Power Generation Using Vertical Axis Wind Turbine

Rohit Malapl[1], Sandeep Shinde[2], Omkar Gawade[3], Chinmay Potdar[4], Prof. Shekhar Gulwade[5] Prof. Paramveer Patil[6]

[1]Rohit Malap (Student, SPPU, Dept .of Mechanical Engineering JSPM'S Jayawantrao Sawant College of Engineering)
[2] Sandeep Shinde (Student, SPPU, Dept. of Mechanical Engineering JSPM'S Jayawantrao Sawant College of Engineering)
[3] Omkar Gawade (Student, SPPU, Dept. of Mechanical Engineering JSPM'S Jayawantrao Sawant College of Engineering)
[4] Chinmay Potdar (Student, SPPU, Dept. of Mechanical Engineering JSPM'S Jayawantrao Sawant College of Engineering)
[5] Prof. Shekhar Gulwade (Professor , Dept. of Mechanical Engineering JSPM'S Jayawantrao Sawant College of Engineering)
[6] Prof. Paramveer Patil (Professor, Dept . of Mechanical Engineering JSPM'S Jayawantrao Sawant College of Engineering)

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Abstract: One of the main types of renewable energy resources that are widely available and utilized as an alternative energy is wind energy. Because fossil fuels are becoming more scarce, wind power is a sustainable source of electricity, with its use growing daily. Vertical axis wind turbines (VAWT) and horizontal axis wind turbines (HAWT) can be used to transform the energy into electricity. Whereas the horizontal axis wind turbine is commonly used for greater volumes of production that demand significant investment and have high efficiency, the vertical axis wind turbine is frequently utilized for domestic applications where the volume of production is modest and efficiency is optimal. The goal of this project was to produce a lot of wind energy in order to increase its efficiency.

1. INTRODUCTION

In order to complete any work in daily life, energy is essential. The majority of energy consumed today comes from non-renewable resources including gas, coal, and oil. The primary issue with non-renewable energy sources is that they are not environmentally safe and contribute to global warming. The greatest solution to this problem is to use renewable energy sources. Renewable energy sources that can be used to meet the need include solar, wind, tidal, and biogas. These resources are plentiful and sustainable. The purest renewable energy source that is extremely available for producing power is wind energy. One natural resource that has no effect on the environment is wind. Due to its low cost in comparison to other renewable energy resources, wind energy is employed as a key source of renewable energy in most nations, including India. The kinetic energy of atmospheric air is transformed into mechanical energy to create wind energy. The turbines used to transform kinetic energy into mechanical energy are the vertical axis wind turbine (VAWT) and the horizontal axis wind turbine (HAWT).

Scope of Project: To minimize the use of non-renewable energy resources while making use of the wind resources that are now accessible. The renewable energy resource with the quickest rate of growth is wind energy. Up until now, the wind energy sector has benefited from market incentives backed by laws that promote renewable energy sources. Controlling the power quality is necessary for large-scale wind facilities that are getting close to the output rating of conventional power plants in order to lessen the negative effects on their network integration.

1.1 LITERATURE REVIEW

Power Generation by Vertical Axis Wind Turbine Niranjana.S.J:

The goal of this vertical axis wind turbine (VAWT) is to allow vehicles traveling on both sides of the roadway to clip the turbine blades. Power is produced by the generator through a shaft intern that is linked to the blades. The VAWT generates power, which is then stored in a battery and put to good use. The VAWT used in this work is designed and constructed in compliance with the requirements. Because of its aerofoil-like shape, the VAWT blades are stiffer and lighter. The able To cut the VAWT's blades, which are attached to a shaft that is internally connected to the generator. This causes the VAWT to generate power, which is then stored in a battery and put to good use. In this project, a tiny capacity model is created and tested in a lab. The power output may reach 1W at a velocity of 25 m/sec. Additionally, it operates in low wind conditions, ranging from 4 to 35 m/sec. One natural resource that can be used to generate alternative energy is wind. An excellent option to offset the need for fossil fuels is wind energy. Other than that, wind energy is pure and can help mitigate the issue of global warming brought on by the overuse of air-assisted combustion in conventional combustion processes. VAWT offers a few benefits. The heavier components are simply maintained and can be set on the ground. The wind can be captured by VAWT in any direction. One of the most straightforward designs for a wind power system is an asynchronous generator that is directly connected to the electrical grid. Proposed are the control systems and the models for each part. In particular, the VAWT model is described in full, encompassing phenomena like wind shear and tower shadow. The study and conclusion are validated by simulation and experimental data. Tests on various vertical axis wind turbine modifier types revealed that this VAWT provided a better efficiency. An alternate option for producing electricity in places without access to the electrical grid could be a wind turbine. Wind turbines come in two varieties: horizontal axis wind turbines and vertical axis wind turbines. The rotor assembly of a vertical axis wind turbine rotates around its vertical axis. This VAWT offered a number of advantages over the more traditional horizontal axis wind turbine, including being independent of wind direction, allowing rotational parts to be mounted close to the ground for easier maintenance, having a lower noise signature, and causing less disturbance of gravity due to non-harmonic reversing stress at the blade's root. For more than 30 years, research has been done on the development of the vertical axis wind turbine. Recently, vertical axis wind turbines have paid more attention to cost-effectiveness and power generation optimization. The tip speed ratio is one of the key components affecting the wind turbine system's output power. The ideal way to control power is to have a wind turbine run at its ideal tip speed ratio and produce its maximum power. However, inaccurate controlling will result in needless system loss.

REVIEW ON VERTICAL AND HORIZONTAL AXIS WIND TURBINE: C.M.Vivek1, P.Gopikrishnan2, R.Murugesh2, R. Raja Mohamed2:

One of the main types of renewable energy resources that are widely available and utilized as an alternative energy is wind energy. Because fossil fuels are becoming more scarce, wind power is a sustainable source of electricity, with its use growing daily. Vertical axis wind turbines (VAWT) and horizontal axis wind turbines (HAWT) can be used to transform the energy into electricity. While the horizontal axis wind turbine is generally used for bigger volume of production that requires huge investment and has high efficiency, the vertical axis wind turbine is highly used for domestic applications where the volume of production is modest and efficiency is optimal. The goal of this article was to increase wind energy efficiency by providing a significant amount of electricity while requiring less installation area. The vertical axis wind turbine (VAWT) and horizontal axis wind turbine (HAWT) can be combined into one tower to achieve this. The cost of producing a greater amount of electricity is decreased by the combined vertical and horizontal axis wind turbine.

Development and analysis of vertical-axis wind turbines by Paul Cooper:

It has been shown that vertical-axis wind turbines (VAWTs) are efficient wind energy harvesting equipment. VAWTs have been applied to a variety of mechanical and electrical energy generation tasks, from small-scale home applications to large-scale utility-scale electricity production. The development of the three primary VAWT designs—the Savonius, Darrieus, and Giromill designs—is summed up in this chapter. To show how the intricate aerodynamics of these devices may be examined using comparatively simple methods, a synopsis of the multiple-stream tube study of VAWTs is also given. An examination of a double-multiple-stream tube is utilized to show the specifics of VAWT performance concerning rotor power output and turbine blade loads as a function of basic parameters like tip speed ratio. We address the consequences for the design of VAWT. Vertical-axis wind turbines (VAWTs) have a wide range of intricate aerodynamic properties and a visually fascinating array of physical shapes. In addition to being the first wind turbines ever created, VAWTs have been constructed and run on a scale that is comparable to some of the largest wind turbines ever manufactured. In theory, vertical axis wind turbines (VAWTs) have the ability to achieve coefficients of performance, C p,max, that are similar to those of horizontal axis wind turbines (HAWTs). Additionally, VAWTs have a number of noteworthy benefits over HAWTs. One of these benefits is that VAWTs take wind coming from any direction because they are cross-flow devices. As a result, unlike all horizontal axis machines, they should not, in theory, require a yaw mechanism to guarantee that they are oriented toward the wind. The mechanical load's ability to be positioned at ground level and directly attached to the VAWT rotor shaft is another significant benefit. As a result, a large tower that might have supported the weight of the gearbox, generator, and yaw mechanism is no longer necessary.. Additionally, slip rings or flexible cables are not required to connect the generator to the load—a feature that can be crucial for small-scale turbines.

Wind Turbine Blade Design Peter J:

The most recent advancements in wind turbine blade design are thoroughly reviewed, covering HAWT blade design, propulsion, theoretical maximum efficiency, and blade loads. The paper gives a thorough overview of wind turbine blade design and demonstrates how horizontal axis rotors are used nearly exclusively in current turbines. A wind turbine blade's aerodynamic design concepts are explained in detail, including the best attack angles, the choice of aerofoil, and the form and quantity of blades. A thorough analysis of the design stresses on wind turbine blades is provided, outlining the gyroscopic, aerodynamic, centrifugal, and operational circumstances. For hundreds of years, wind power has been used to power windmills, which are historical structures made of stone, wood, and cloth that are used to grind corn or pump water. In the 19th century, fossil fuel engines and the establishment of a nationally dispersed power network supplanted the massive, heavy, and inefficient historic designs. In the second half of the 20th century, wind energy extraction has returned due to breakthroughs in materials science, particularly polymers, and a better knowledge of aerodynamics.. These days, electricity is produced using wind power devices, sometimes known as wind turbines. The wind turbine's first classification is based on how the shaft and rotational axis are oriented. A horizontal turbine is one that has its shaft positioned horizontally, parallel to the ground.

A Review of Research on Large Scale Modern Vertical Axis Wind Turbines at Uppsala University Senad Apelfröjd *, Sandra Eriksson and Hans Bernhoff:

A review of more than ten years of Uppsala University research on Vertical Axis Wind Turbines (VAWTs) is presented in this study. Among other things, the article provides a summary of the 200 kW VAWT in Falkenberg, Sweden, and details the work completed on the 12 kW prototype VAWT in Marsta, Sweden. Our two experimental study sites have effectively tested and demonstrated several important characteristics. This method simplifies things by allowing the electrical converter system to regulate most or all of the turbines' control, which lowers investment costs and maintenance requirements. The idea includes an H-rotor that is omnidirectional with respect to wind direction, which eliminates the requirement for a yaw system and allows energy extraction from all wind directions. The ground-level permanent magnet synchronous generator (PMSG), which is specifically designed to regulate and extract power from the turbine, is connected to the turbine. The goal of the ongoing research is to soon achieve a multi-megawatt VAWT. During the past century, wind energy has become a new, large-scale renewable energy source. A combination of technological advancement and political aspirations has propelled the new technology. The goal to lower carbon dioxide emissions and the current debates surrounding global climate change are the primary political motivators. In this sense, gas emissions and fuel costs are eliminated by using wind power, making it an environmentally benign energy source. Modern technology, which is dominated by megawatt-scale Horizontal Axis Wind Turbines (HAWT), has shown that large-scale systems are feasible and can contribute significantly to the nation's or even the continent's electric energy supply. Many projects have attempted to create Vertical Axis Wind Turbines (VAWT), but none have yet achieved a substantial commercial takeoff. Eole project, a joint venture between Hydro-Quebec and the National Resource Council of Canada to create a large-scale Darrieus VAWT in the early 1980s, is one of the more well-known initiatives. Constructed in 1986, the Eole is a 96-meter-tall Darrieus turbine with a swept area of 4000 square meters and a rated maximum power of 3.8 MW. Over the course of its five years of operation, it generated over 13 GWh of electrical energy. The bottom bearing failed in 1993, causing the machine to be shut down. Another such is the American business FloWind, which constructed multiple wind farms using Darrius turbines in the 1980s. The blades on the machines, which were meant to flex, became fatigued. implemented to offer reduced costs and increased efficiency

2.Design and Development Method:

A monopole design is the most widely used technique for a wind turbine mounting structure. This is made out of a steel-structured pole that extends to the owner's preferred height attached to a foundation, usually made of concrete. Roof-mounted systems have become more and more popular as turbine technology has advanced. Research on these roof-mounted systems has not been as extensive as that on the conventional monopole type. The need to eliminate the shortcomings that plagued earlier roof-mounted systems is growing along with the popularity of roof mounted turbine.

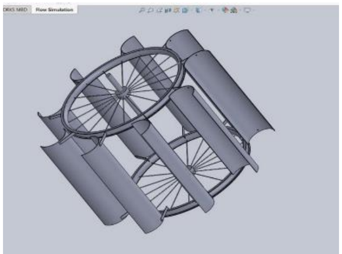


Fig- VAWT Design

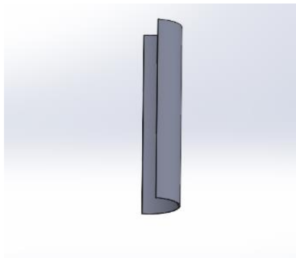


Fig- Blade Design

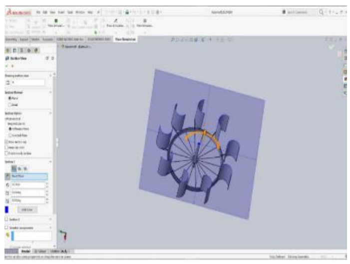


Fig - Cross-section

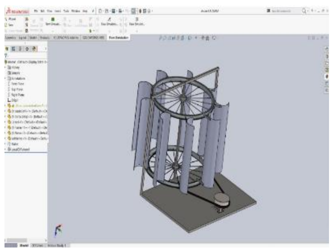


Fig - VAWT Assembly

The finest design that WPI has tested thus far is the split Savonius. The split Savonius's high surface area, which allows it to capture the most wind, is the cause. This aspect leads us to assume that more research with other Savonius designs should be conducted. The Savonius turbine designs are easy to construct, inexpensive, and less susceptible to wind turbulence. Our favorite design, which can be seen in Fig. Savonius in a Savonius, is a Savonius within a Savonius. The split Savonius that we used is improved upon in this design. This design expands the area that can be used to harness wind energy.

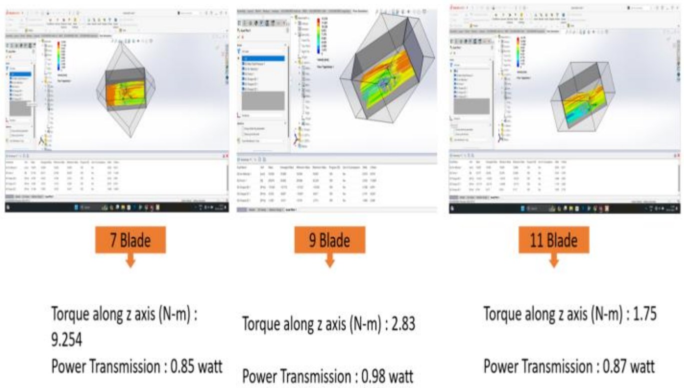
3. RESULT AND DISCUSSIONS

Results in Simulation:

Utilizing Soldiworks Flow simulation software, the stresses and torque that will be applied to the wind turbine design are computed. The boundary conditions are given by us. The entrance, rotor, outlet, and tunnel wall have already been identified, and named selections have been made. We will enter the wind direction and speed and specify that the inlet is of the "velocity inlet" kind. We indicate that the rotor is of type "interior," the tunnel wall is of type "wall," and the outlet is of type "pressure outlet." Make it clear that a gauge pressure of zero serves as the outlet's boundary condition. This implies that the pressure at the outlet, which is rather remote from the rotor, ought to match the pressure at the input.. We do not need to specify any reference values as the will not be asking the solver to compute any ratios or coefficients.

Choosing No. Of Blades:

With Constant wind Speed of 10 m/s



As Result Shows the power and torque generation by using different No. of blades(Odd numbers are preferred) .Based on this results the 9 blades gives highest power transmission thus are selected for further fabrication of Vertical axis wind turbine.

4.Conclusion:

All of the highways can be made lighter with this technique without requiring the usage of non-renewable energy sources. Additionally, this technique has the potential to generate a significant quantity of power if it is used on all national highways. Additionally, it can offer numerous educated fellowship recipients jobs. In order to reduce the percentage of accidents, it can develop more energy and light up the highways by growing in number. The "Highway Windmill" idea was created with the ability to supply power for turning on the emergency headlamp. The dynamo uses wind energy to transform mechanical rotation into direct current (DC) using electromagnetic principles. Using a wind turbine configuration, the device uses an unconventional approach to create electrical power from wind energy. The blade profile needs to be carefully chosen in order to maximize power generation while minimizing losses. The wind energy source is not continuous, which means that the wind machine's operation will be intermittent and its power production rate will fluctuate. Therefore, the component should be designed to minimize losses.The VAWT is built and designed to be able to collect wind from all directions. The project generates 18 W of power at a speed of 6.1 m/s. By altering the size and shape of the blade, the efficiency of the VAWT can be increased. The differences between the theoretical and experimental results arise from the fact that, although in theory, the wind is assumed to be hitting all eight turbine blades, in reality, this is not the case. The outcomes of our research strongly suggest that, even in less than optimal conditions, vertical axis wind energy conversion is a feasible and possibly significant contribution to the generation of clean, renewable electricity from wind commute and in need of emergency Street lights will be powered by the highway idea. Highways are typically a quicker route for daily travel in cities.

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BIOGRAPHIES:

Rohit Vijay Malap
BE Mechanical
JSPM's Jayawantrao Sawant
College of Engineering, Hadapsar
Pune
royamalap456@gmail.com

Sandeep Marotrao Shinde.
BE Mechanical
JSPM's Jayawantrao Sawant
College of Engineering, Hadapsar
Pune
sandeepshinde905@gmail.com

Omkar Appasaheb Gawade
BE Mechanical
JSPM's Jayawantrao Sawant
College of Engineering, Hadapsar
Pune
omgawade037@gmail.com

Chinmay Nitin Potdar
BE Mechanical
JSPM's Jayawantrao Sawant
College of Engineering, Hadapsar
Pune
chinmaypotdar70@gmail.com

Prof. Shekhar Gulawade.
Assistant Professor Dept. of
Mechanical Engineering.
JSPM's Jayawantrao Sawant
College of Engineering Hadap-
sar Pune.
shekhar.gulwade@yahoo.com

Prof. Paramveer Patil.
Assistant Professor Dept. of
Mechanical Engineering.
JSPM's Jayawantrao Sawant
College of Engineering Hadap-
sar Pune.
param.patil12@gmail.com