Design and Fabrication of Horizontal Axis Wind Turbine

Mula Pavan Kumar Reddy¹, Hanumanthe Gowda², Nalina L³, Kariyanna Gari Shashank⁴, Prabhu G V⁵

¹, ³, ⁴, ⁵ UG Students, Department of Mechanical Engineering, R L Jalappa Institute of Technology, Doddaballapur, Karnataka, India

²Associate Professor, Department of Mechanical Engineering, R L Jalappa Institute of Technology, Doddaballapur, Karnataka, India

Corresponding Author: Dr. Hanumanthe Gowda and E-mail Id: hanumanthegowda@rljit.in

ARTICLE INFO

Article History:
Accepted : 01 May 2024
Published: 05 May 2024

Publication Issue
Volume 8, Issue 3
May-June-2024
Page Number
18-21

ABSTRACT

We Know that there exists a significant wind potential worldwide that could potentially fulfill a substantial portion, if not the majority, of humanity’s energy needs if harnessed efficiently and at scale. By enhancing the efficiency of wind turbines, we can generate more power, thereby reducing reliance on costly and polluting conventional power sources. This project aims to design an experimental setup for Horizontal Axis Wind Turbines (HAWTs), which present practical, straightforward, and cost-efficient alternatives to existing systems. One key advantage is their ability to capture wind from all directions.

Keywords: Wind Turbine, Power, Horizontal Axis Wind Turbines

I. INTRODUCTION

The quest for sustainable energy solutions has intensified in recent years, driven by concerns over climate change and the finite nature of fossil fuels. Among renewable energy sources, wind power stands out as a promising avenue for clean electricity generation. Traditional horizontal-axis wind turbines have dominated the landscape of wind energy generation for decades. However, limitations such as space requirements, complex maintenance needs, and inefficiencies in capturing wind energy from varying directions have prompted researchers to explore alternative turbine designs [1-5].

One such design that has gained traction is the spherical blade turbine (SBT). Unlike conventional turbines with flat blades mounted on a horizontal axis, spherical blade turbine features a vertical axis configuration with blades arranged in a spherical pattern around a central mast. This unique design offers several potential advantages over traditional turbines, including multidirectional wind capture, compact footprint, simplified maintenance, and enhanced aerodynamic efficiency [6-10]. The study, design and analysis on wind turbine and evaluates the aerodynamic performance of variable speed fixed pitch horizontal axis wind turbine blade using two- and three-dimensional computational fluid dynamics. Yogesh Patil is focused on the ever-advancing field of wind energy (HAWT)
and Objective is to design, fabricate a wind turbine with the help of Fibonacci spiral [11-15]. The carried Analysis of Archimedes Spiral Wind Turbine, In this study, the performance of an Archimedes spiral wind turbine is analyzed by simulation and validated by a field test [16-20]. The main objective of this Project work is to harvest and recapture the maximum amount of wind energy from atmosphere. Our aim is to design the turbine which will capture the maximum of wind in any direction by placing it at optimum place and height by considering both the cost and safety of the system. This paper presents a comparative study of the Horizontal Axis Wind Turbines (HAWTS) and Vertical Axis Wind Turbines (VAWTS) which are used for generating electrical power from the wind. The studied the design component aspects of a Magnetically levitated Vertical Axis Wind Turbine and Design and Analysis of Generator [21-24].

**Problem Definition**

Energy is indispensable for diverse daily activities, encompassing lighting, phone charging, transportation like biking and driving, with the prevalent use of non-renewable sources such as petrol, kerosene, and nuclear power raising pollution concerns meanwhile, current wind turbines depend on high-velocity air for operation.

**Scope of the project**

As per the literature survey the efficiency of Horizontal Axis Wind Turbine (HAWT) is less, as we are changing the blade positions to grab the air from the lower level also this can increase the efficiency. But the efficiency not only depends up on blade position but also depends up on availability of air and climatic condition. The main motto and scope of the project is to increase the efficiency and rely on low velocity of air of the horizontal axis wind turbine by changing blades and blade position and to make use for human needs.

**II. METHODOLOGY**

First the air coming from the atmosphere is going to use for the rotation of blades. Then air striking on the blades play’s a major role in efficiency. These blades are connected to the rod and it is connected to an alternator. These will help in converting mechanical energy to electrical energy. After converting these energy transfers to battery. The electrical energy stored in the battery can be used for domestic purpose.

**Fig 1: Block diagram of working procedure of turbine**

**III. COMPONENTS DETAILS**

HAWT consist of following major components

5.1 Blade & Shaft

Spherical blades depart from the conventional flat or airfoil-shaped blades commonly used in horizontal axis wind turbines (HAWTs). This unique design aims to optimize aerodynamic performance, energy capture, and structural integrity while potentially reducing manufacturing complexity and cost.

**Fig 2: Shaft of HAWT**

The shaft of a wind turbine plays a crucial role in transferring the rotational energy generated by the turbine blades to the generator, where it is converted into electrical energy.

5.2 HAWT Base with Vertical Support

The base of a wind turbine, often referred to as the foundation or tower base, is a fundamental structural component that supports the entire turbine assembly and anchors it to the ground.

**Fig 3: HAWT Base with Vertical Support**
5.3 Supporter

Fig 4: Supporter

The support structure of a horizontal axis wind turbine (HAWT) is a critical component that provides stability, elevation, and support for the rotor, nacelle, and blades. The tower of a HAWT serves as the primary support structure, elevating the rotor and nacelle to an optimal height to capture wind energy efficiently.

5.4 Bearings

Fig 5: Bearings

A ball bearing is a type of rolling-element bearing is to reduce rotational friction and support radial and axial loads.

5.6 Electric Components

Fig 6: Multimeter

A DC generator, also known as a dynamo, is a device that converts mechanical energy into direct current (DC) electrical energy. A DC generator operates based on the principle of electromagnetic induction.

Table 1: DC Generator specification

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Voltage</td>
<td>24 VDC</td>
</tr>
<tr>
<td>Operating Current</td>
<td>1.3 AMPS</td>
</tr>
<tr>
<td>Speed</td>
<td>3000 rpm</td>
</tr>
<tr>
<td>Power</td>
<td>25 W</td>
</tr>
</tbody>
</table>
The above fig 9 shows Horizontal axis wind turbine, as we can see the arrangement of blades in a spherical manner. Due to this type of arrangement, we can capture every layer of wind in low altitude with minimum turbulence.

**Fig 9:** Fabricated Model of HAWT

IV. RESULTS AND DISCUSSIONS

4.1 Parameters

The various parameters involved in the performance of wind turbine:

- Swept area
- Power and power co-efficient
- Tip speed ratio
- Blade chord
- No. of blades
- Solidity
- Initial angle of attack

According to Betz's law, the maximum power that is possible to extract from a rotor is $P_{\text{max}} = 0.18 \, \text{kg} \cdot \text{m}^3 \cdot \text{s}^{-1} \cdot \text{h} \cdot \text{d} \cdot \text{v}^3 \cdot \text{mah}$

Example: Let assume, velocity of air $v = 1 \, \text{m/s}$

Height of the shaft $h = 5 \, \text{m}$

Diameter of the blades $d = 0.44 \, \text{m}$

$P_{\text{max}} = 0.18 \, \text{kg} \cdot \text{m}^3 \cdot \text{s}^{-1} \cdot \text{h} \cdot \text{d} \cdot \text{v}^3 \cdot \text{mah}$

$P_{\text{max}} = 0.18 \times 5 \times 0.44 \times 1^3$

$P_{\text{max}} = 0.396 \, \text{mah}$

**Table 2:** Power generated values

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Height of the shaft (m)</th>
<th>Diameter of the blades (m)</th>
<th>Velocity of the air (m/s)</th>
<th>Total Theoretical Power Generated (mah)</th>
<th>Total practical Power Generated (mah)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>0.44</td>
<td>1</td>
<td>0.396</td>
<td>0.250</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>0.44</td>
<td>1.5</td>
<td>2.673</td>
<td>2.5</td>
</tr>
<tr>
<td>3</td>
<td>15</td>
<td>0.44</td>
<td>2</td>
<td>9.504</td>
<td>10.12</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
<td>0.44</td>
<td>2.5</td>
<td>16.866</td>
<td>15.45</td>
</tr>
</tbody>
</table>
Fig 10: Graph between power and velocity of air & height of shaft agl

Above graph shows the curve of theoretical and practical power generated values in mph at different height and different velocity of air. From the graph it is clear that at lower altitude the velocity of air is low which leads to lower power generations. As the altitude increase the velocity of air gradually increases which interns increases the power generation.

V. CONCLUSION

In the world of competition and energy crisis, wind power proves the best opinion to meet the growing need of electrical energy as it is a renewable energy source, pollution free, free of cost. so we developed the Horizontal Axis Wind Turbine which is best because it having maximum efficiency and also have ability to extract 80% power from the available power in wind. New generation Spiral blade wind turbine is compact in shape, having low working speed on smaller heights and much more economical.

VI. REFERENCES

[9]. Anil K C, Kumaraswamy J, Mahadeva Reddy, Mamatha K M, Air Jet Erosion studies on


