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Dual Power Generation Using Vertical Axis Wind Turbine

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ABSTRACT

The dual way power generation from vertical axis wind turbine (VAWT) have more advantages when compared to horizontal axis wind turbine (HAWT). The structure of VAWT is that the rotor rotates the shaft where the shaft is connected to a generator. This means that there is no heavy nacelle or yaw system required. Generally, permanent magnet (PM)are connected to the shaft of the VAWT and the coil is surrounded by the magnet and during the rotation of the turbine blades shaft also rotates thus PM connected to the shaft starts to generate power. The implementation of this type of arrangement will serve as another source of power. They are placed in bottom of the shaft. This new technique of wind turbine employing shaft permanent magnet (PM) generator producing more energy than a conventional turbine, and also decreasing operational costs. In future by implementing this type the efficiency of the VAWT can be improved because of the increase in power production. Thus a dual power generation VAWT with shaft permanent magnet (PM) generator will be an efficient, versatile and elegant method for harnessing wind power and also it is a zero pollution method.

Keywords: VAWT, HAWT, Magnetic levitation and Electromagnet.

1. INTRODUCTION

Now a day, we will ultimately need to search for renewable or virtually inexhaustible energy for the human development to continue. Renewable energy is generally electricity supplied from several sources such as solar power, geothermal energy, hydropower and wind power, the popularity of renewable energy has experienced a significant upsurge in recent times due to the exhaustion of conventional power generation methods.

The exploration of renewable energy is the only approach to reduce our dependence on fossil fuels. Among the renewable energy sources Wind Energy is one of the fastest growing energy sources which is growing at the rate of 30% annual graph.

The wind speeds in most of Asian zone is much lower than 7 m/s, especially in the cities, but existing wind turbines has high mechanical frictional resistance, 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.

Shaft PM generator wind turbine has the features of PM which is connected to the shaft of the wind turbine and the PM which is surrounded by the coils this arrangement makes the production of emf during the rotation of the turbine by introducing the shaft PM generator into turbine system with the intention to increases the efficiency.

Then more power can be generated thus reducing the need for expensive power mills that reason pollution. Since one of the essential proceedings approximately wind turbines is the sound they produce, this is a splendid gain over other turbine designs.

2. HARDWARE DESIGNING OF VAWT

Design Requirements

General Requirements

1. The VAWT will be a self-starting H-Type.
2. It will self-start use of wind energy only.
3. It can have blade dimensions of 1m (4.9') high by 0.6m (8.1') diameter.
4. It may be manufactured from lightweight components like aluminium.
5. It will be designed to connect to an electrical generator to measure electricity output.
6. It might be rated to supply 50W at common Nova Scotia wind speeds (5-7 m/s).

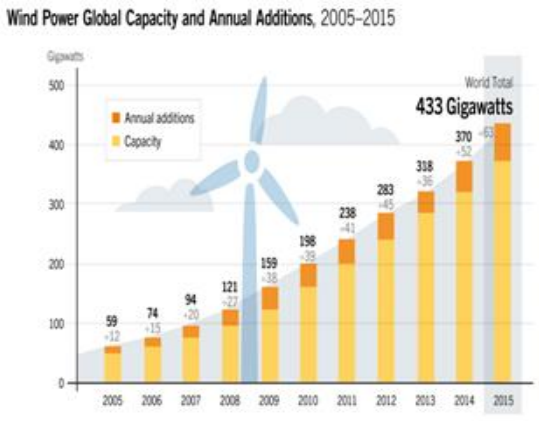

Fig 1. Power generation 2005 - 2015

Costs and Usage

1. Turbine may be capable to carry out outdoor.
2. Life expectancy of 5 years with proper protection.
3. All mechanical components will be located at floor level.

4. The system could be easy to gather.

Timing and Intellectual Property

This property is the exploration of various options for self-starter designs, and testing of self-starter design ideas with mock up models in the wind tunnel, and design of the wind turbine will be completed.

3. BLADE DESIGN OF TURBINE

Turbine blades are designed by combining two turbine types Darrieus vertical axis wind turbine and Savonius vertical axis wind turbine. Because both of them have some advantages and disadvantages. By combining the designing of both Darrieus and Savonius vertical axis wind mill we can be able to come away from some of the negative aspects of them and we can make it as an advantage and improve the efficiency of the power generation from vertical axis wind turbine.

Savonius vertical axis wind turbine has simplified design because, in contact to with Horizontal Axis Wind Turbines (HAWTs), no pointing mechanism is needed to allow for shifting wind direction and the turbine is self-starting. It's only form has essentially cups or half drums fixed to a central shaft in opposing directions. Each drum catches the wind and so turns the shaft, bringing the opposing drum into the movement of the wind. This drum then repeats the method, so reason the shaft to rotate in addition and in addition for completing a full rotation. This technique can maintains all the time the wind blows and the turning of the shaft is used to drive a pump or a small generator. Savonius machines are top at pumping water and other high torque, low rpm software. They can sometimes have long lengthy helical scoops for easy torque.

The Darrieus vertical axis wind turbine is primarily based on the precept of operation depends on the truth that its blade pace is a multiple of the wind velocity, and resulting in an apparent wind during the entire revolution coming in as a head wind with only a restricted variation in attitude. The airfoil blades have been designed to bearing in the greater centrifugal forces in excessive wind speeds.

Fig 2. Model of Turbine Blade

A Darrieus turbine cannot be self-starting; it needs to be brought to a sufficiently high blade speed by external means. The original Darrieus turbine suffered from some negative features such as violent vibrations leading to a high noise level, blade failure and a relatively low efficiency.

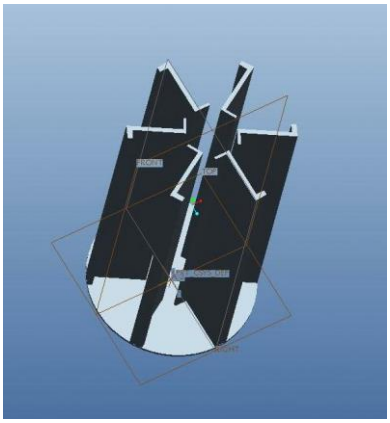

Fig 3. Blade design in software

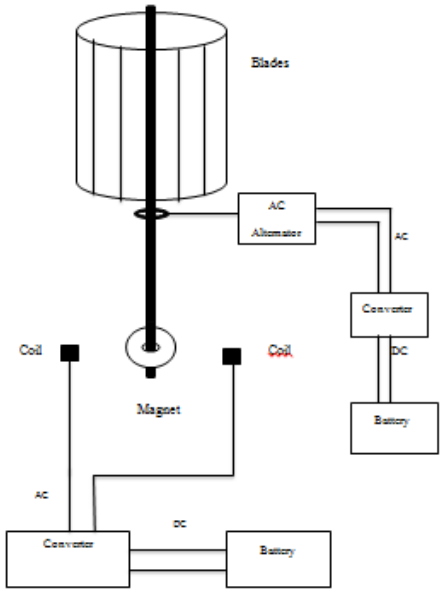

Fig 4. Block Diagram

A combined Savonius and Darrieus vertical axis wind turbine would have many advantages over an individual Darrieus or Savonius 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. The research demonstrated a simple way to enable a Darrieus VAWT to be self-starting and achieve higher efficiencies. Evidence shows that a Darrieus turbine using fixed geometry symmetrical airfoils can self-start in the field during atmospheric gusting it was suggested that using a Darrieus blade together with a Savonius blade has better performance than using them individually according to self-start ability and efficiency of the turbine.

By combining both Darrieus and Savonius vertical axis wind turbine we can have the advantages of self-starting, more amount of wind can be made to fall on the turbine blades and

the timing for the stopping of turbines after removal of wind force can also be improved.

4. VAWT

In the vertical axis wind turbine shaft permanent magnet generator has been connected bottom side of the turbine. When the turbine starts to rotate, power can be generated from the motor and also the power generated from the shaft PM generator.

The shaft generator which is placed bottom side of the turbine blades produces an output voltage of 24V each. The permanent magnet DC generators connected to the shaft can produce a voltage output of 12V.Thus by combining the three output we can get a voltage output of 36V and a power output of 200Watts can be achieved.

In the conventional vertical axis wind turbines there will be only one power generator are employed. Compared to the conventional wind turbines, the proposed model seem to have more efficiency.

5. DESIGN CALCULATION

The length to diameter ratio is kept as greater than 1 for better performance of turbine.

Height of blades (L) = 1m
Width of blades = 20 cm
Diameter of turbines (D) = 60 cm
No of blades used for turbine = 6
Angle between two adjacent blades = 60°

Swept Area

Swept area limits the volume of air passing by the turbine. The swept area is the section of air that encloses the turbine in its movement.

Swept Area = 2RL
= 2*(60/2)*100
= 60 m².

Power generated, P = ½ρAu³Cp watts

Where ρ = air density (kg/m³)
A = turbine blade area (m²)
u = wind speed (m/s)
Cp = power coefficient

Density of air, = 1.225 Kg/m³
Area of the turbine $A = \pi r^2$ sq.m
Where r = 0.3m
Area of the turbine $A = \pi r^2$ sq.m
= π*0.3²
Area of the turbine A = 0.283 m²
Power coefficient, Cp=$b/(2r + b)$
b = 0.6m
Cp = $0.6/(2(0.3) + 0.6)$
Cp = 0.5
Power generated, P = ½ρAu³Cp
For velocity of air, u = 4.5 m/s
= ½*1.225*0.283*4.5³*0.5
P = 7.897 w
For velocity of air, u = 10 m/s
P= ½*1.225*0.283*10³*0.5
P = 86.66 w

6. TESTING

Test procedure:

Test 1: Testing the starting wind speed of wind turbine model

1. The model is assembled to be the two manner power generation vertical axis wind turbine.
2. A fan is placed in the direction parallel to the wind turbine model.
3. The fan is switched on and the wind produced is directed to the model.
4. The model is replaced by anemometer and the fan is switched on. The wind speed is recorded.
5. The test is repeated by way of the usage of traditional wind turbine model.

Test 2: Testing the rotational speed of wind turbine model at constant wind pace

1. The steps 1 until 4 in test 1 are repeated.
2. The reading of rotational velocity of version is recoded after 1min for 5 instances.

Test 3: Testing the time taken by wind turbine model to stop rotation

1. The steps 1 until 3 in test 1 are repeated.
2. The fan is then turn off after 5min and a card bock is placed in front of it.
3. The time at which the model to stop its rotation completely is recorded.
4. Steps 2 and 3 are repeated for two times.

Test results and discussions

The wind turbine model starts to rotate at lower wind speeds than that of conventional wind turbine.

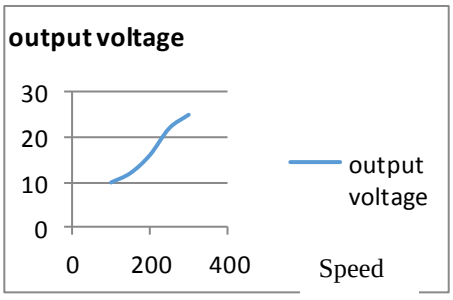

Fig 5. Graphical representation

Most of the existing wind turbine requires high starting wind speed to operate. Higher rotational speed means higher kinetic energy of rotating turbine blades and hence more electric energy can be generated by proposed model of wind turbine. The wind may come to a lower speed and even stop at every instant of time.

Higher stopping time is desired because the wind turbine can still rotate at lower speed in longer time when the speed of flowing wind decrease. And when the wind speed increases, the wind turbine immediately rotate faster without achieve the starting wind speed (if wind turbine stop in few seconds). Higher stopping time has been achieved using proposed turbine model.

7. ADVANTAGE OF VERTICAL AXIS WIND TURBINE OVER HORIZONTAL AXIS WIND TURBINE:

There are several reasons why we would choose a vertical axis wind turbine over a horizontal axis windmill:

1. They are mounted lower to the ground making it easy for maintenance if needed.
2. They start creating electricity at speeds of only 6 mph. and
3. Third, they may be able to be built at locations where taller structures, such as the horizontal type, can't be.
4. Higher power utilization-- 20% higher than HAWT.
5. Lower noise level--only 27-37 DB, suitable for your living condition.
6. Safer operation--Spin at slower speeds than horizontal turbines, decreasing the risk of injuring birds and also decreasing noise level.
7. Simpler installation and maintenance-- besides the traditional installation site, it can be mounted directly on a rooftop, doing away with the tower and associated guy lines.
8. Not affected by orientation variation—no matter the wind blow from any orientation, VAWT can work without regard to its face.
9. Economical and practical-Although one-time investment expenses are larger, but you don't have to pay higher tariffs forever

8. APPLICATIONS

Wind-turbine generators have been constructed an extensive variety of power outputs from kilowatt or so to a few thousand kilowatts, low power devices can generate enough power for space heating & cooling & for operating domestic appliances.

Low energy wind turbine were used for decades for the corrosion protection of buried metal pipe strains. Application of greater effective generators up to about 50kw, used for running the irrigation pumps. Aero generators in the intermediate power range, more or less 100W to few KW can supply electricity to isolated populations.

9. CONCLUSION

Over all, the two manner electricity technology from vertical axis wind turbine become a notable success. The rotors that were designed for harnessed enough air to rotate the stator at low and high wind speeds at same time as preserving the center of mass closer to the bottom yielding balance. The Vertical Axis Wind Turbine (VAWT) with magnet connected to the shaft surrounded by the coils which they completed higher than the traditional wind turbine.

The home for the vertical axis wind turbine would be in residential areas. It can be established on roof and be very efficient and able to extract loose easy power as a consequence experiencing a discount of their software fee and also make contribution to the "Green Energy" cognizance this is increasingly gaining recognition.

By mounting it on the roof of the house a home owner might be able to extract free clean energy. The two manner windmill may be designed for using in a mild scale electricity generation starting from 500 Watts to few KW. Also it is far appropriate for integrating with the hybrid power generation units consisting of solar and other natural resources

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