APPLICATION OF THE PERMANENT MAGNET PROPELLING PHENOMENON IN THE SAVONIUS TYPE TRADITIONAL-VAWT STRUCTURE TO IMPROVE THE EFFICIENCY AT VARIOUS WIND SPEED CONDITIONS

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Abstract:
Air could seem insignificant in the current context. Since the surface of the globe is uneven, as is well known, different parts of the planet get sunrays of varying intensity. This creates unequal heating of a surface, will results in differences in an environmental air pressure on the surface of the Earth's, which causes wind. K.E (kinetic energy) of the air molecule is known as wind energy, which is there on earth surface. The wind turbine nothing but a mechanical structure that converts an air molecule kinetic energy which is there in surrounding to required mechanical form. Here, in our research it concentrated on repulsive behaviour of permanent magnets like poles. This intrinsic magnetic repulsion properties were utilized to generate required form of power.

As the result of inclusion of features such as like polarity magnet repulsion, here our structure will perform even at lower wind speeds condition; with greater efficiency. When these magnets are utilized as an additional power source to VAWT structure, they induces a repulsive force which adds kinetic power to the structure of wind turbines rotor as they transforms the wind kinetic power into the required form of mechanical movement. As a consequence, our PM-Propelled VAWT can function at lower wind speeds and with more efficiency. In this case, we've opted to compare the effectiveness of the regular VAWT to that of its counterpart, the permanent magnet propelling VAWT.

Keyword: Wind Energy, Magnet, Magnetic Repulsion, Renewable Energy, Wind Turbine.

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1. INTRODUCTION:

Human being were using these wind to power the mill, to sail the boat for several of years. But starting in the 1980s, the energy industries had a great growth, which was especially appears in the wind power industry. Consequently, in present sustainable energy sector, they will also play a significant part in the sustainable energy bank in addition to the hydro-energy, solar power, and wind power [3]. Kinetic energy of the air molecule is transformed to appropriate form of mechanical energy by mechanical system which makes up-the wind turbine structure.

Now, this mechanical force can be used to move or operate another system, or it can be used to turn the generator shaft to produce energy. Currently, it has been chosen to concentrate on the design and advancement of a permanent magnet-driven VAWT in our paper. This technology is good enough to operate in a various wind-velocity condition environment. Here in this research study, we compare, efficient operation of VAWT structure in magnet style to the traditional VAWT system they are meant to replace.

2. WIND TURBINE DESIGN :

Wind rotor structure are the mechanical structures composed of rotor-blades, rotor-shaft, and many then support components. When a structure is installed, and then exposed to the atmospheric air molecule flow, the movement of air molecule will get contact with the turbine rotor-blades, causing the pressure to change. As a result, the rotor spins in the direction of the lift. When the system's rotor parts begin to rotate, wind kinetic power is transformed into mechanical energy and delivered through the shaft to the generator or other device. When these mechanical power rotates the generator shaft, the magnetic field inside the generator is disturbed, and the generator begins to create electrical energy.

The main sub-stream of wind turbine system, known as the Vertical-axis (VAWT) and Horizontal Axis (HAWT). The rotating shaft of a turbine structure is vertical and rotating plane also vertical, and the rotating shaft looks like a cylindrical form. The VAWT structure is the old and least common member of the rotor family. But these design provides a number of benefits over a more popular horizontal-axis wind rotor-turbine arrangement. There are basically two sub-model in the VAWT rotor, which are as follows:

i. Darrieus Type Sub-Structure.
ii. Savonius Type Sub-System.
iii.

The Savonius-based VAWT system is drag-type structure which functions similarly to a pedal-boat on water. Mr.S.J. Savonius is the system's creator. Over time, a buckets, plates, or cups was used as a pulling mechanism, and the drag-based Savonius Structure emerged. In this article, rotor devices of the Savonius type are employed, which are S-shape model blades are which a pull type system. This pull type system offer a very high beginning torque force in comparison to the lift based sub-systems.

We eventually decided, later analysing two main sub-systems of vertical axis rotor components, to build our design on foundation of basic drag based svonius arrangement with some small modifications. Here, the major change in a basic Savonius type design is that addition of a repulsion force of a permanent magnet characteristics in-between the moving portion to stationary segment of the turbine.

It is vital to exclude cogging effect on upper portion of a structure to contribute a smoother torque when the rotor starts to spins since this repulsion which will induces amount of scoop at the top of the rotor stucture [6]. We slightly altered our design compared with standard Savonius structure [4] by proving a curving form from a rotor bottom to top scture. These can be achieved by spiraling of blade, in line with our design standards, a group of triangle faces cut out of an aluminium filament bottom to top of it. These final version of an improved Savonius design is shown in Figure 1.

Figure 1: Savonius type modified turbine**.**

3. MAGNETIC CHARACTERISTICS:

In order to create the magnetic propelling phenomena, permanent magnets were employed together, repulsion between magnets with identical polarity were used as an energy source to produce the magnetic propelling phenomenon [2].

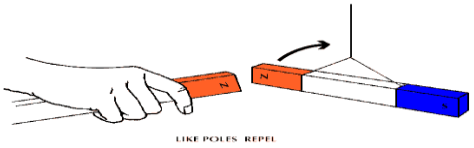


Figure 2: Features of magnetism that repel**.**

Here the repulsion property of magnets of same polarity is exploited like a power source, and permanent-magnets are utilized to achieve the magnetic propelling phenomena. Magnetic repulsion was achieved here by arranging permanent magnets constructed of Neodymium-Iron-Born (Nd-Fe-B) with comparable polarity facing each.

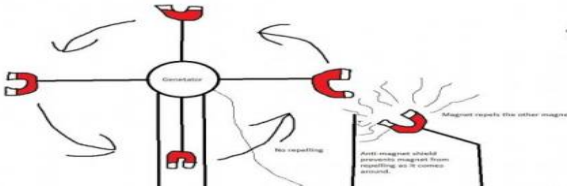


Figure 3: Magnets that provide rotational motion with repelling force.

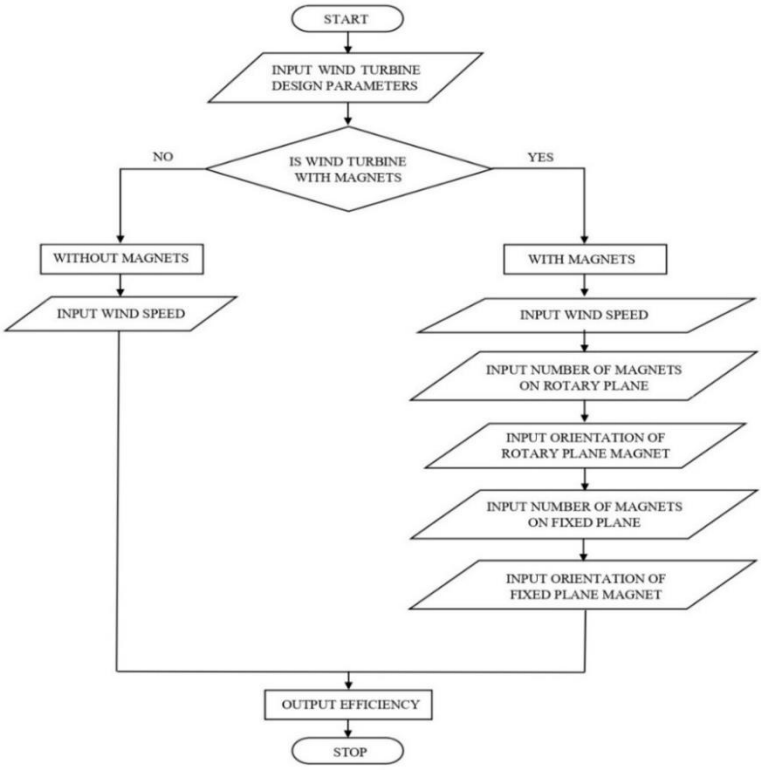
This kinetic energy generated by magnet repulsion were added to rotor structure while transforming the kinetic power of wind into required sort of mechanical movement [9]. Magnet repelling qualities were added in our research studies endeavour which offer extra kinetic energy to rotor to achieve improved performance at lower wind speed condition and increased turbine efficiency at varying wind speed condition [7].

Magnetic repulsion may be immediately felt after implementing the repulsion feature in-between structures fixed and the rotational planes. As a result, while the VAWT converts the kinetic power of wind into required mechanical form, these repelling force induced by a set of magnets will contribute some sort of kinetic power.

4. VALIDATION PART

Here, the MATLAB software application is developed by Mathwork Team that also includes supplemental capabilities like Simulation and Linking. In a dynamic environment with a graphical user interface, this tool enables users to model, simulate, and analyses a system. Here an person can construct, various domain system dynamics just picking inputs from selection box. Then the system will plotted and analyses chart by using modified array of matrix for its functional operations from its set of block of library. Here the MATLAB software models were our choice because of this [9].

The flowchart 1 shows the control flow and input parameters required at that point of time. In traditional vertical axis wind turbine data validation. We just have to opt without magnet option as shown in figure 4 and need to input the wind speed to get the efficacy of given specific VAWT.



Flowchart 1: Control flow of validation programing

In case of Permanent Magnet Propelled VAWT, we need to opt with magnet option and need to give various input such as Wind speed, No. of magnets on each plane and its angle of orientation to get the efficacy of given specific VAWT.

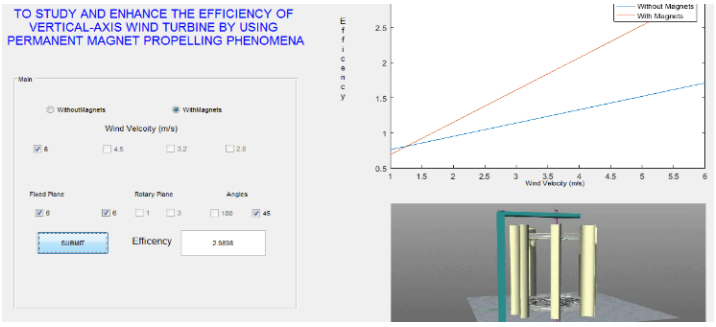


Figure 4: GUI of Validation by MATLAB software.

The tests were carried out to determine the optimal installation configuration of permanent-magnets for various wind speeds.

5. EXPERIMENTAL PROCEDURE :

A sweep front surface of a turbine structures is nothing but, air-density, and wind velocity will all proportional to an overall stored power of the wind stream flow in this condition [3]. It is also possible to write it as follows:

$P_w = 0.5\ \rho\ A\ V^3$

P_w = Wind Power (W/m^2)

A = Swept area perpendicular to air flow in a turbine (m^2) = 0.173 m^2

ρ = Air density at a particular condition (kg / m^3)

V= Velocity of Wind (m/ sec)

Table1: Calculated Power of the Wind under Different Wind velocity circumstances.

Sl. N	V=Avg. Wind Speed (m/sec)	Pw= Wind Power
1	6.0	22. 54
2	4.50	9. 52
3	3.20	3. 4
4	2.80	2. 28

The turbine's mechanical power (P_T) is simply a function of the tangential forces (F) and turbine rotational velocity of turbine shaft given by N_R (RPM).

$P_T = 2\ \pi\ N_r\ F / 60$

Force (F) = Angular acceleration X turbine mass.

N_R = Revolution/ minutes of Turbine.

Turbine of the Mass = 3.1 kg

Here, mechanical output power P_T divide by an maximum amount of kinetic power obtained from an turbine perpendicular to the stream of wind may be represented as C_P, which is called as power co-efficient of VAWT [5].

$C_P = P_T / P_W$

Table 2: The optimal angle of magnet placement orientation in our Modified Wind Turbine in different wind velocity circumstances validated

Sr. No	Magnets Placement Orientation.	Wind Speed in m/s	Turbine RPM	P_T	$C_P = P_T/P_W$
Conventional - VAWT					
1	Magnet less Conventional Turbine	6	88.00	385. 24	**17.08**
2		4. 5	76.00	137. 00	**14.40**
3		3. 2	72.00	37. 08	**10.84**
4		2. 8	68.00	17. 51	**7.64**
Permanent Magnet Propelled VAWT					
5	6 magnets were positioned parallel to one another at a 180-degree angle.	6	87.00	425. 67	**18.88**
6		4. 5	79.00	162. 75	**17.11**
7		3. 2	70.00	36. 05	**10.54**
8		2. 8	61.00	15. 71	**6.85**
9	A stationary component has 6 no permanent magnets, while a rotating	6	89.00	.389. 62	**17.28**
10		4. 5	78.00	140. 60	**14.78**
11		3. 2	71.00	36. 57	**10.69**

12	portion contains 1 magnet oriented 180°.	2. 8	66.00	17. 00	**7.42**
13	3 permanent magnets were inserted with a 180° orientation in the rotating component, & 6 PM were mounted on the stationary section.	6	92.00	426. 44	**18.91**
14		4. 5	76.00	137. 00	**14.40**
15		3. 2	70.00	18. 03	**5.27**
16		2. 8	43.00	11. 07	**4.83**
17	1 permanent magnet was inserted at a 45° angle in the revolving segment, and six were mounted at a 180° angle on the stationary part.	6	90.00	394. 00	**17.47**
18		4. 5	82.00	147. 81	**15.54**
19		3. 2	71.00	36. 57	**10.69**
20		2. 8	65.00	16. 74	**7.30**
21	Three permanent magnets were put at a 45° angle on the spinning component and six on the stationary section.	6	91.00	398. 37	**17.67**
22		4. 5	78.00	160. 69	**16.89**
23		3. 2	.73.00	37. 60	**10.99**
24		2. 8	70.00	18. 03	**7.87**
25	Three permanent magnets and six permanent magnets were positioned at a 45-degree angle in the spinning component.	6	94.00	435. 71	**19.32**
26		4. 5	85.00	175. 11	**18.41**
27		3. 2	73.00	56. 40	**16.49**
28		2. 8	64.00	32. 96	**14.38**
29	The six magnet sets were angled at 45 degrees.	6	102.00	551. 59	**24.46**
30		4. 5	82.00	211. 16	**22.20**
31		3. 2	78.00	60. 26	**17.61**
32		2. 8	71.00	36. 57	**15.96**

The simulation experiment was conducted to measure the efficiency of specified design modified savionus form of VAWT at an various wind velocity. For a given specific condition, it's found that 17.08% will be the maximum efficiency at a wind speed of 6m/sec.

Here the 3 sets of blade were installed on rotor plane, each set containing one advancing blade and one returning blade initially with respect to the number of blades, same number of magnets were opted to install on both rotary plane and fixed plane. The magnets were installed on periphery of the rotor and fixed plane to grasp more kinetic energy from the magnetic repulsion of the similar pole of magnets.

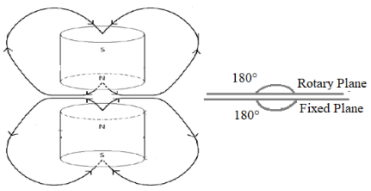


Figure 5: Magnets are placed in 180° angle Orientation (Parallel to Each other)

The magnets were placed in such way that the angle between the face plane of the magnet and plane of rotor plane and fixed plane were 180° as shown in above figure 5.

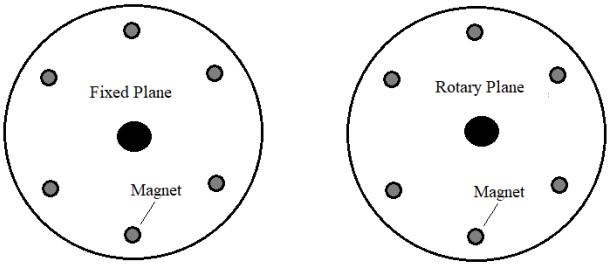
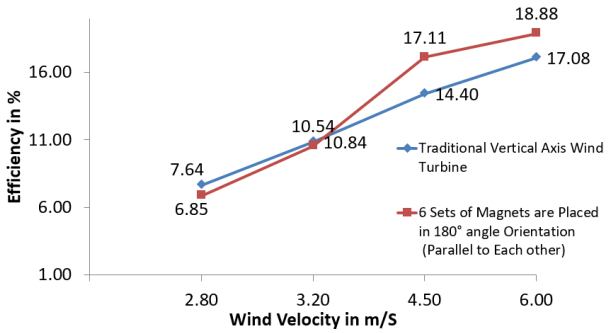


Figure 6: Sets Magnets were placed in 60° cut angle on full rotor panel and fixed plane each

Here the 6 set of magnets i.e 6 Number of magnets were placed on rotary plane and 6 Number of magnets were placed on fixed plane with an equal angle separation with respect to shaft i.e 60° cut angle of full rotor plane arrangements as shown in above figure 6.



Graph 1: 6 Sets of Magnets are placed in 180° angle Orientation (Parallel to Each other)

It's observed that, there won't be much difference in efficiency at lower wind speed condition in both traditional vertical axis wind turbine and the PM-VAWT. There is a breakeven point were the efficiency will start getting improved at and above the 3.2m/sec wind speed, at 6m/sec the efficiency was much better than traditional vertical axis wind turbine which is 17.08% compared to Permanente magnet propelled vertical axis wind turbine which 18.88% which gains additional kinetic energy from magnetic repulsion phenomenon during transferrin the kinetic power of wind in the required form of mechanical movements.

Here in this way the 6 Numbers of magnets were installed on fixed plane with an equal angle separation with respect to shaft i.e 60° cut angle of full fixed plane arrangements and rotary plane as shown on figure 7.

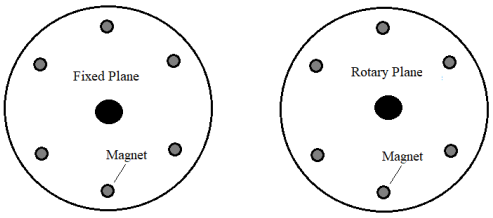


Figure 7: 6 Sets Magnets were placed in 60° cut angle on full rotor panel and fixed plane each

Here the angle between the face plane and installed magnet in both fixed plane and rotary plane were 45° as shown in the above figure 8.

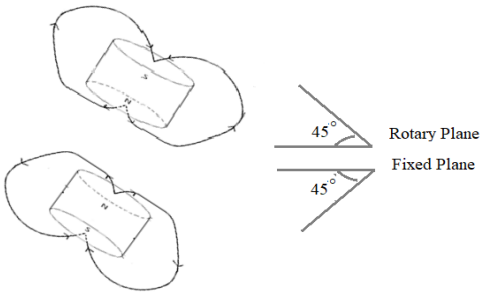
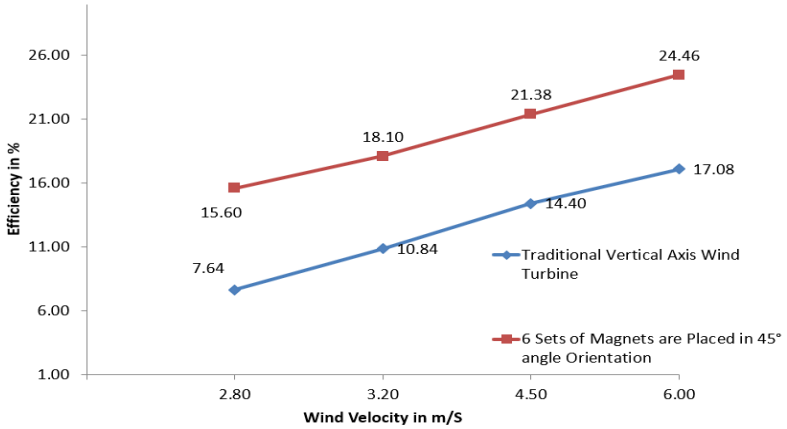


Figure 8: Magnets are placed in 45° angle orientation on both plan

In this combination the permananet magnet propelled vertical axis wind turbine was found performing even better compared to traditional vertical axis wind turnine in both lower and higher wind speed condition at PM Proplelled VAWT can harness apprciable ammoint of additional kinetic energy from magnetic replusion, which resluts in improved efficiecny i.e from 7.64% to 15.60% and in higher wind speed confition it is obsereved that the trubine can was operating with higher efficiecny that is 24.46%.



Graph 2: 6 Sets of Magnets are Placed in 45° angle Orientation

6. THE RESULTS & DISCUSSION:

As a result, power banks were created using magnetism's qualities, which includes its capacity for repulsion. In this instance, the wind's stored kinetic energy was converted into the appropriate kind of mechanical power by using turbine and while transforming that kinetic energy into mechanical energy the repulsive force produced by permanent magnets of like polarities. In this case, wind power will be converted to the necessary kind of mechanical power during that turbine will gain the kinetic energy which is created by permanent magnets' repulsive force, which will contribute some kinetic energy to the turbine construction [8].

In this performance improvement research, it is identified as speed of rotation on of the Permanent Magnet propelled turbine (VAWT) looks higher compared to its counter-part Traditional-VAWT. Although a permanent-magnet VAWT designed reached a higher efficiency of 24.48% when it's compared to its identical counter-part i.e. Traditional-VAWT only achieved 17.08 percent efficiency in same wind speed condition. Additionally, it has been seen that efficiency rose in situations with decreased wind speeds. As a result, it may function more effectively in low wind situations when permanent magnet propelling features are applied.

7. CONSLUSION:

Without a doubt, in order to support a current situational improvement in human-being life style standard, this world's electricity supply must expand quickly in the near future. Also we are conscious about underlying reality of the wind which is formed as the result of rotation of earth glob, then the non-uniform heating of the surface layer, and day - night to which causes different temperatures. According to the molecule's temperature, the hot air molecule will thus expands towards equator of the earth surface later move near to the planetary pole as a result of this process, producing the wind.

Wind energy is the kinetic energy that these winds create. Climate change won't lead to a shortage of wind energy in the future, then basic features of these permanent magnets, including its attracting or repelling phenomenon, were became significant. Despite low wind speed and velocity, our turbine's efficiency increased as a result of the magnetic repulsion property. As a result, there is an opportunity to deliver a solution to the world's energy needs.

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