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# Fabrication and Study of Vertical Axis Wind Turbine by Maglev Suspension

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***Abstract: Renewable energy sources are gaining more importance in recent years. Many developments have taken place to utilize solar and wind energy. Wind is present everywhere but windmills are present in few places to generate power. An attempt has been made to develop prototype of vertical axis windmill using maglev suspension. Comparisons between single ended arrangement and double ended arrangement have been carried to extract more power. In the later type of arrangement more power was generated than the former.***

***Keywords: vertical axis windmill, maglev suspension, Savonius, Darrieus****, wind energy.*

## I. INTRODUCTION

Renewable energy is generally electricity provided from sources, such as wind power, solar power, geothermal energy, hydropower and various forms of biomass. The popularity of renewable energy has experienced a significant growth in recent times due to the exhaustion of conventional power generation methods and increasing realization of its adverse effects on the environment. This work focuses on the utilization of wind energy as a renewable source. The aim of this work is to fabricate and test magnetically levitated vertical axis wind turbine system that has the ability to operate in both high and low wind speed conditions. Contrasting to the traditional horizontal axis wind turbine, this turbine is levitated via maglev (magnetic levitation) vertically on a rotor shaft. This levitation is used between the rotating shaft of the turbine blades and the base of the whole wind turbine system. By using appropriate mechanisms in place to harness enough wind for power generation by way of an axial flux generator built from permanent magnets and copper coils. Magnet arrangement will cultivate an effective magnetic field and copper coils will facilitate voltage capture due to the changing magnetic field.

## II. LITERATURE SURVEY

Several types of turbines exist today and their designs are usually inclined towards one of the two categories: Horizontal Axis Wind Turbine (HAWM) and Vertical Axis Wind Turbine (VAWM). The former is the more conventional and common type everyone has come to know, while the latter due to its seldom usage and exploitation, is quiet unpopular. The HAWTs usually consist of two or three propeller like blades attached to a horizontal and mounted on bearings the top of a support tower as seen in Fig 1a.

A typical vertical axis wind turbine is shown in Fig 1b Their design makes it possible for them to utilize the wind power from every direction unlike the HAWT that depend on lift forces from the wind similar to the lift off concept of an airplane. Vertical axis wind turbines are further subdivided into two major types namely the darrieus model and the savonius model as shown in Fig 3a and 3b. The functioning of this model is dependent on the drag forces from the wind. This drag force produced is a differential of the wind hitting by the inner part of the scoops and the wind blowing against the back of the scoops. Like the darrieus model, the savonius turbines will work with winds approaching in any direction and also work well with lower wind speeds due to their very low clearance off the ground.

Bittumon et al [1] developed two bucket savonius rotor and placed it on central shaft. They demonstrated a simple way to enable a darrieus VAWT to be self-starting and achieve higher efficiency. They suggested that using a darrieus blade together with a savonius blade has better performances than using them individually

Gene Abbascia et al [2] implemented an alternate configured wind turbine for power generation purposes. Using the effects of magnetic repulsion, spiral shaped wind turbine blades are used for stability during rotation and suspended on magnets as a replacement for ball bearings which are normally used on conventional wind turbines. Power will be generated with the use of permanent magnets and a set of coils.

Pravesh k. Sahare et al [3] used maglev method by which an object is suspended with no support other than magnetic fields. The main advantage of maglev vertical axis wind turbine is to reduce mechanical friction. Maglev has more advantages from other conventional wind turbines as it can work on low speed of air i.e., 1.5 m/s.

James A Rowan et al [4] used magnetic vertical axis wind turbine in which the vertical axis and foils mounted there on are magnetically levitated above the turbines base there by reducing friction within the system. The system has an axial flux alternator which can be turned on or off depending on wind conditions.

Aravind C V et al [5] proposed the vertical axis turbine and the novelty of levitation concept. It is expected that with the use of the levitated turbine design wind as low as 1 m/s can produce power. This type of wind setup does not require any significant land for installation. With the Maglev VAWT, the cost is significantly low with smaller size generator.

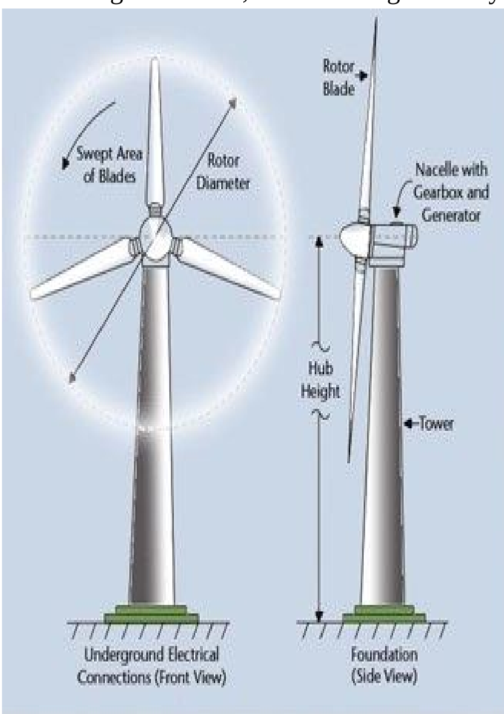


Fig 1 Horizontal axis wind mill

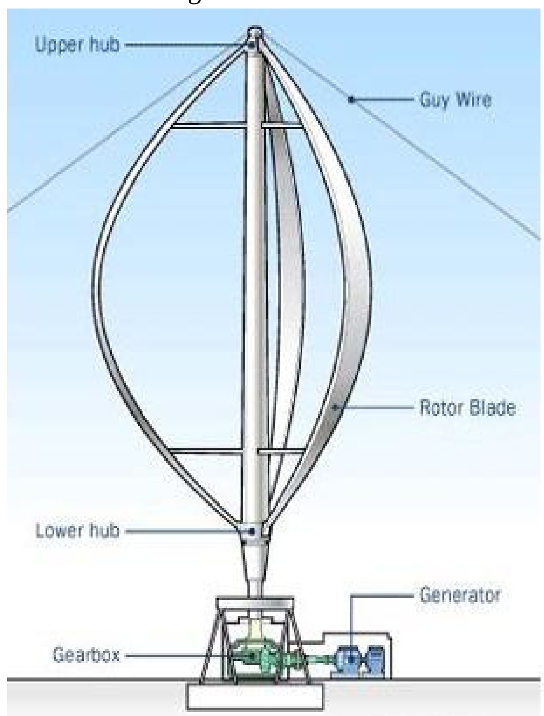


Fig 1b Vertical axis wind mill

Fig 3a Darrieus model

Fig 3b Savonius model

## III.PRESENT WORK

Two ring type neodymium magnets of outer diameter 40 mm, inner diameter 20 mm and thickness 10 mm are placed at the centre of the shaft by which the required levitation between the non-rotating plate (stator) and the rotating plate (rotor) is obtained. Similarly disc type magnets of 30 mm diameter and 4 mm thickness are arranged as alternate poles one after the other,

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along the periphery of the rotor. These magnets are responsible for the useful flux that is going to be utilised by the power generation system. The same arrangement is repeated on the upper side of the turbine.

Ten coils are arranged in the periphery of the stator exactly in a line to the arranged disc magnets. Each set of coils are connected in series aiding to obtain maximum output voltage. The series connections of the coils are preferred over the parallel connection for optimizing a level between the output current and voltage. Similar arrangement is made on the upper side of the turbine (double ended arrangement).

The stator and rotor are separated in the air using the principle of magnetic levitation. The rotor is lifted by a certain centimetres in the air by the magnetic forces created by the ring type neodymium magnets. This is the principle advantage of maglev wind mill from a conventional one. That is as the rotor is floating in the air due to levitation, mechanical friction is reduced. That makes it possible to rotations even at low speeds. Fig 5 illustrates the magnetic levitation between stator and rotor. GI sheet is formed to semi-circular blade profile having radius of 45 mm. The overall structure of the fabricated prototype is as shown as shown in Fig 6.

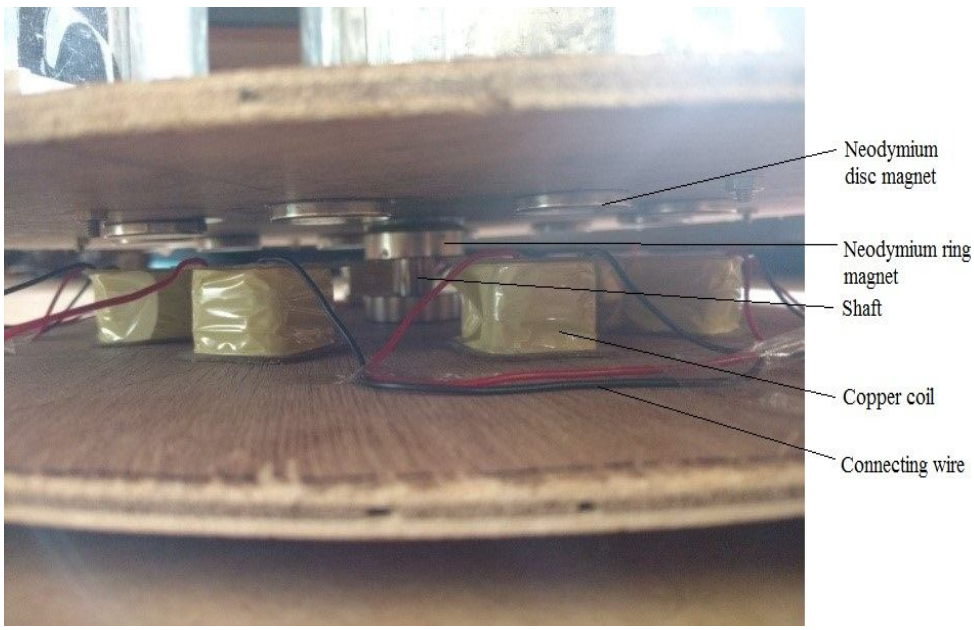


Fig 5 Levitation between stator and rotor

Fig 6 Final model of VAMT

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*1) Single ended arrangement*

Single ended arrangement consists of ten copper coils mounted on the non-rotating plate and ten neodymium magnets mounted on the bottom part of the rotating plate of vertical axis wind turbine. These two plates are separated by magnetic levitation.

*2) Double ended arrangement*

In case of double ended arrangement there are two non-rotating plates above which ten copper coils are placed on each plate and two rotating plates of vertical axis wind turbine above which ten neodymium magnets are placed on each plate. Magnetic levitation is provided at the lower part between rotating and non-rotating plate and at the upper side the non-rotating plate is provided by using circular rubber clamp.

## IV. RESULTS AND DISCUSSIONS

The fabricated VAMT was tested by placing them on roof top. An anemometer used to measure wind speed and a multimeter was connected to measure the output voltage generated by the rotation of blades by wind forces acting on them for both single and double ended arrangement. The experimental results are as shown in table 1.

TABLE 1

| Sl. No | Wind Speed (m/s) | Voltage (V) | |
|---|---|---|---|
| | | Single end | Double end |
| 1 | 2.1 | 3.1 | 5.8 |
| 2 | 2.3 | 3.6 | 6.3 |
| 3 | 2.7 | 3.4 | 6.5 |
| 4 | 3.0 | 4.1 | 7.3 |
| 5 | 3.3 | 4.0 | 8.0 |
| 6 | 3.7 | 5.1 | 9.3 |
| 7 | 4.0 | 5.8 | 10.1 |
| 8 | 4.3 | 6.6 | 10.2 |
| 9 | 4.7 | 5.9 | 11.2 |
| 10 | 4.9 | 6.7 | 11.7 |

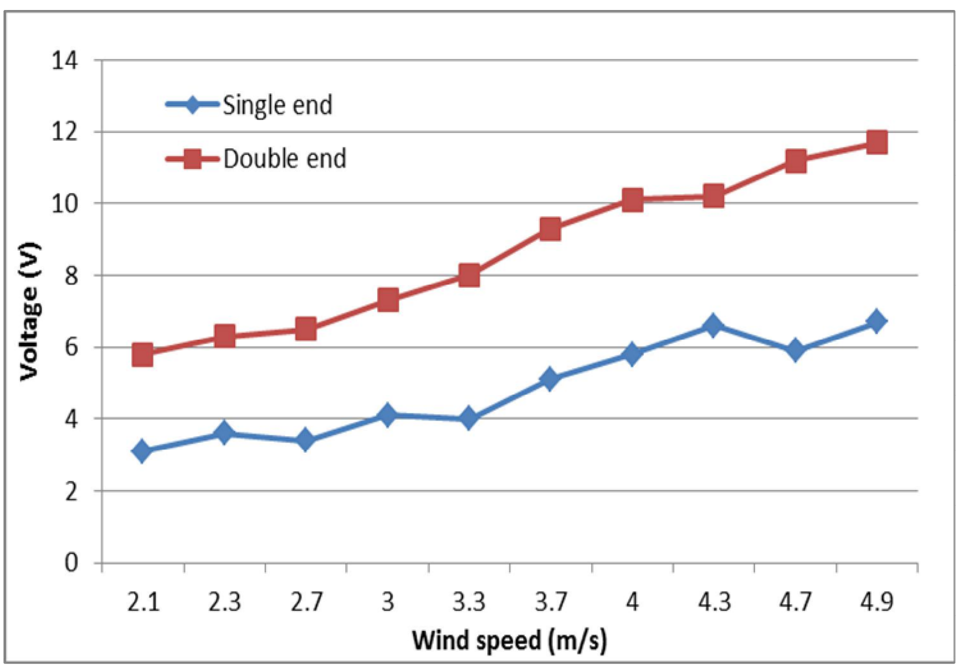


Fig 7 Wind speed v/s Voltage

1) he voltage obtained in single ended condition is 6.7 volts at a wind speed of 4.9 m/s.
2) The voltage obtained is 11.7 volts at a wind speed of 4.9 m/s for dual ended condition.
3) From the above results more power can be produced using double ended arrangement than single ended arrangement for available wind speeds.
4) As observed from the above table 1, there is 41.7% increase in voltage between single ended arrangement to double ended arrangement.

## V. CONLUSION

1) The blades harnessed enough air to rotate at low and high wind speeds.
2) Wind turbine rotors and stator levitated properly using permanent magnets which allowed for a smooth rotation.
3) More voltage were produced by using double ended arragement.

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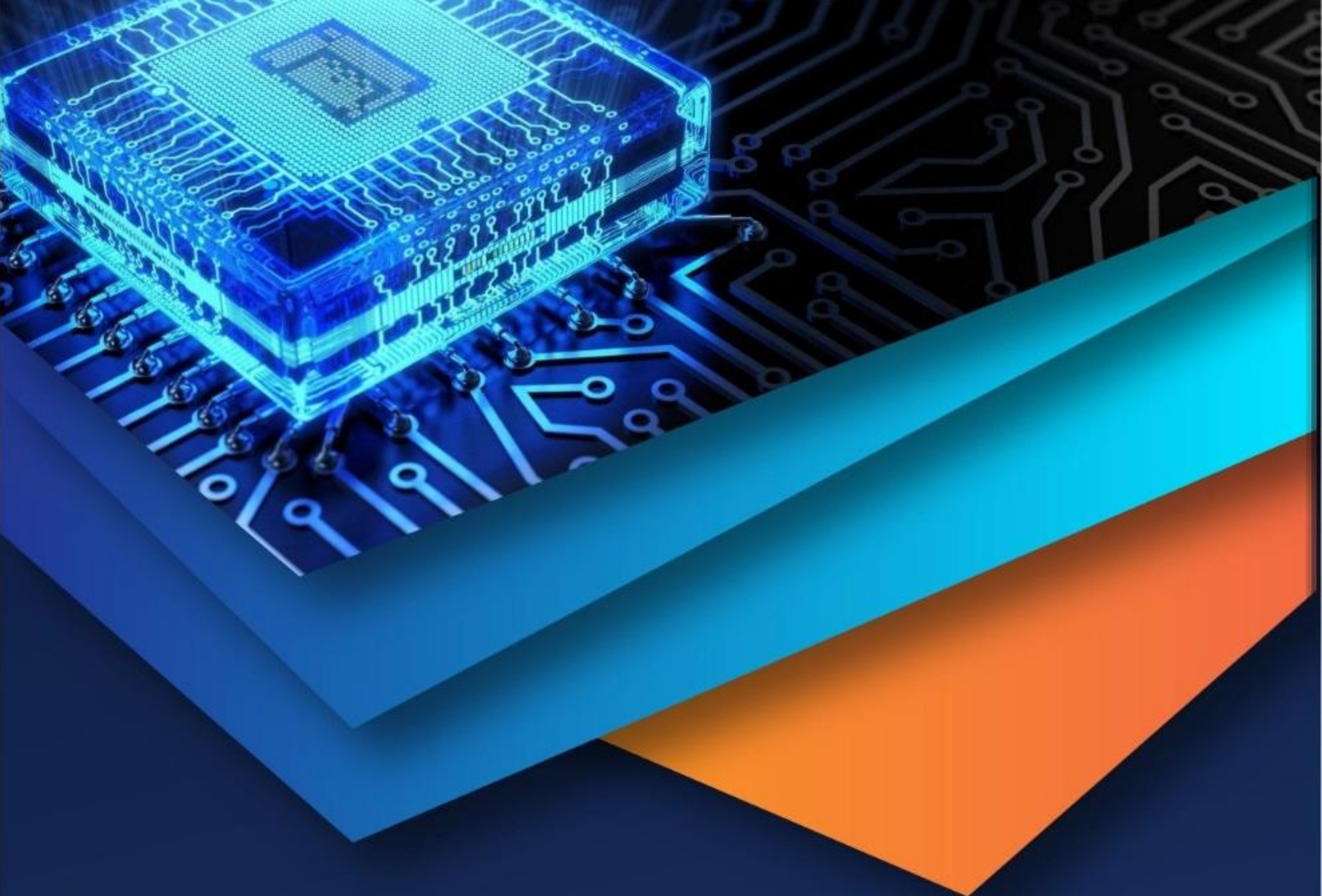


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