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IMPROVEMENT OF PERFORMANCE AND EFFICIENCY OF MODIFIED VERTICAL AXIS WIND TURBINE BY IMPLEMENTING A MAGNETIC PROPELLING PHENOMENON OF PERMANENT MAGNETS

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Abstract: In the current situation, air may not seem like anything at all. Here the wind is moving air, as we all know that earth having an even surface, hence sunrays reach earth with different intensity at different part of the surface which creates uneven heating o earth surface, which is causes the differences in the atmospheric air pressure which causes wind, and the kinetic energy of these air is called as wind energy. The mechanical system, which converts kinetic energy available in this atmospheric air in to the required form of mechanicals energies is called is called as wind turbine. So we focused on the like Pole Magnets repulsion characteristics of permanent magnets. These natural properties of magnetic propelling are used as sources of energy. Hence our VAWT system will operate with the, add on features like, magnetic repulsion. When this natural properties is used as source of energy in VAWT, will create the repulsive force which will add some sorts of kinetics energies to the wind turbines, when transferring kinetics energies of wind power into required form of mechanical power. Hence our PM-Propelled VAWT is able to work in the lower wind velocity conditions also. Here our choice is to compare the Permanent magnet propelled VAWT efficiency with its counterpart traditional VAWT.

Keyword: Efficiency, Wind energy, Magnets, Repulsion, Wind Turbine.

1. INTRODUCTION:

We humans were using the wind power from thousands of the years to move the sail boat and to run the mills. But from the calendar year 1980s, there was a dramatic development in the energy industries and this development registered in terms of wind energies. So presently in this sustainable form of energy sector, apart from hydro power, accompanied by solar energies, these wind energy will also takes pivotal role in sustainable energy bank [2]. Now, this wind turbine system is an mechanical structure which changes the kinetic energies obtained from wind in to required form of mechanicals energy. Now this mechanical power can be used to run/ move the other system or to rotate generator shaft to produce electrical power. Presently in our paper, its decided to concentrate on the design and develop a permanent magnet propelled VAWT, the system have the capability to work in varying wind speed conditions. In this paper our course of action to compare efficiency of PM - Vertical Axis Wind Turbines structure with its counterpart traditional VAWT system.

2. WIND TURBINE DESIGN

Here the wind turbines are mechanical structure, with a combination of blade, shaft and supporting elements. When system is installed and exposed to movement of atmospheric air, the air will hits to turbine blades, and causes in change in change in pressure. This result in lift then causes rotor to turn in its direction. When systems rotor parts starts rotating, the wind kinetic energy is transformed into required form of mechanical energy which transmitted through shaft to generator or other system. When this mechanical energy used to rotate generator shaft, generator will start producing electrical energy by cutting magnetic field in it. Here are the two main group of the wind turbines structure, i.e. Horizontal Axis (HAWT) and Vertical Axis (VAWT). Horizontal Axis structure is a Pedestal fan like structure, and were vertical axis structure will be in cylindrical motion [4].
In VAWT Structure, the rotating shaft will be arranged in vertically direction, and its rotating plane will be vertical and resembles the cylinder like structure wile rotating. The VAWT System is oldest and non-popular member of the turbine family. This system offers a several advantages over the commonly known Horizontal axis wind turbine system. Here are there is mainly two sub-types in VAWT Structure and it's as follows,

- Savonius System.
- Darrieus System.

In the VAWT system, the Savonius based wind turbine system are drag type VAWT structure, which works on the concept of pedal boat in water. This sytem was invented by S.J. Savonius. The drag based Savonius Structure evolved over a period that used a bucket / plate/cup as a pulling devices. In this paper, Savonius type rotor devices are the S- model turbine blades which is also pull type system. These pull type VAWT system having a relatively high starting torque when compared to the its lift based systems part. Then after studying the both common sub types of VAWT system rotor elements, we finally decided to base our design foundation on Savonius configuration with small modifications. In our design we made a bit modification as compared to our standard model of savonius turbine, by modifying a curvy outline from the top of a rotor blade to its base of rotor blades[6]. This can be achieved with a set of triangular face cut out of the aluminiums sheet element, and by using its flexibility we spiralled it as per our design requirements from top of the rotor blade to bottom of it. Final design of Modified savonius design is shown in Figure 1.

Figure 1: Modified Savonius Turbine

Here is the main factor to modify the standard Savonius model is the implementation of the magnetic repulsion characteristics in turbine between moving part and fixed part of the turbine. This repulsion will create scoop on upper half of the plane, hence to eliminate these scoop and to provide smoother torque during the rotation of turbine rotor [3].

3. MAGNETIC REPLUSION CHARACTERISTICS:

The repulsion feature of like polarities of magnets is used as a energy sourse and permanent magnets were used to obtain magnetic propelling phenomenon [5].

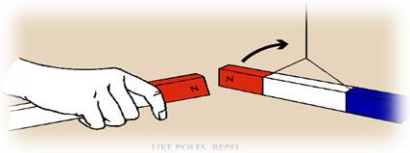


Figure 2: Magnetic Repulsion Characteristics

Here the Neodymium Iron Born (Nd-Fe-B) permanent magnet were used to produce magnetic repulsion by arranging permanent magnets such that, the like polarities of magnets facing each other's. The kinetic energy produced due to the repulsion of magnets is utilized while converting kinetic power of wind in to required form of the mechanical power.

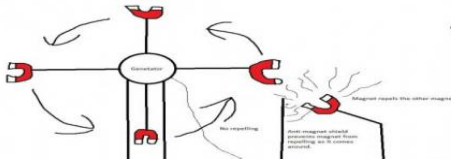


Figure 3: Permanent Magnets Repulsive force were used to provide rotational motion.

Here in our research work, the repulsion characteristics of magnets were introduced to add some additional kinetic power to achieve higher efficiency of turbine structure [8]. Magnetic repulsion can easily be experienced by sandwiched this repulsive feature, in the rotary plane of structure and fixed plane of the structure. Hence repulsive force produced by the permanent magnets will add some kind of kinetic power to the VAWT while converting the kinetic power available in the wind in to the required form of mechanical power.

4. EXPERIMENTAL PROCEDURE :

In this given condition, in wind turbines structures the swept front area perpendicular to the flow of air, air density and the wind speed will be proportional to the total power of wind flow [8]. Also can be written as bellow;

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

P_w= Wind Power (W/m^2)

A = Turbine Swept area perpendicular to air flow (m^2) =$0.173m^{2.}$

ρ= Density of air for given condition (kg/ m^3)

V= Velocity of Wind (m/sec)

Table1: The Calculated Power in wind at different wind speed condition

S. N	V= Avg. Wind Speed.	Pw=0.5ρAV^{3}9
1	6m/sec	22.55 w/m^2
2	4.5m/sec	9.51 w/m^2
3	3.2m/sec	3.42 w/m^2
4	2.8m/sec	2.29 w/m^2

Mechanical Power (P_T) is obtained from the turbine, is nothing but function of the tangentials forces (F) & turbine rotational speeds (RPM) give by N_R of the turbine shaft.

$$P_T = 2\pi NrF/60$$

Force (F) = Angular acceleration X turbine mass.
N_R = Revolution/minutes of Turbine
Angular Acceleration = (acceleration / radius of the turbine) rev/m^2
Turbine Mass = 3.1kg

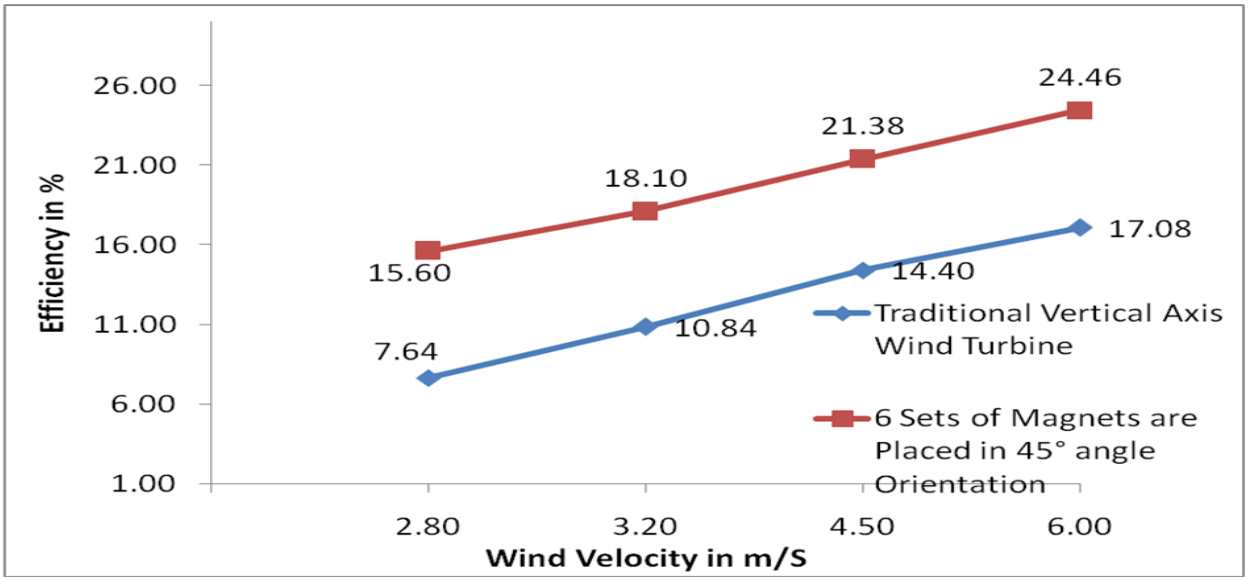
C_P the coefficient of power of the given turbine structure can be written as mechanical output of powers P_T divided by a maximum total kinetic energy accessed by the area of a given wind turbine perpendicular to stream of wind [5].

$$C_P = P_T/P_W$$

The experiments were carried out to determine the optimal orientation and combination of magnets sets for different wind speed.

Table 2: Experimental value of the optimal position and combination of magnet placements in an PM-Propelled VAWT at different win speed condition.

Sl. No	Magnetic Orientation	Wind Velocity	Output RPM	$P_T = 2\pi NrF/60$	Eff = P_T/P_W
The Traditional VAWT					
1	Traditional Vertical Axis Wind Turbine	6.00	88	385.24	**17.08**
2		4.50	76	137.00	**14.40**
3		3.20	72	37.08	**10.84**
4		2.80	68	17.51	**7.64**
Permanent Magnet Propelled VAWT					
5	6 set of magnets were placed in an 180° angle orientation as i.e. parallel to each other.	6.00	87	425.67	**18.88**
6		4.50	79	162.75	**17.11**
7		3.20	70	36.05	**10.54**
8		2.80	61	15.71	**6.85**
9	6 No Permanent Magnets inserted on an n fixed part and 1 magnet in Rotational part in the 180° Orientation i.e. parallel to each other.	6.00	89	389.62	**17.28**
10		4.50	78	140.60	**14.78**
11		3.20	71	36.57	**10.69**
12		2.80	66	17.00	**7.42**
13	6No of permanent magnets were inserted on fixed part and 3 No of magnets placed in rotational part with an orientation of 180°	6.00	92	426.44	**18.91**
14		4.50	76	137.00	**14.40**
15		3.20	70	18.03	**5.27**
16		2.80	43	11.07	**4.83**
17	6 No of permanent magnets were inserted on fixed part in 180° orientation & 1 No in rotational part in 45° orientation.	6.00	90	394.00	**17.47**
18		4.50	82	147.81	**15.54**
19		3.20	71	36.57	**10.69**
20		2.80	65	16.74	**7.30**
21	6 No of permanent magnets were inserted in fixed part in 180° angle orientation & 3 No on rotational part in 45° angle orientation.	6.00	91	398.37	**17.67**
22		4.50	78	160.69	**16.89**
23		3.20	73	37.60	**10.99**
24		2.80	70	18.03	**7.87**
25	6 No of permanent magnets were inserted on fixed part in 45° orientation & a 3 magnets in rotational part in 45° orientation.	6.00	94	435.71	**19.32**
26		4.50	85	175.11	**18.41**
27		3.20	73	56.40	**16.49**
28		2.80	64	32.96	**14.38**
29	The 6 Set of Magnets were Placed in 45° angle Orientation.	6.00	102	551.59	**24.46**
30		4.50	82	211.16	**22.20**
31		3.20	78	60.26	**17.61**
32		2.80	71	36.57	**15.96**



Graph 1: Efficiency comparison of Traditional VAWT and PM propelled VAWT

5. VALIDATION PART

The Mathwork Team have developed a software called as MATLAB with an add on feature like Simulation and Linking. This software allows user to model a system, and then simulate and analyse with a dynamic system with Graphical User Interface environment. Here user can model a multi domain dynamic system with a just click on selection box which allowed by customized library block an array and matrix operation to plot and analyse those functional elements on graphs. So here we opted this MATLAB App models [7].

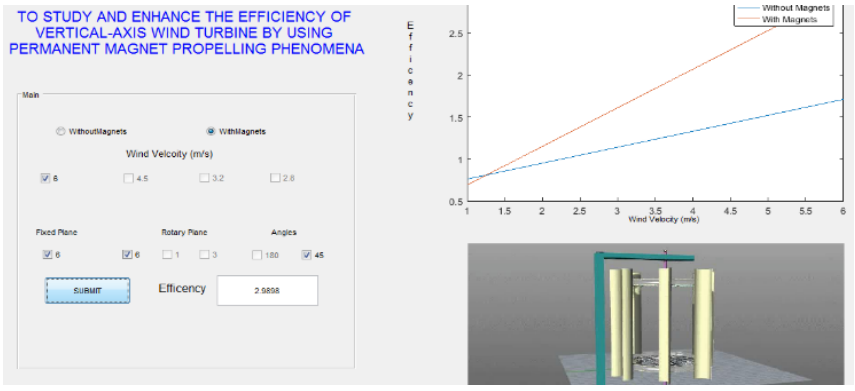


Figure4: Simulation using MATLAB software.

6. THE RESULTS AND DISCUSSION:

Hence, the attractive feature of permanent magnets, i.e. repulsion & attraction of characteristics were used like a source of power bank. Here the repulsive force produced by the like polarities of permanent magnets was used while converting the kinetics power stored in the form of wind in to the required form of mechanical

power. Here, repulsive force created by the permanent magnets will add some form of kinetics power to turbine structure while converting wind power to required type of mechanical power [8].
Here in the performance analysis it observed that the turbine rotational speed increased in Permanent Magnets propelled-VAWT, while compared to our Traditional VAWT. And the efficiency of the Traditional-VAWT is 17.08% were for same wind speed condition the Permanent magnets propelled VAWT achieved an efficiency of 24.4% and its observed that efficiency improved for lower wind speed condition also. Hence it can operate in low wind speed condition with higher efficiency when it's implemented with permanent magnet propelling features.

7. CONSLUSION:

Presently the live standard of human being became increased hence; there won't be any doubt in the power supply to the glob has to drastically increase soon to reach all the people. At the same time we have basic knowledge that, the wind produced because of uneven heating of the surface of the and due to earth rotation which causes day and night with change in temperature. So due to this procedure hot atmospheric air will rises at equator & slowly expands towards pole of the earth depends on temperature of molucule, this will causes the air in moment which is called as wind. The kinetic energy associated with these wind is called as wind energy. Due to global warming in future there won't be any scarcity for wind power & key feature of magnets such free energy like repulsive and attraction characteristics looks futuristic in the present situation. Due to implementation of magnetic repulsion feature our turbine efficiency increased even in low wind velocity/speed condition also.

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