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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: Windmill, Wind Power Generation, Electricity Generation, Wind Power Generators, Fossil Fuels.

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. The wind power has been harnessed by mankind 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.

II. LITERATURE SURVEY

Huachun Wu et al., [1] carried out study on magnetic levitation wind turbine for vertical type and low wind speed and geometric parameters were optimized using FEM analysis. The system dynamic analysis was performed. By using no mechanical contact for magnetic bearing, substitution of traditional bearing in general wind turbine, reducing the damping of the wind turbine, which solved wind turbine start up with low speed wind and work with breeze. The modeling and implementation of an axial position controller was presented, the simulation results show stable levitation and good levitated rotation.

Santosh kumar Chaturvedi et al., [2] An experimentational investigation of maglev wind generator using savonius rotor. In the design, stator had 10 set of coils in 10 slots with each coil having 300 turns of copper wire measuring resistance of 40Ω; a smaller gage wire would further reduce this resistance. For rotor, two circular plates containing 10 permanent magnets of ferrite type with the powers of 2500 gauss each were used with an angular distance of 36 degree equal to the distance between two coils. The magnets placed on these two plates create the magnetic fields. The output of 8.48V was obtained. To get more output, turbine's own inertia's be reduced by using lighter weight materials for turbine. So that for the same wind speed it will rotate faster, hence it will generate more power.

Minu John et al.,[3] carried out an experimental study on vertical axis windmill working on maglev using Nd-Fe-B ring shaped permanent magnets of grade N-42 of outer diameter 40 mm, inner diameter 20 mm and thickness 10 mm placed at the center of the shaft by which the required levitation between the stator and the rotor was obtained. Similar disc type magnets of 30 mm diameter and 4mm thickness were arranged as alternate poles one after the other, along the periphery of the rotor made of acrylic of 40mm diameter. 26 gauge wires of 1000 turns each were used as coils for power generation. 12 sets of such coils were used in the prototype and were arranged in the periphery of the stator exactly in a line to the arranged disc magnets. The output voltage obtained from this prototype was a maximum of 45 volts DC.

Dinesh N Nagarkar et al.,[4] carried out study on construction and working of magnetic levitation based power plant which has colossal structure where blades were placed vertically along the outer rim of the cylinder. Since the whole assemblage was levitated by permanent magnets there was no friction which allowed the wind turbine to transform all the wind energy into electrical energy thus increasing output and reducing cost. The

benefit of having it floating in midair is that it cuts down on the friction that causes so much inefficiency in the traditional windmill. It would also increase generation capacity by 20% over conventional wind turbines and decrease operational costs by 50%. It reduces maintenance costs and increases the lifespan of the generator. Magnetic levitation is an important development to reduce stress from the mechanical load on the wind turbine.

Amit D. Patil et al.,[5] designed a prototype model of a VAWT using magnetic bearing. The rotors that were designed harnessed enough air to rotate at low and high wind speeds while keeping the centre of mass closer to the base yielding stability. The wind turbine rotor levitated properly using permanent magnets, which allowed for a smooth rotation with negligible friction. The no. of blades hub is 4 selected to use in project. (Width= 0.1cm, breath= 10cm, height= 26cm.)Other component which is mounted on the base are emf generator, charging circuit, battery. (Model: Height= 45cm, length= 38cm, width=1.5cm. The output voltage obtained from this prototype is measured using a multi-meter and a maximum of 5volts DC was obtained.

Aravind CV et al.,[6] carried design procedure and analysis of vertical axis wind turbine using magnetic levitation where gears were replaced with direct drive technology, thereby reducing the maintenance and power loss. Bearing were replaced with magnetic levitation. From the analysis he concluded that the introduction of maglev to the VAWT increases the efficiency and reduces the vibration with by 30% compared to that of the turbine without mechanical bearing.

Nirav Patel et al.,[7] incorporated use of magnetic levitation concept using the rare earth permanent magnets between dual rotors to reduce the losses. A novel design and performance improvement of an axial flux PM generator has been presented in this paper. Friction between rotors and stator has been made minimal using passive magnetic levitation in AFPM generator. Moreover, the design helped to reduce the noise and vibration which has been a big issue by AFPM generators in residential area. Additionally, bearing less design reduces the maintenance cost and enhances the life span of the system. Savonius type model of VAWT has been presented for AFPM generator which is very simple design and can run at low wind speed according. The uniqueness of the proposed work was the dual rotor levitating turbine, which was more efficient than the few existing single rotor levitating turbines.

Kamalinni et al.,[8] paper presented the design component aspects of a Magnetically levited Vertical Axis Wind Turbine and reported the result analysis using an modified magnetic circuit. A dual magnetic surface was attached into the structure through an external mechanical structure to reduce the mechanical oscillations. The system was then investigated with and without the maglev structure. It is found that the vibrations are reduced by 37.5%.Computational fluid dynamics based finite element approach is used for the analysis on the blade design and the positioning of the blade on the rotor. The lift and drag characteristic of the airfoil was investigated using the FEA tool. The optimal angle is at 30° with respect to the wind approach was determined.

B. Bittumon et al.,[9] carried out research on combined savonius and darrieus rotors which is very scarce. He designed and analyzed a Maglev VAWT using a combined savonius and darrieus vertical axis wind turbine would have many advantages over an individual savonius or darrieus rotor. A savonius produces high torque which would be useful in self-starting and darrieus rotor having a high tip speed ratio useful for electrical generation. This developed a two bucket savonius rotor and placed it on the central shaft of a traditional darrieus. Using a counter rotating wind turbine with a freely rotating generator can produce higher amounts of power than common wind generators.

Shahrukh Adnan Khan et al.,[10] analysed performance of a three phase Permanent Magnet Synchronous Generator(PMSG) connected to a Vertical Axis Wind Turbine(VAWT). The entire simulation was carried out in Matlab/ Simulink environment and then the generator was fabricated and tested in a laboratory and compared with the simulation result for error analysis for power upto 1.5KW under different operating scenario. The range of error was about 5-20% for the same output power value.
S.C Tay et al.,[11] carried out analysis on three different wind profiles using CFD and the suitable airfoil for the vertical axis wind turbine was reported in the paper. A five blade structure was used for the analysis to determine the best position of the blade structure. He concluded that the degree of impact at angle of 30^0 was found to have the highest lift coefficient.

Yanjun Yu et al.,[12] presented the new structure of self decoupling magnetic levitation generator (SDMLG) for wind turbines. Then the expressions of levitation forces were deduced by analyzing magnetic flux distributions and winding flux linkages. Finite-element analysis method (FEA) tool for analyzing the performance of the new generator was used and the results verified that the levitation windings and armature windings were effectively decoupled.

III. CONCLUSION

As per the project concept the future scope is to save depleting fossil fuels and use maglev technology in generating power even in residential areas as it is cost effective, less spacious, 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.

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