

THE ARCHIMEDES WIND TURBINE TREE (ASWT)

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ABSTRACT: Wind power is a sterling clean source, unlike its sister energy supply of fossil fuels. It is a renewable and sustainable energy source as wind will recurrently be produced as long as the sun shines. It has increasingly become an attractive alternative to fossil fuels. Wind turbines refrain from polluting the air and do not produce atmospheric emissions that can lead to dangerous acid rain and global warming. This composition is about reviewing, scrutinising and designing a Horizontal Axis Archimedes Spiral Wind Turbine (HAWT) which metamorphoses the wind's kinetic energy into electrical energy through rotational motion. These are designed to produce about 1500 watts of energy per hour, accounting for roughly half of what a regular household consumes. When procreated into multiple units and engineered onto an aluminum mount of a tree, these turbines result in colossal electricity production, which can be installed in public areas like parks, roads, theme parks and residential areas. High efficiency, low cost, easy installation, eco-friendly and recyclable are some advantages of the HAWT Archimedes Spiral Model. By harnessing the power of the wind, this project will help to create a more sustainable future.

KEYWORDS: *Horizontal Axis Wind Turbine, Lift Force, Drag Force, Aero Foil, Vertical Axis Wind Turbine.*

INTRODUCTION

Wind energy is an abundant resource in comparison with other renewable resources. Moreover, unlike solar energy, the utilization could not be affected by the climate and weather. It is a source of renewable power that comes from air currents flowing across the earth's surface. Wind turbines act as a converter that extracts kinetic energy from wind and converts it into usable power which can provide electricity for the home, farm, school or business applications on small, medium, or large scales. A wind turbine

consists of several parts, like the rotor, generator, control system, etc. The wind propels the rotor and revolves at a velocity commensurate with the wind speed, enabling the generator to generate electrical energy output. The power output of wind turbines relies heavily on the interplay between the blade design⁹ and the speed of the wind. To harness the maximum kinetic energy from wind, skilled researchers devote considerable resources to developing highly efficient blade geometries. The orientation of the shaft and rotational axis determines the first classification of the wind turbine. In the early stage, the aerofoil shapes of

aero plane wings were used for wind turbine blade design⁹. The selection of aero foil shape is the most crucial of the wind turbine design⁹ as the ultimate responsibility for the maximum conversion of kinetic energy into rotational energy. In India, average wind speeds are 3 ms⁻¹ at 20m height; therefore Archimedes wind turbine is perfect for low, medium and turbulent wind speeds. The Archimedes wind turbine is a revolutionary piece of engineering that boasts a novel design⁹ featuring three circular blades. This state-of-the-art turbine is expected to surpass traditional wind turbines in terms of efficiency⁶ and performance, making it a game-changer in the field of renewable energy. These are wrapped around one another, as coils and then expanded, creating a three-dimensional conical turbine. Unlike old-fashioned HAWTs, which use the lift force to take power from wind energy, the Archimedes spiral wind turbine uses both the lift and drag force. This special construction guarantees that wind is drawn into the turbine with an effective angle of 60 degrees and the wind is being turned 90 degrees by the coils.

It is also proved that this one wind turbine can produce up to 1500 watts of energy per hour and then imagine it being multiplied and designed to be placed on a tree made out of aluminum and used in our urban cities to produce electricity⁹. Just think of the amount of energy produced from it. This design⁹ is a similar replication of the famous aero-leaf VAWT Tree but replaces this VAWT aero-leaves with the Archimedes Spiral Wind Turbines for better electricity production and efficiency⁶. In

this paper, we would like to show why the Archimedes spiral wind turbines are replaced in the place of the vertical axis aero leaf in the tree structure.

HORIZONTAL AXIS WIND TURBINES (HAWTS)

Horizontal axis wind turbines (HAWTs) are the most widely used type of wind turbine in the world. They consist of a tower, blades, and a nacelle that houses the rotor and the electrical generator. HAWTs can be distinguished by the orientation of the rotor shaft in the direction of the wind. This configuration allows the turbine to capture wind energy from any direction. HAWTs come in various configurations, including single-bladed, double-bladed, or three-bladed design⁹s, and their blades are meticulously crafted to optimize aerodynamic lift, which drives them to rotate. The blades of a HAWT are aerodynamically design⁹ed and can be made of wood, fibreglass, or carbon composites, for example. The shape of the blades is curved to maximize the amount of lift generated by the pressure differential between the upward and downward faces of the blades. The air velocity on the front side of the blade is greater, resulting in low pressure, whereas on the rear side, the air velocity is low, creating high pressure. The air from the high-pressure region propels the blades upward, imparting an aerodynamic lift. This phenomenon is known as Bernoulli's principle, which states that where pressure is high, speed is low for a fluid. The blades of the turbine are

connected to the rotor of the electrical generator, which is housed in the nacelle atop the tower. The rotor is composed of a shaft, hub, and electromagnets. When the blades rotate, they turn the rotor, and the electromagnets create a magnetic field that generates electricity. HAWTs are capable of capturing robust winds and are exceptionally efficient. They can capture wind energy from heights of up to several hundred feet, where the wind is typically stronger and more consistent. The efficiency⁶ of a HAWT is influenced by several factors, including blade length, blade design⁹, and wind speed. Longer blades generate more power, but slower winds are required to rotate them. Conversely, shorter blades generate less power but can be rotated by faster winds. The optimal design⁹ for a HAWT depends on the wind resource at a particular location.

VERTICAL-AXIS WIND TURBINE (VAWT)

A vertical-axis wind turbine⁴ (VAWT) is a type of wind turbine that uses a vertically oriented rotor shaft, which means the turbine's main components are located at the base of the structure. This design⁹ allows for easier access and maintenance of the generator and gearbox, as they are closer to the ground. Unlike horizontal-axis wind turbines (HAWT), VAWTs don't need to be pointed directly into the wind. This eliminates the need for wind-sensing and orientation mechanisms, which simplifies the design⁹ and reduces costs. Early VAWT design⁹s had some drawbacks, such as significant torque ripple during each revolution

and large bending moments on the blades. Later design⁹s addressed these issues by incorporating helically swept blades. This design⁹ allows for a smoother and more consistent rotation, which increases the turbine's efficiency⁶ and lifespan. Although VAWTs are less common than HAWTs, they have some unique advantages, particularly in disturbed flow fields. These turbines are an excellent choice for distributed generation devices in urban environments that face complex wind patterns. A

VAWT's axis is perpendicular to the wind flow and vertically aligned with the ground, making it a good option for areas with varying wind directions. Overall, VAWTs are a reliable and efficient alternative to HAWTs, especially in urban areas with complex wind patterns. They are a promising solution for generating clean energy, and with continuous development, they have the potential to play a significant role in the renewable energy sector.

ADVANTAGES OF HAWT OVER VAWT

Horizontal Axis Wind Turbines (HAWTs) are an excellent choice for generating electricity from wind power due to their outstanding efficiency⁶ in converting wind energy into electrical power.

HAWTs can produce a greater amount of electricity from the same amount of wind as compared to other wind turbines, making them more energy-efficient. One of the key benefits of HAWTs is that they are design⁹ed for easy

maintenance. The components of HAWTs are readily accessible, allowing for quick and efficient repairs or replacements. This results in less downtime and increased productivity.

Another advantage of HAWTs is their ability to accommodate larger blades than other wind turbines. This design⁹ allows them to capture more wind energy and convert it into electricity. The larger blade size also enables HAWTs to generate more electricity, making them a popular choice for wind power projects.

In summary, HAWTs are a superior option for wind power generation due to their exceptional efficiency⁶, easy maintenance, and ability to capture more wind energy and convert it into electricity.

DISADVANTAGES OF HAWT

1. The Horizontal-axis wind turbines (HAWTs) are known to generate a significant amount of noise, which can be a major concern for people living near wind farms. The sound is produced by the friction of the blades cutting through the air, and it can be heard for miles around. The noise level can be so high that it can cause sleep disturbance and even hearing loss if a person is exposed to it for long periods.

2. HAWTs are large structures that can be as tall as a 30-story building and have blades that span up to 100 meters long. They require a significant amount of space to operate, making them challenging to install in densely populated areas where land is

scarce. In addition, the turbines need to be spaced far apart from each other to avoid turbulence and interference between the blades. This means that wind farms need to cover a large area to be effective.

3. HAWTs can pose a significant risk to birds and bats. The rotating blades can move at speeds of up to 320 km/h, making them almost invisible to the naked eye. This can result in birds and bats colliding with the blades, leading to injury or death. The number of birds and bats killed by wind turbines is a matter of concern for environmentalists and conservationists alike.

THE ARCHIMEDES SPIRAL WIND TURBINE (ASWT)

When we typically think of wind power, we imagine the towering, three-blade propeller turbines that we see in wind farms. However, there is a new player in the field that is changing the way we think about wind energy. The Archimedes Urban Wind Turbine is a revolutionary device that can bring the same benefits to your home and city as those towering structures have brought to the electric grid. This innovative turbine can convert up to 80% of extractable energy from the wind into electricity, on par with the top-performing wind systems in the world. What sets the Archimedes Urban Wind Turbine apart from conventional windmills is its unique design⁹. This turbine can capture wind from different directions at different times, thanks to its inherent ability to catch the wind head-on, regardless of the wind direction.

This is achieved through an automatic adjustment system that positions the turbine in the optimal wind position, much like a weather vane. Not only is this turbine highly efficient, but it's also compact and can easily be installed on urban rooftops. This makes it the perfect solution for those who want to generate their own energy and reduce their reliance on the grid. In addition to being efficient and compact, the Archimedes Urban Wind Turbine is also environmentally friendly. By reducing our carbon footprint, this turbine helps combat climate change and contributes to a cleaner, healthier planet. In short, the Archimedes Urban Wind Turbine is a game-changer in the world of wind energy. Its unique design⁹, high efficiency⁶, and eco-friendliness make it an ideal solution for anyone looking for a sustainable energy source. It's efficient, innovative, and environmentally friendly, and it has the potential to revolutionize the way we generate and use energy.

Marinus Mieremet, a Dutch scientist, has dedicated 20 years of his life to developing a revolutionary wind turbine that utilizes the principle of the Archimedes screw. This innovative technology generates power in a more efficient way than traditional wind turbines. The turbine's design⁹ is inspired by the ancient Greek Archimedes screw pump, which was used to pump water. The structure features a helix-patterned pipe with a blade that spreads out from the front to the back, forming a cone-like spiral. The unique spiral shape allows the turbine to pivot and catch gusts of wind entering at an angle as wide as 60 degrees

from the axis. The helix-patterned pipe is design⁹ed specifically to enhance the turbine's efficiency⁶ in harnessing wind energy. As the wind flows through the helix, it

causes the blade to rotate, driving a generator to produce electricity. One of the most remarkable features of this turbine is its ability to work efficiently even at low wind speeds, from 0.9 meters/second to as high as 14 meters/second. This is due to the blade's ability to capture wind from multiple directions and convert it into energy. Its performance is exceptional, making it a more effective and reliable source of energy than traditional wind turbines.

The Archimedes spiral wind turbine differs from conventional Horizontal Axis Wind Turbines (HAWTs) as it harnesses both lift and drag forces to extract power from wind energy. As a result, the Archimedes spiral wind turbine can utilize the kinetic energy of the wind in a more efficient manner than traditional HAWTs.

ADVANTAGES OF ASWT

1. The wind direction can be highly variable in an urban setting, which makes it challenging for traditional wind turbines to function effectively. However, the Archimedes wind turbine is specifically design⁹ed to address this issue. It is equipped with an automatic wind direction tracking system that enables it to work efficiently even at low and turbulent wind speeds. This

innovative technology makes it a reliable and effective solution for urban environments.

2. The Archimedes wind turbine is not only efficient but also cost-effective and simple to maintain. Its lightweight design⁹ ensures that it can be easily installed and transported. This feature makes it an ideal solution for individuals or organizations who are looking for a sustainable energy source. 3. One of the essential aspects of the Archimedes wind turbine is its bat or bird-friendly design⁹. It is a crucial feature that ensures the safety of local wildlife in an urban area. The turbine's design⁹ is such that it does not pose any danger to bats or birds that fly near it. This feature makes it an eco-friendly choice for environmentally-conscious individuals and organizations.

4. This wind turbine is design⁹ed to extract up to 80% of the energy in the wind, making it an efficient and effective energy source. Its advanced technology ensures that it can harness energy from even low wind speeds, making it a viable option for urban areas.

5. The Archimedes wind turbine is not only efficient and eco-friendly but also virtually silent in an urban environment. With a sound level of only 30-40dB, it is quieter than the average conversation, making it an excellent solution for urban areas where noise pollution is a concern.

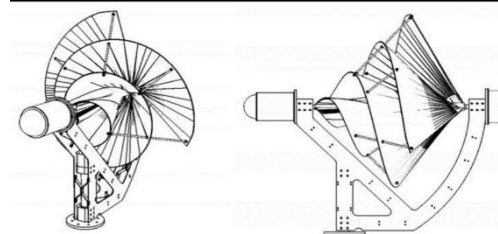
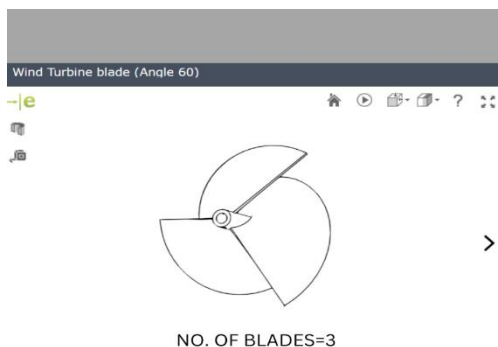
DESIGN OF ASWT

The Archimedes spiral wind turbine is a truly extraordinary example of engineering innovation. It operates with exceptional efficiency⁶, even in low and turbulent wind conditions, thanks to its unique and ground breaking design⁹. Its structure comprises two to three circular blades forming an axis, which are then wrapped around each other to create a spiral effect like a golden spiral. The spiral is one of the most fascinating and intricate shapes found in nature. Its complexity can be better understood through the principles of fractals, which are repetitive patterns that give rise to logarithmic spirals. The golden ratio, a fascinating mathematical concept, is an irrational number 1.61803 that is often observed in nature. This ratio of numbers is found in various forms ranging from the arrangement of leaves on a stem to the pattern of scales on a fish. One of the most striking examples of the golden ratio in nature is the unique spiral pattern observed in sunflowers. This spiral, which is formed at non-repeating angles, allows for maximum absorption of photons. The discovery of the golden ratio can be traced back to Euclid, the Greek geometer who first described this phenomenon.

The turbine's distinctive appearance is achieved by extending one side of the blades in a way that mimics the shell of the Nautilus snail, using a technique

known as biomimicry. This approach has created a visually striking and instantly recognizable wind turbine. The design⁹ of the structure is inspired by

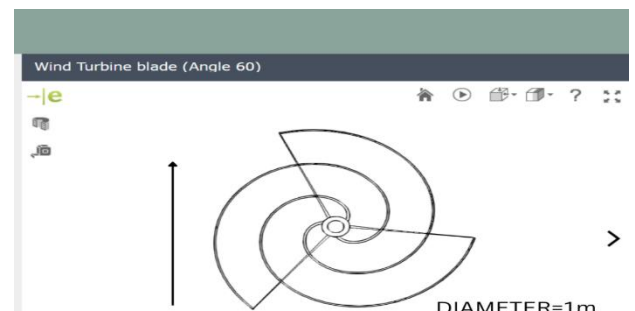
the ancient Archimedes screw pump, which was used in Greece to pump water. The turbine's underlying principle is based on the legal principle of Archimedes, which makes it a testament to the enduring relevance of ancient principles in modern engineering.



Schematic representation of turbines

The turbine boasts an impressive axial length of 1.5 metres, with a radius of 0.5 metres, making it a compact yet powerful machine. It features three spiral blades, each with a thickness of 0.005 metres and a breadth of 1.2 metres, which are design⁹ed to capture the maximum amount of wind energy. The most striking aspect of this turbine is its innovative design⁹, which closely resembles the elongated shells that can be found along seashores.

The three-dimensional conical shape of the turbine is specifically engineered to channel wind into the blades, resulting in a significantly higher yield compared to a typical urban windmill propeller. This advanced turbine design⁹ represents a breakthrough in wind energy technology, providing a more efficient and effective way to generate clean energy.



Composite materials are a type of engineered materials that are produced by combining two or more constituent materials, each with different properties. Fibreglass and carbon fibre are two such composite materials⁷ that are widely used in the wind energy industry⁸. These materials are known for their exceptional mechanical properties, including high strength, stiffness, and lightweight. They are also highly flexible in terms of design⁹, which makes them ideal for constructing wind turbines of various sizes and shapes. Fibreglass is made by combining glass fibres with a polymer matrix, while carbon fibre is made by combining carbon fibres with a polymer matrix. Both materials are highly resistant to corrosion, fatigue, and extreme temperatures. In addition, they are

environmentally friendly as they are recyclable, which makes them a sustainable option for the wind energy industry⁸. Overall, composite materials⁷ play a critical role in the production of wind turbines, enabling the construction of efficient and durable wind energy systems that can generate clean and renewable energy for years to come. Thus, these are the materials used in the making of this turbine.

DESIGN OF ASWT TREE

An Archimedes Spiral Wind Turbine tree is a structure where multiple turbines are placed in the form of leaves at the end of the metal frame to form a tree which helps us to produce more efficient energy. This exponentially increases the production of the electricity generated by one turbine. The efficient energy produced by one turbine is 700 watts after the other energy losses which produces 57% more energy compared to one aero leaf which produces 300 watts.

ABSTRACT DESIGN OF THE ARCHIMEDES SPIRAL WIND TURBINE TREE:

The black tree trunk in the picture represents the aluminium structure and the red spirals represent the spiral wind turbines. The majestic tree is not only a thing of beauty but also a marvel of engineering. Its frame, which supports the entire structure, is made of a recyclable and high-strength aluminium alloy. This composition provides the tree with a sturdy and durable structure that is also

lightweight and easy to machine. Moreover, the aluminium frame is non-toxic and reflective, adding to the tree's eco-friendly and aesthetically pleasing qualities.

Not only does the tree serve as a beautiful sight, but it also supports a wind turbine, which harnesses the power of the wind to generate electricity. The frame holding up the turbine is also made up of the same composition as the tree's frame, providing the turbine with a sturdy and stable foundation that can withstand the forces of nature. The combination of the tree's frame and the wind turbine provides a sustainable and eco-friendly solution for generating clean energy.

Imagine walking down a bustling city street, and amid all the concrete and steel, you come across a towering metal tree. But wait, this is no ordinary tree. Its branches are adorned with micro wind turbines that resemble leaves that are in the form of spirals, swaying gently in the breeze according to its direction. As you approach this unique structure, you notice that the colour of the trunk and leaves can be customized to suit any setting. But the metal tree's appeal extends far beyond its striking appearance. Standing at a height of between five and ten meters, these compact turbines are easy to install, even in the most urban of environments, without the need for extensive engineering work. A single bracket and three bolts are all that are required to complete construction once the turbine is in place. In addition to their ease of installation, the compact size of these turbines

eliminates some of the problems usually associated with giant wind turbines, such as bird collisions. Furthermore, they operate silently in the urban environment, making them an ideal alternative to traditional wind turbines. Rather than being connected to the national grid, these turbines provide energy directly to a building's existing electrical system. So, the next time you see a metal tree with turbines sprouting from its branches, you can appreciate the innovative technology that's helping to create a more sustainable future.

Composition and Specifications

The specifications for the experiment to take place are given in table 1.

Theoretical proof

Power generated = Voltage * Current

$$P=V*I$$

$$RPM= (wind\ speed*60)/ (\pi*diameter)$$

Total installed capacity:

Here for one aero leaf, the power generated is $P=48*0.3A= 14.4W$

Thus if one turbine gives 14.4W then 6 turbines give $14.4*6=86.4W$.

At a wind speed of 5m/s, the rpm is $(5*60) / (3.14*.70) = 136rpm$

The Power generated by one Archimedes Spiral Turbine is $P= 48*0.7A= 33.6W$

Thus if one turbine produces 33.6W then 6 turbines give $33.6*6=201.6W$.

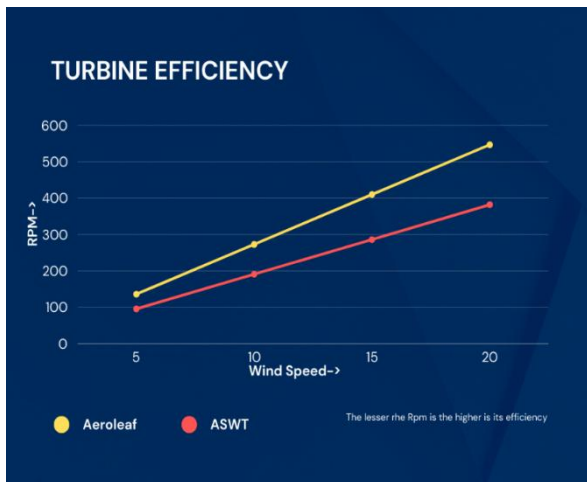
At a wind speed of 5m/s, the rpm is $(5*60)/ (3.14*1) = 95.5rpm$

RESULTS AND DISCUSSION

From the above, here are a few rpm calculated with the gradual increase in the wind speed (table 2). The lower the rpm the more efficient the power generation in the turbine occurs. Higher rpm causes damage to the equipment and too much energy loss in other ways.

The table presented above provides a comprehensive comparison between the ASWT wind turbine and the aero leaf, in terms of efficiency⁶ and cost. The data presented in the table highlights that the ASWT wind turbine is the more efficient option, with a lower energy loss through other mechanisms compared to the aero leaf. This is significant because energy loss leads to lower energy output, which can impact the overall effectiveness of the wind turbine. The ASWT's improved efficiency⁶ not only leads to higher energy output but also reduces the environmental impact of energy production.

Furthermore, the ASWT's cost efficiency⁶ is an important consideration when choosing between wind turbine options, especially for organizations and individuals looking to maximize their return on investment. The ASWT is more cost-effective, with a price of 450000 rupees per unit, compared to 1200000 rupees per unit for the aero leaf. This reduced cost makes it a more attractive option for individuals and organizations looking to invest in renewable energy solutions.



CONCLUSIONS

We conducted a thorough examination of the Horizontal Axis Wind Turbine (HAWT) pivot systems and arrived at numerous meaningful insights and recommendations that can aid in the advancement of this technology. Our analysis revealed a notable decline in the revolutions per minute (RPM) yield of the current HAWT model compared to the previous Vertical Axis Wind Turbine (VAWT) aero-leaf model which means that the electrical energy production is more efficient in our model. Our model was 70% more efficient.

Using our meticulous tabulations and calculations, we have identified several crucial design elements that could be improved to enhance the efficiency and performance of the system. These

In summary, the ASWT wind turbine is the more efficient and cost-effective option compared to the aero leaf. By choosing the ASWT wind turbine, individuals and organizations can benefit from increased energy output, reduced environmental impact, and cost savings.

recommendations can have a significant impact on the future development of individual HAWT pivot wind turbines, ushering in an era of improved sustainability and energy production.

In this paper, we delved into the fascinating world of wind turbines and present a comprehensive comparison between two popular types - horizontal axis wind turbines (HAWTs) and vertical axis wind turbines (VAWTs). Wind turbines are a critical component of sustainable development, and this composition aims to underscore the significance of

HAWT frameworks. By advocating for more research and testing on HAWTs, we aim to enhance their efficiency and performance, making them more dependable sources of renewable energy. Sharing the knowledge gained from these tests with different groups can foster more fruitful discussions and further advancements in this field.

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Tables

Things Required (ASWT Turbine)	Specifications	Things Required (Aero leaf Turbine)	Specifications
1. DC Motor	1750rpm,90V	1. DC Motor	1750rpm,90V
2. Battery	4 nos., 12*4=48V	2. Battery	4 nos., 12*4=48V
3. Load Current	0.7A	3. Load Current	0.3A(from the referred paper)

Table 1. The specifications for the experiment

Wind Speed(m/s)	Rpm (ASWT)	Rpm (Aero leaf)
5m/s	95.5	136
10m/s	191	274
15m/s	287	411
20m/s	382	548

Table 2. Calculated rpm with the gradual increase in the wind speed