

Generation of Electric Power Using Spiral Wind Turbine

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ABSTRACT

The increasing demand for clean and decentralized energy has created a need for compact renewable-energy systems capable of operating under relatively low and variable wind conditions. Conventional horizontal-axis wind turbines generally require considerable installation space, supporting structures, and suitable wind speeds, which can limit their application in urban and space-constrained locations. This paper presents the design and development of a spiral wind turbine based on the Archimedean spiral concept. The proposed turbine utilizes a spiral blade arrangement to capture wind energy from different directions and converts the resulting mechanical rotation into electrical energy using a DC generator. The generated electrical power is regulated through a charge controller and stored in a 12 V battery. The prototype consists of spiral PVC blades, an iron supporting frame, shaft, ball bearings, DC generator, battery, charge controller, and connecting wires. The theoretical power output was evaluated using the wind-power relationship proportional to the cube of wind velocity. Experimental testing showed generator outputs of 20 V and 21 V, while the battery voltage increased from approximately 11.3 V and 11.10 V to 12 V in charging durations of 32 and 37 min, respectively. The proposed system demonstrates the feasibility of a compact spiral wind turbine for small-scale and off-grid renewable-energy applications.

Keywords— Archimedean spiral wind turbine, renewable energy, wind energy, DC generator, battery charging, low-speed wind, small-scale power generation.

INTRODUCTION

Wind energy is one of the most abundant renewable energy resources and provides an environmentally friendly alternative to conventional energy sources. Wind turbines convert the kinetic energy of moving air into mechanical energy through rotor rotation and subsequently into electrical energy using a generator. Based on the orientation of the rotor shaft, wind turbines are broadly classified into Horizontal Axis Wind Turbines (HAWTs) and Vertical Axis Wind Turbines (VAWTs). The performance of a wind turbine mainly depends on wind velocity, rotor dimensions, and blade geometry. Therefore, considerable research has been focused on developing turbine configurations capable of extracting energy effectively under different wind conditions.

Conventional wind turbines generally require large installation areas and supporting structures, which can restrict their application in urban and space-constrained locations. They may also produce significant noise during operation and require suitable wind conditions for effective power generation. Spiral wind turbines have emerged as a promising alternative because of their compact structure and ability to utilize wind from different directions. The Archimedean Spiral-Type Wind Turbine uses a spiral blade arrangement and combines lift and drag forces to extract energy from the wind. The spiral geometry redirects the airflow and enables the turbine to operate under relatively low wind-speed conditions, making it suitable for small-scale renewable-energy applications.

In this work, a compact spiral wind turbine is designed and fabricated for small-scale electrical power generation and battery charging. The proposed system consists of three spiral blades, a supporting frame, shaft, bearings, DC generator, charge controller, and a 12 V battery. The generated mechanical energy from the rotating spiral blades is converted into electrical energy through the DC generator and stored in the battery. The prototype is experimentally evaluated by measuring generator voltage and battery charging performance under available wind conditions. The developed system demonstrates the potential of spiral wind turbines for rooftop, residential, remote, and other off-grid applications where compact and low-maintenance renewable-energy systems are required.

LITERATURE SURVEY

Arman Safdari and Kyung Chun Kim [1] investigated the aerodynamic and structural performance of an Archimedes spiral wind turbine and reported a maximum efficiency of approximately 12% for the studied model. Their work examined the influence of blade angle on turbine performance and highlighted the contribution of drag force in the Archimedes configuration compared with conventional HAWTs. Dr. S. Srinivasa Rao and Kota Shan Mukesh [2] studied aerofoil-based wind-turbine blade designs and discussed the suitability of Archimedes wind turbines for low- and medium-wind-speed conditions. Their work described a three-blade configuration in which the blades form a three-dimensional spiral structure and utilize both lift and drag forces for energy extraction.

Ankit Kulshrestha [3] experimentally studied the aerodynamic characteristics of an Archimedes spiral wind turbine using Particle Image Velocimetry (PIV), focusing on tip-vortex formation, angle of attack, wind speed, power coefficient, and aerodynamic power. The study showed the importance of aerodynamic behavior and operating conditions in determining turbine performance. Naveen Krishna [4] conducted design and CFD analysis of an Archimedean spiral wind-turbine blade using SOLIDWORKS, investigating the effects of pitch, opening angle, and wind speed on turbine performance. The study also analyzed pressure and velocity distributions to evaluate blade loading and structural performance. These studies indicate that blade geometry, aerodynamic characteristics, and operating wind speed are important factors influencing the performance of spiral wind turbines. Based on these findings, the present work focuses on the fabrication and experimental evaluation of a compact spiral wind turbine for electrical power generation and battery charging.

PROBLEM STATEMENT

Traditional wind turbines require large installation areas and supporting structures, generate operational noise, and generally require suitable wind speeds for effective operation. These limitations restrict their use in urban areas and other locations where land availability and wind conditions are limited.

OBJECTIVES

The main objectives of the proposed work are:

1. To design and fabricate a compact Archimedean spiral wind turbine for small-scale electrical power generation.
2. To evaluate its capability to generate electrical energy and charge a 12 V battery under available wind conditions.

PROPOSED SYSTEM

The proposed system is a compact spiral wind turbine developed for small-scale electrical power generation and battery charging. The system is based on the Archimedean spiral principle, in which the specially shaped blades capture wind energy and convert it into rotational mechanical energy. The spiral rotor consists of three blades arranged at 120° to each other. The blade configuration allows the turbine to utilize both lift and drag forces and capture wind from different directions. The rotating shaft transfers the mechanical energy from the rotor to a DC generator, where it is converted into electrical energy.

The proposed system consists of spiral blades, a supporting frame, rotating shaft, ball bearings, DC generator, charge controller, connecting wires, and a 12 V battery. The spiral blades are fabricated using suitable lightweight material and mounted on a central hub. A rigid supporting frame maintains the alignment and stability of the turbine, while bearings reduce friction during rotation. The DC generator is coupled to the turbine shaft to produce electrical output. The generated electrical energy is supplied through the charge-control arrangement to the 12 V battery for storage. The developed prototype is tested by monitoring generator voltage and battery voltage before and after charging. The

design and implementation procedure includes blade fabrication, frame construction, generator installation, electrical wiring, testing, and performance monitoring.

The proposed system is intended to provide a compact and relatively simple renewable-energy solution for locations where conventional wind turbines are difficult to install. Its compact structure, multi-directional wind capture capability, and potential for operation under low-wind conditions make it suitable for rooftop installations, residential applications, remote areas, and off-grid systems.

BLOCK DIAGRAM

The **Fig. 1** shows the block diagram of the wind energy conversion system, where wind energy drives the aero turbine coupled to a generator through a shaft. The generated electrical energy is regulated by a charge controller, stored in the battery, and supplied to the load through an inverter.

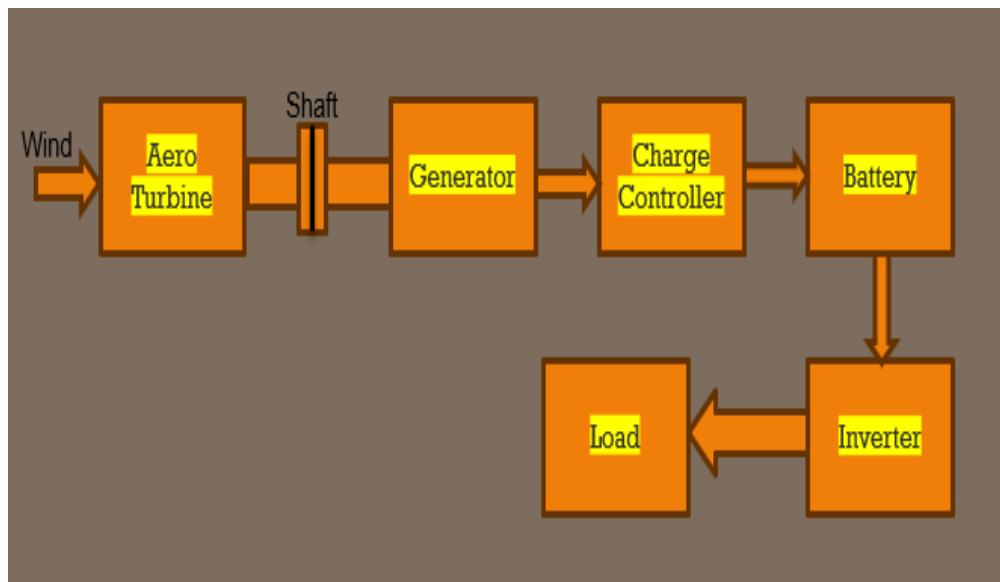


Fig 1 Block diagram

CIRCUIT DIAGRAM

The **Fig. 2** shows the circuit diagram of the wind power generation system, consisting of a generator-side battery charging circuit and an inverter section. The generated power is regulated to charge the 12 V battery, while the inverter converts the stored DC power into AC output for supplying the load.

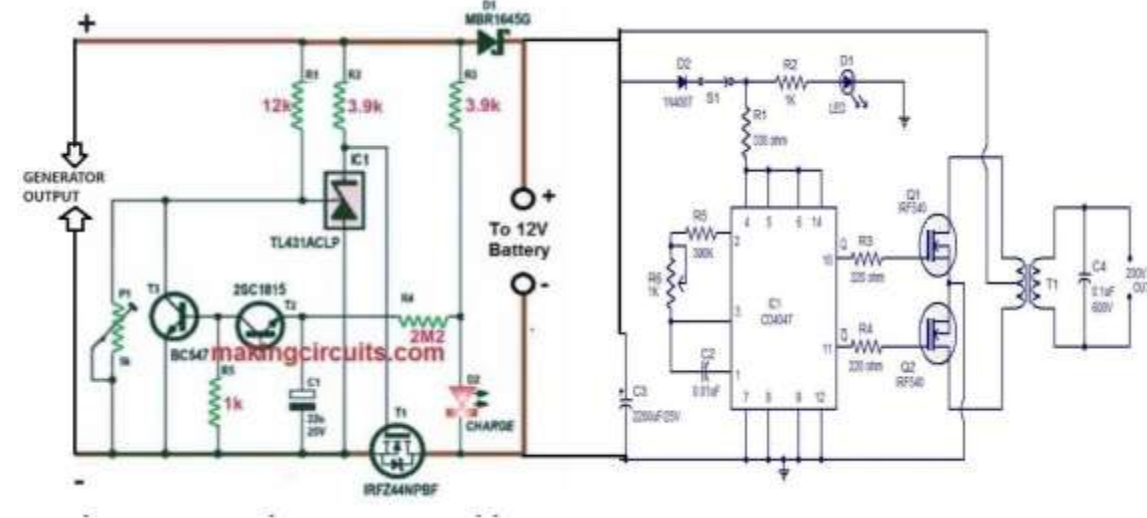


Fig 2 Circuit Diagram

RESULTS AND DISCUSSION

As shown in **Fig. 3**, the spiral wind turbine employs a helical blade structure that rotates around a central axis to capture wind energy from different directions. The spiral configuration provides a larger surface area for interacting with the wind and supports operation under varying wind conditions. The rotational motion of the turbine converts wind energy into mechanical energy, which is transferred to the generator and converted into electrical energy through electromagnetic induction. Due to its compact structure and ability to respond to multidirectional wind flow, the spiral wind turbine is suitable for urban environments and locations with limited space or frequently changing wind directions.

However, the aerodynamic efficiency of a spiral turbine may be lower than that of conventional turbines because of increased drag and differences in blade geometry. Structural integrity is also an important challenge, particularly under high wind speeds, as the turbine must withstand mechanical and aerodynamic forces. The overall energy conversion efficiency depends on factors such as the number of spiral coils, blade angle, materials, and rotor configuration. Therefore, further research and experimental prototypes are required to optimize the design and evaluate its performance compared with traditional horizontal-axis and vertical-axis wind turbines.

Table 1experimental results

Testno.	Output from the Generator	Batteryvoltage before charging	Batteryvoltage after charging	Time taken
1	20V	11.3V	12V	32 min
2	21V	11.10V	12V	37 min



Fig 3 experimental setup of Spiral Wind Turbine

Conclusion

Spiral wind turbines are a promising approach to wind energy generation due to their compact design, multi-directional wind capture, reduced noise, and potentially lower maintenance requirements. These features make them particularly suitable for urban environments, residential rooftops, off-grid applications, small wind farms, and industrial installations. Although their efficiency and performance still require further optimization, advances in aerodynamics, materials, and hybrid energy systems can improve their overall effectiveness.

With continued research and development, spiral wind turbines could become an important alternative for decentralized renewable energy generation. Their adaptability to different environments and potential integration with other renewable energy sources can contribute to sustainable energy development and reduced dependence on conventional energy resources. As the demand for clean energy continues to grow, spiral wind turbines have significant potential to support the global transition toward reliable and environmentally sustainable power generation.

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