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The Savonius Type Traditional Vertical Axis Wind Turbine System Modification to Incorporate the Permanent Magnet Propelling Phenomenon to Improve the Efficiency and Performance at Various Wind Speed Conditions

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Abstract

One of the sectors in the world that uses the most energy is mining. In addition, it offers a vital supply of raw materials for the building, transportation, industrial, and energy industries. With an increasing global population comes an expected rise in the demand for raw commodities. The mining sector will probably need more energy as a result of this rise in mineral demand for the extraction process, shifting and purifying. Because of their distant location, mining operations rely on fossil fuels including coal and diesel. Hence 4-7 % of greenhouse gas emissions overall are linked to the mining industries. Operating permits for mines are necessary, and these permits are subject to Environmental, Social and Governance policies. In this context, the benefits of renewable energy go beyond simply financial savings. They are also a component of plans to maintain a mine's license. These issues may be effectively solved by wind power. It is an entirely risk-free, economically viable, and environmentally responsible source of clean and green energy. In the studies we performed, we focused on how objects with comparable poles and continuous magnetic fields repel one another. In this scenario, magnetic propulsion's innate characteristics serve as the energy-sources. Our turbine is going to work much better in the specified circumstances, even in conditions with a slower wind speed, thanks to the additional features including the repulsion of similar polarity magnets. When used as a supplementary energy source in a VAWT, i.e. magnetic repulsive properties will add some kinetic energy to the turbine's rotational momentum, as it transforms wind power to desired form of mechanical movement.

Keywords: *Magnet, Renewable Source of Energy, Turbine, Wind-Power*

1.0 Introduction

The power available in wind stream is transformed to useful form of power by a workings apparatus. Once this mechanical force has been generated, it may be used to spin the generator axis and generate energy, or well as to move or power other mechanisms. Because of the propeller blades, the holding shaft will rotate cylindrically[1]. The shaft had a generator connected, which converted mechanical energy into electrical energy, which is used to directly

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power other machinery[2]. The two main types of wind turbines are vertical shaft and horizontal shaft. Vertical-axed wind turbines are the more widespread, but less well-known, kind. Narrow blades VAWT gives multiple advancements versus conventional HAWT i.e. currently operating the most. Since this won't requires yaw-steering system, which can be piloted towards direction of the air movement. Which can be extremely helpful in areas with changing patterns of winds or significant obstructions. The following techniques were used in several studies to increase the effectiveness of wind turbine systems:

- Various Turbine Design
- Variable pitch control
- Design features the wind flow
- Self -staring Device
- Pulse Booster System
- Hybrid Technology for Power Synchronization (Wind and Solar)
- Magnetic Characteristics (Maglev)

Our study is now concentrating on creating the VAWT that is driven by a magnetic field. This gadget employs hybrid energy technology that draws energy from magnetic fields, allowing it to operate with variable wind stream velocity. Here this study measures the efficiency of typical turbine and will be contrasted to that of PM-driven vertical axis wind turbines.

1.1 Design Consideration and Experimental Mythology

In the course of our research, we proposed to integrate magnetic repulsions into a vertical-axis turbine. The turbine design is characterized by a system's plane and vertically rotating shaft. The rotating shaft seems to be shaped like a cylinder. These were the oldest and least prevalent turbine systems in the turbine series. Compared to the horizontal-axis turbine architecture, which has become more common. In essence, there are two subtypes that make up the VAWT structure: both the Darrieus and Savonius models.

A member of the VAWT device family's Savonius-based turbine employs a comparable to the pedal operated type of watercraft model. This approach was developed by SJ Savonius[3]. The S-rotary model's blades were referred to in this article as Savonius type rotors. Such pull-type VAWT devices presents a considerably higher starting force and self-starting capabilities than lift-based systems.

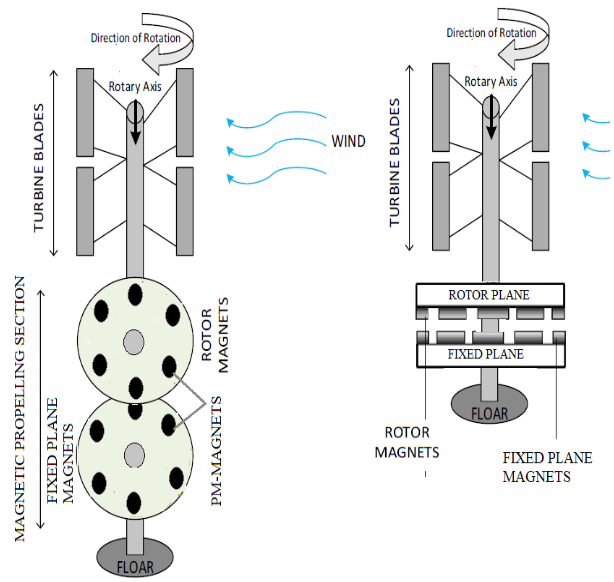

Figure 1. Front line visualization of magnet propelled VA-wind turbine.

We therefore chose to base its framework upon the Savonius hypothesis but with a few improvements after analyzing the two major types of VAWT device rotor components.

According to studies, adding further kinetic energy to spinning structures while keeping the magnets' repelling qualities may boost their efficiency. By squeezing this repelling property across both revolving and static surfaces, as seen in Figure 1, magnetic repulsion may also be readily assessed. However, VAWT converts wind energy into the required, comforting mechanical power, and it's possible that the force produced by the permanent magnet may also be used to give a very little amount of kinetic power.

The incorporation of Permanente magnetic repelling attributes with a revolving frame, then the stable parts of a system will be a key modification to a fundamental Savonius mechanism. In order to generate a cleaner torque as the rotor rotates, the scoops formed by this repulsion on the turbine's top half of the blades must be removed[4]. Here it's altered by altering the rotor blades' top-to-bottom bending curve corresponds with our own normal Savonius turbine model[5]. To accomplish this, we created a series of triangle faces that swirling throughout the top towards the depths of the propeller. These triangle faces were cut from an aluminum sheet element. Figure 2 shows how the modernized Savonius design looks.

Figure 2. Modified savonius turbine prototype.

Neodymiumu-Iron-Borons magnets were used because they had greater corrosion resistance, mechanical strength, and the ability to resist demagnetizing. By leveraging other magnetic qualities such the repulsion of magnets of the same polarity, as seen in Figures 3 and 4, one may provide an additional energy source.

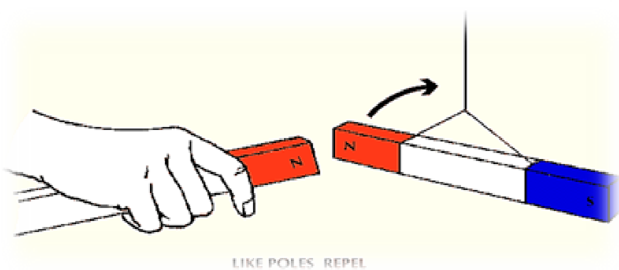

Figure 3. Same polarity magnet repels.

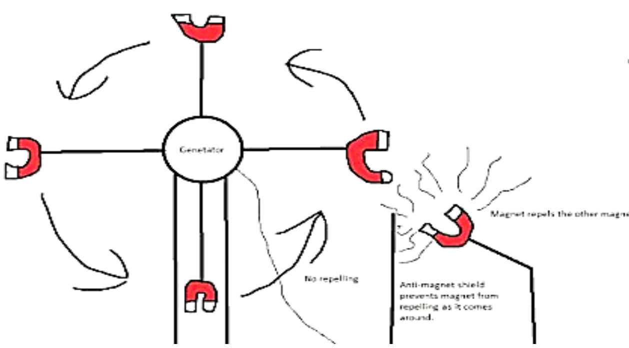

Figure 4. Same polarity magnet repels.

In addition to the coding MATLAB, the Mathwork Team has created other components like Simulation and Linking. Users of this program can develop, test, and

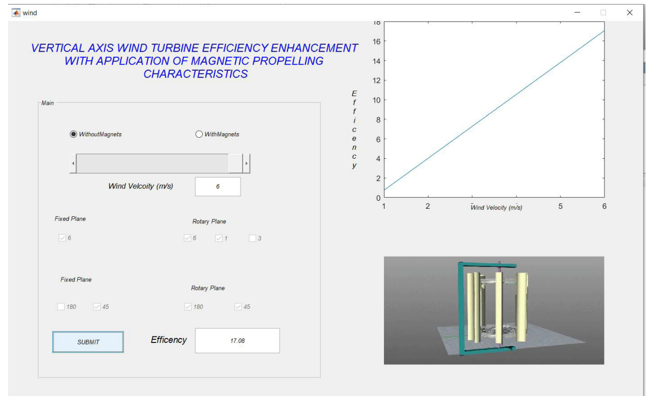

Figure 5. Validation of practical results using MATLAB software.

assess a subject in a highly dynamic environment using graphical computer software. The user may build and test a multi-domain dynamic system on graphs through the selection of a choice from the menu that appears. Using arrays an adaptable library block's matrix and scalar functions. In light of this, we frequently use our MATLAB-App modeling[1].

In this context, the overall force of wind flow may be proportional to the front cross-sectional area of a swept wing, and then wind velocity[6]. Alternatively, you might write something like this:

$P_W = 1/2 \rho A V^3$

P_W = Here the total Wind Power in Weber /m^2

A = Swept Wing area of a rotary turbine perpendicular to the airflow = 0.173m^2.

ρ = Air density at a specific circumstance in kg/m^3.

V = Speed of wind flow measured in meter/sec.

Table 1. Wind Power theoretically calculated for various wind speed characteristics

Sl.-No	Wind-Speed	PW
1	6.0	22.54
2	4.50	9.52
3	3.20	3.4
4	2.80	2.28

The operation of tangential forces and rotational turbine movement velocity in revolutions/min given-by

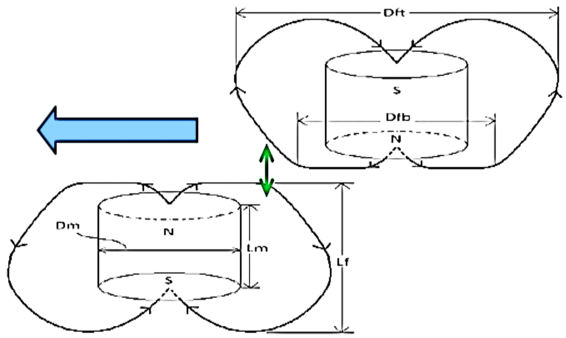

Figure 6. Two magnets were placed parallel towards one another.

the N_R is all that the rotary turbine system needs to create mechanical power (PT), which is nothing more than that.

$$P_T = \frac{1}{60} 2\pi N_r F$$

N_R = RPM of Turbine.

Turbine Mass = 3.1 kg

F= Force

The largest volume of the total K.E. felt by a certain turbine area powers the power coefficient CP, which is used to compute PT.

C_p= PT/ PW

Figure 6 shows magnets mounted on the rotating and steady planes at a 180-degree angle or in line with one another[5]. The turbine's ability to rotate was marginally impeded by this. It is difficult for the turbine to spin because it will be resisted by the magnet's magnetic field of comparable polarity when they are arranged parallel to one another.

Table 2. Through validation, the ideal positioning of a magnet in a PM-Propelled VAWT was determined in order to increase kinetic energy and reduce operating costs

S. No	Position and Magnet Alignment	Speed of Wind	Efficiency
1	Standard Turbine Without Magnets	6	**17.08**
2		4. 5	**14.40**
3		3. 2	**10.84**
4		2. 8	**7.64**
Permanent Magnet Propelled VAWT Magnet Orientation			
1	Six magnets were arranged either parallel to one another or 180 degrees apart.	6	**18.88**
2		4. 5	**17.11**
3		3. 2	**10.54**
4		2. 8	**6.85**
5	One permanent magnet is positioned 180 degrees on the spinning section, and six permanent magnets are put into the stationary component.	6	**17.28**
6		4. 5	**14.78**
7		3. 2	**10.69**
8		2. 8	**7.42**
9	In the rotating component, 3 magnets were positioned with a 180° orientation, while 6 PM were positioned on the stationary component.	6	**18.91**
10		4. 5	**14.40**
11		3. 2	**5.27**
12		2. 8	**4.83**

13	One magnet was placed within the revolving section at a 45-degree angle, and six magnets were attached on the stationary component with a 180° configuration.	6	**17.47**
14		4. 5	**15.54**
15		3. 2	**10.69**
16		2. 8	**7.30**
17	The six permanent magnets of the stationary section and the three permanent magnets of the rotating part were angled at 45°.	6	**17.67**
18		4. 5	**16.89**
19		3. 2	**10.99**
20		2. 8	**7.87**
21	Three permanent magnets and six permanent magnets were arranged at a 45-degree angle in the rotating component.	6	**19.32**
22		4. 5	**18.41**
23		3. 2	**16.49**
24		2. 8	**14.38**
25	The angles of the six magnet sets were 45 degrees in both the plane	6	**24.46**
26		4. 5	**22.20**
27		3. 2	**17.61**
28		2. 8	**15.96**

Here, the repelling force that was created when the magnetic fields of the rotating and stationary plane magnets came into contact and increased resistance proved challenging to reduce. The turbine uses the magnetic attraction between two permanent magnets to transform moving air kinetic force to mechanical force[7]. As illustrated in Figure 7, the magnetic particles were angled at 45 degrees to reduce the opposing repellant power. Thus, that repulsive power generated when magnets and the magnetic field separated was higher than the resistive force generated when they came back together. These repelling forces are combined with wind kinetic energy to produce the fundamental form of

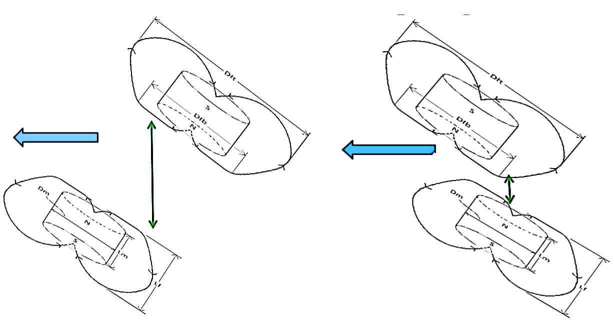

Figure 7. When the turbine enters a magnetic field, the resistive force caused by magnetic repulsion will be less intense.

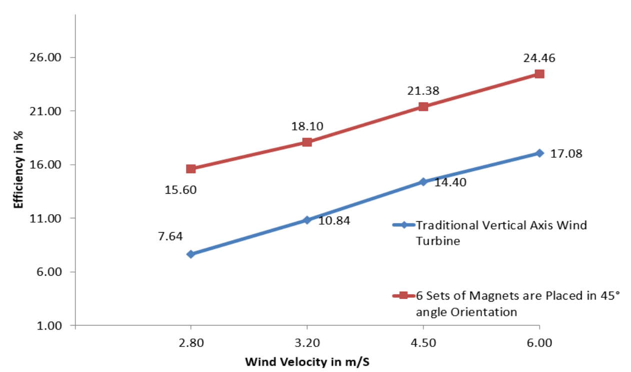

Figure 8. Graph contrasting the efficiency of PM-driven and conventional VAWT.

physical power. Determining the ideal orientation and position of the magnet units with varied wind speed characteristics remained the primary objectives in these studies.

As seen in Figure 7, the magnetic-flux density generated from both magnetic components with a similar pole as it aligns with oriented at a 45-degree angle, which lessens the restive force brought on by magnetic repulsive force. The fact that the flux densities produced by magnets of like pole due to the 45-degree tilt, are less separated after leaving the field, shows that magnetic repulsive force has a higher restive effect.

In accordance with this study, the rotation speed of our conventional VAWT was lower than that of the PM-driven VAWT. For the particular wind speed, the ordinary Vertical Axis Windmill achieved a performance efficiency of about 17.081%, however the turbine powered by a permanent magnet component system had a 24.465% efficiency.

2.0 Findings and Discussion

While still supplying a certain amount of motion to the rotary blade structure, the forces generated by the set of magnets in this situation could impart kinetic energy to the turbine converting wind power to mechanical power[8]. This performance evaluation revealed that the shaft rotation speed of the turbine powered by magnet sets was higher than that of our standard Turbine. In comparison to the set of magnet-driven turbines, considering the exact speed of the wind, typical VATs had an efficiency of somewhere 24.46 percent. Additionally, it's reported their power improved even in reduced wind speed. Thus, when there is less wind, using static magnetic repulsion qualities, the system will work better. These analyses clearly show that the PM Powered Turbine is superior to the concept of integrating solar and wind energy.

3.0 Conclusion

Energy that is sustainable is derived from natural resources that refill quicker rather than exhaust themselves. Some resources that continuously regenerate themselves are the sun and the wind. We understand that the earth's rotation creates wind, which in turn causes temperature variations from day to day and surface to surface. Here, wind is created as the warm air expands at the equator and finally spreads to the poles of the planet. The world's energy issues may be long-term solutions. The study and research were done to create and utilize the magnetic repulsive phenomenon as another source of energy for the turbine in order to increase turbine efficiency. The following day's wind energy supply won't be constrained, thanks to rising temperatures, which generate additional flexible energies in the form of wind. The attracting and repelling forces of magnets, among other fundamental characteristics, make it seem impossible to develop a hybrid power system energy source. Even in situations with little wind, these repulsion features of magnetic components improve the effectiveness of the system. Consequently, there is a potential to help meet the world's energy needs. There are ways to enable the scalability of renewables in the mining sector despite economic and technical hurdles. In order to reduce energy usage and emissions, special attention should be paid to minerals extraction and processes that might benefit from renewable energy solutions. In other ways renewables aid miners beyond reducing their carbon footprint, it's arguable that reducing emissions will be a great goal itself. Hence the mining firms adopting ecologically conscious practices will not go unnoticed.

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