s and reported to operate in winds reaching 40 m/s. Producing 20% more energy than a conventional turbine, at the same time decreasing operational costs by 50% over the traditional wind turbine. Eliminates need of long distance transmission line.

X. DISADVANTAGES

Every system or machine with the highest efficiency and performance has one or the other demerit. Similarly this maglev wind turbine also has few disadvantages as stated below. The capital cost of wind power is third higher than conventional thermal power. Further electrical problems like voltage flicker and variable frequency affect the implementation of wind farm. Because of their low height they cannot capture the wind energy stored in higher altitudes.

XI. RESULTS

Table 11.1: RPM v/s voltage generated.

<table>
<thead>
<tr>
<th>Sl:No</th>
<th>Speed of Turbine (in rpm)</th>
<th>o/p voltage (in volt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
<td>9.9</td>
</tr>
<tr>
<td>2</td>
<td>150</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>200</td>
<td>16</td>
</tr>
<tr>
<td>4</td>
<td>250</td>
<td>22</td>
</tr>
<tr>
<td>5</td>
<td>300</td>
<td>25</td>
</tr>
</tbody>
</table>

Fig 11.2: Speed of turbine v/s voltage output curve.
Table 11.3: Output power when loaded

<table>
<thead>
<tr>
<th>Sl:no</th>
<th>Voltage (in volts)</th>
<th>Current (in amper)</th>
<th>Power (in watts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12</td>
<td>0.9</td>
<td>10.8</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
<td>0.9</td>
<td>10.8</td>
</tr>
</tbody>
</table>

The output power depends on the load and the maximum capacity of generator used is 20W. Hence it should be loaded below 20W for smooth and continuous operation. The fig 11.2 shows the graph of variation of voltage with respect to rpm.

XII. FUTURE PROSPECTS

The one this picture is about 4,000 to 5,000 feet tall. The footprint for the whole device is 100 acres and produce up to 1000MW. That is about 2,100 feet square at the base. The inside cylinder would be about 700 feet in diameter. The project cost $54 million to make, but I think they should spend more and use the internal cylinder for housing and stores. That is about 300,000 square feet per feet of office space.

CONCLUSION

Magnetic Suspension Wind Power Generators, represent a very promising future for wind power generation. A single large Maglev turbine can output more than conventional horizontal wind turbines. The rotor that is designed harness enough air to rotate the stator at low and high wind speeds while keeping the center of mass closer to the base yielding stability due to the effect of magnetic levitation.

The efficiency of turbine is increased by replacing the bearings by magnets, the magnetic levitation helps the turbine to spin at much faster rate as it will eliminate the stress on the shaft of the turbine. The major components are placed at ground level. We can say the maglev turbine can power more output with high efficiency conversion compared to traditional wind turbine.

The system will provide electricity at a rate lower than coal and nuclear. Thus we believe this technology has the capacity to completely displace current technology in use for wind farm.

REFERENCES


[2] T. Letcher, the Ohio State University, Columbus, OH “Small Scale Wind Turbines Optimized for Low Wind Speeds”.


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