IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

MAGLEV VERTICAL AXIS WIND TURBINE

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Abstract—

With the increase in population, the demand for energy is also adding to a very fast pace. To attain the adding need of population the conventional resources are depleting at a very fast rate. So, it becomes Necessary to find an alternative to these resources. Wind energy is the result of the kinetic energy generated by the motion of extensive air masses, constituting an indirect derivative of solar energy. A wind turbine serves as a mechanism to harness this kinetic energy from the wind to generate electrical power. Wind turbines are classified into two types: horizontal-axis wind turbines (HAWTs) and vertical-axis wind turbines (VAWTs). Vertical-axis wind power generators, with their superior overall efficiency and cost-effectiveness, present a highly auspicious outlook for the future of wind power generation.

In recent years, Vertical-axis wind turbines (VAWTs) have undergone extensive exploration, driven by their straightforward design and unidirectional functionality, allowing them to operate regardless of wind direction. The Savonius wind rotor, which relies on drag, shows excellent starting capability, whereas the Darrieus wind rotor, based on lift, achieves higher efficiency over a wider range of conditions. Therefore, to optimize their advantages, both rotor types are combined on a common axis to form a hybrid system.

The objective of this research was to develop hybrid vertical-axis wind turbines (VAWTs) to leverage the benefits of Darrieus and Savonius rotors, aiming to enhance overall power generation efficiency. To improve turbine performance, magnetic levitation technology was implemented. This system harnesses the properties of permanent magnets and ball bearings to suspend the turbine components, thereby reducing rotational energy losses, a common challenge in conventional wind turbines. Power generation is achieved through an axial flux generator, integrating permanent magnets with a coil assembly.

Keywords— VAWT, HAWT, Magnetic Levitation.

I. INTRODUCTION

The wind is formed from the variance brought about by the atmosphere's warming by the Sun. There has long been evidence of the great benefits of wind energy. The wind was also employed as a fuel in the past for a variety of purposes. For example, before engines were developed, ships were propelled by sails. Windmills were also used to grind or chop grain and provide irrigation. The idea to use wind power to generate energy first emerged in the early 1920s. Almost 90 nations worldwide employ wind energy for commercial electricity generation. The fact that wind turbines produce electricity without harming the environment or emitting any greenhouse gases makes them the most significant source of electricity. An apparatus that transforms wind energy into usable electric energy is a wind turbine. When in operation, a wind turbine converts wind energy from kinetic to mechanical form. For later use, this mechanical energy is converted into electricity and other forms. Wind or wind energy is the only source of use for wind turbines. The primary determinant of wind turbine electricity output is wind availability.

II. LITERATURE REVIEW

A. Wind Turbine:

The primary operations of a wind turbine include the absorption of kinetic energy from fast-moving air by the turbine blades, commonly referred to as wind. As the blades initiate rotation, a shaft linking the rotor hub to an electricity-generating generator also spins. Wind turbines are classified into two types: horizontal-axis wind turbines (HAWTs) and vertical-axis wind turbines (VAWTs). HAWTs, featuring horizontally aligned blades at ground level, are engineered to harness wind energy. Aerodynamic lift facilitates their rotation when the blades are perpendicular to the wind flow, making HAWTs the predominant choice in wind turbine technology.

Recently, there has been a surge in interest in developing environmentally friendly energy solutions, leading to a rise in the popularity of VAWTs. VAWTs are characterized by their ability to rotate freely and are mounted on a vertical axis. Their compact size, quiet operation, ease of installation, omnidirectional wind capture, and proficiency in windy conditions have sparked a new area of research in wind turbine technology, catering to the energy needs of individuals ready to embrace and invest in small-scale wind energy solutions.

A vertical axis wind turbines are classified into two types: -

1. SAVONIUS WIND TURBINE:

Savonius wind turbines represent a category of vertical-axis wind turbines (VAWT), harnessing drag forces to transform wind energy into rotational torque. They are made up of a central shaft that is connected to two or three curving blades. Savonius wind turbines have low efficiency and power coefficient, but they are simple, reliable, and can operate in low wind speeds and variable wind directions.

2. DARRIEUS WIND TURBINE:

Darrieus Wind Turbines, classified as vertical axis wind turbines (VAWT), are utilized for generating electricity from wind power. Constructed with numerous curved aerofoil-shaped blades, these turbines are affixed to a shaft capable of free rotation. Only at very high rotational speeds is the blade able to be strained due to its curvature. The shape of the leaves present in the Darrieus type wind turbines could be of two types, Egg-Beater type rotors and H-rotor type rotors.

B. MAGNETIC LEVITATION:

Magnetic levitation enables the suspension of an object solely through the manipulation of magnetic fields, countering gravitational force to elevate the object. By utilizing magnetic repulsion between magnets with similar polarities, the force generated keeps them apart when stacked atop each other. Implementing magnetic levitation offers numerous advantages such as friction reduction, force measurement, design flexibility, and entertainment applications. Recently, this technology has been integrated into transportation systems, facilitating the movement of vehicles at high speeds along a guideway using magnetic fields for guidance, propulsion, and support without physical contact. The concept of magnetically levitated vehicles fosters the development of practical applications across various industries, including power generation.

C. MAGLEV WIND TURBINE:

A permanent magnet is used to provide magnetic force, which raises the wind turbine's vertically oriented blades, so they are hanging in the air above the machine's base. This system doesn't need electricity to function because it doesn't use electromagnets. The turbine blades do not rely on ball bearings to maintain their position; instead, they are held in place by the magnetic force produced by the permanent magnet. This decreases energy waste by enabling a significant reduction in friction between the ball bearing and the blades. This also reduces maintenance costs and extends the generator's lifespan.

III. PROJECT OBJECTIVE:

The objective of this project is to build a hybrid vertical axis wind turbine for the purpose of electricity generation through harnessing wind energy. A larger working range is achieved by the higher efficiency of the lift-based Darrieus wind rotor, whereas the drag-based Savonius wind rotor has superior beginning capabilities. Thus, both rotors are linked along a common axis to form a hybrid or combined system, leveraging the individual benefits of each. To optimize the performance of the turbine, magnetic levitation technology is used. An object is suspended using just magnetic fields for support in a technique known as magnetic levitation.

The magnetic force produced serves to counteract the gravitational effects and raise the object. With this kind of vertical axis windmill, electricity can be produced without the need for an alternator or generator. The application of magnetic levitation will produce power. The gravitational force exerted on the windmill was lessened by magnetic levitation. This windmill will be engineered to withstand all wind forces. Its primary benefit lies in its significantly lower cost compared to other options. The proposed vertical axis windmill has three vanes or blades (Darrieus type) on the outside and two blades (Sovonius type) on the shaft periphery, which are attached to the shaft. The blades or vanes will be shaped to accommodate wind blowing from all angles.

IV. METHODOLOGY/EXPERIMENTAL

This section describes the proposed Turbine prototype model. It will initially provide information about the components utilized in the prototype model, followed by an explanation of the prototype making procedure.

MATERIALS AND PROTOTYPE:

Model preparation in prototype making process, the main components used are Neodymium Magnet, Fan Coils, Rotor Disk, Stator, Blades and Wings.

1. NEODYMIUM MAGNETS:

Neodymium magnets are a form of permanent magnet created using an alloy comprising neodymium, iron, and boron. They are the strongest and most broadly used type of rare-earth magnet, with applications in various fields such as electronics, medicine, industry, and entertainment. 2 Ring Magnets and 6-disc magnets of model N35 were selected for this application. The Ring magnets mentioned are permanent magnets with a ring shape, made from Nd-Fe-B alloy, and are nickel plated for both reinforcement and protection of the magnet. The Ring magnets' dimensions—40 mm for the outside diameter, 20 mm for the internal diameter, and 10 mm for height—are fair.

Fig. 1. Neodymium magnets

2. COILS:

Coils consisting of 500 turns each of 24-gauge copper wire are employed for power generation. This prototype uses five of these coils in total. Our proposed axial flux generator generates voltage by means of the magnets' fluctuating magnetic field. Many coils are passed over by the revolving magnets, each of which generates a different voltage.

Fig. 2. Fan coils

3. ROTOR AND STATOR:

A rotor is a mechanical device's revolving component. In this instance, wind energy drives the rotor disc to rotate. Two PVC blades that are positioned in the middle of the shaft and have been precisely cut through are part of the rotor. A windmill's stator is a stationary component made up of enameled copper coil windings. The stator is positioned below the rotors, as the image below illustrates. The placement of the rotor should allow for a certain amount of space between it and the stator. The north facing magnet of the higher rotor disk must face the south facing magnet of the lower rotor disk.

Fig. 3. Rotar and Stator

4. BLADE DESIGN:

In this prototype, three Darrieus type blades are mounted on a freely rotating shaft, with two Sovonius type blades attached to the shaft's periphery. To create these savonius-style blades, a 22-centimeter PVC pipe is chopped into two equal parts. These blades can operate at low wind speeds and provide initial rotation to the shaft. In the darrieus type blades, several airfoil shaped pieces of 12 cm are cut and then wrapped in the plastic to prepare the blades.

Fig. 4. Blades

An airfoil is any structure designed to manipulate the flow of a fluid to produce an aerodynamic lift. Lift is created by the airflow over the wing increasing speed and decreasing pressure, which is perpendicular to the airfoil's chord. In this Prototype Model, NACA 0015 airfoil is used.

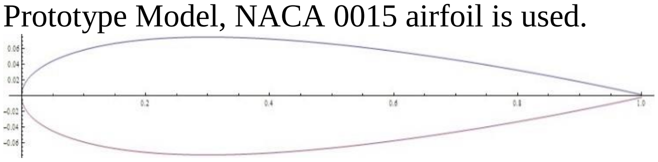

Fig. 5. NACA 0015 airfoil

5. MAGNET PLACEMENT:

A rotor was made by placing 6 neodymium disc magnets on it and was placed around the coils of the ceiling fan.

Fig. 6. Magnets Placement

To ensure the required levitation between the stator and the rotor, two ring-type neodymium (NdFeB) magnets, graded N-35 and measuring 40 mm in outer diameter, 20 mm in inner diameter, and 10 mm in thickness, are positioned in the center of the shaft. These magnets generate the usable flux necessary for the power production system. A ceiling fan was employed as the generator, alongside a converter, enabling it to fulfill the function of a generator.

6. LEVITATION BETWEEN STATOR & ROTOR:

In the designed prototype, the stator and rotor are kept apart in the air utilizing the principle of magnetic levitation. The magnetic pull forces generated by the ring-type neodymium magnets elevate the rotor to a predetermined height in the air. This stands as the primary advantage of a maglev windmill over a conventional one. Specifically, mechanical friction is entirely eliminated since the rotor is suspended in the air through levitation. This enables rotation even at very low wind speeds. Figure 7 depicts the magnetic levitation in our prototype.

Fig. 7. Levitation

7. FINAL MODEL:

The comprehensive layout of the designed prototype is depicted in Figure 6.6. By employing a multimeter, the output voltage of this prototype was assessed, yielding a maximum of 5 volts DC. The turbine is linked to a 3W LED load, with the current passing through it measured at 0.4 amps.

Fig. 8. Final Model

V. RESULTS:

To determine the output of the wind turbine, the generator was linked to a multimeter, resulting in observed readings of 3V. A ceiling fan was utilized for the generator, alongside a converter to fulfill the function of a generator. The multimeter's dial was adjusted for voltage indication, with the red wire serving as the positive connection and the black wire as the negative connection (common).

VI. CONCLUSIONS:

In the end, the magnetically levitated vertical axis wind turbine proved to be a success. The designed rotors demonstrated stability and effectively captured sufficient air to rotate at both high and moderate wind speeds, achieved by bringing the center of mass closer to the base. A smooth rotation with very little friction was made possible by the wind turbine rotor's proper levitation thanks to permanent magnets. In order to deliver the LED load, the generator had to meet certain parameters. When everything was taken into account, the magnetic levitation wind turbine model worked well.

VII. REFERENCES:

1. Sharangdhar Dehadrai and Anurag Wasnik, “Study on Magnetic Levitation for Vertical Axis Wind Turbine and Low Wind Speed”, International Journal of Science Technology & Engineering (IJSTE), April 2016.
2. Shubham Patil, Pratik Kumbhar, Oslaniya Siddharth, Patil Rohit and C.S.Wagle, “Magnetic Vertical Axis Wind Turbine”, International Research Journal of Engineering and Technology (IRJET), May 2017.
3. Samir J. Deshmukh and Sagar M.Charthal, “Design and Development of Vertical Axis Wind Turbine”, IRA-International Journal of Technology & Engineering, International Conference on Science & Engineering for Sustainable Development (2017).
4. T G Sriganesh, G J Naveen and Vishnu P, “Development of vertical axis wind turbine by Maglev suspension – An innovative approach”, International Conference on Thermo-fluids and Energy Systems (ICTES2019).
5. S. Brusca, R. Lanzafame and M. Messina, “Design of a vertical-axis wind turbine: how the aspect ratio affects the turbine’s performance”, Int J Energy Environ Eng (2014).
6. Saravanakumar m and nagaraj a, “Design and fabrication of combined savonius and

darrieus wind turbine", International Research Journal of Engineering and Technology (IRJET), Mar 2023.

7. Minu John, Rohit John, Syamily P.S3 and Vyshak P.A, "Maglev Windmill", International Journal of Research in Engineering and Technology (IJRET), May 2014.
8. Magedi Moh. M. Saad and Norzelawati Asmuin, "Comparison of Horizontal Axis Wind Turbines and Vertical Axis Wind Turbines", IOSR Journal of Engineering (IOSRJEN), August 2014.
9. Nur Muhammad Amin Mohd Hosnan, Khairul Anuar Mohd Nor1, Nur Irwany Ahmad, Habibah Mokhtaruddin, Diyya Hidayah Abd Rahman, Saidatul Shema Saad, Mohamad Zhafran Zakariya, Nazrul Azril Nazlan and Nurhafiza Azizan, "Development of Vertical Axis Wind Turbine (VAWT) using Magnetic Levitation (MAGLEV)", Journal of Advanced Research in Engineering Knowledge,2020.
10. Abhilasha Pawar, Pravartika Sengar, Rakesh Kumar Sharma and Satyam Singh, "MAGLEV Wind Turbine", International Conference on Intelligent Control and Computation for Smart Energy and Mechatronic Systems, 25-26 September 2020.