IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 2, June 2023

Electricity Generation using Turbo-Ventilator

Prof. P. D. Kabudke[1], Mr. Jatin R. Sonawane[2], Mr. Rushikesh A. Kate[3], Mr. Pramod B. Urhe[4], Mr. Rushikesh G. Wani[5]
Professor, Department of Mechanical Engineering[1]
Students, Department of Mechanical Engineering[2,3,4,5]
Pravara Rural Engineering College, Loni, India

Abstract: *This study presents three different approaches to harnessing electricity generation from modified roof ventilators. The first approach focuses on enhancing the system's efficiency by incorporating additional fins for increased spinning speed. The second approach utilizes the warm air naturally expelled from crowded spaces, such as auditoriums and workplaces, to generate electrical energy through rooftop ventilators. Lastly, the third approach combines wind energy and roof ventilators, integrating small direct current electric generators to produce electricity for various applications.*
By optimizing design and performance, these systems offer sustainable solutions for low-speed wind areas and provide alternatives to fossil fuel-based electricity generation. The observed performances include voltage and current measurements of the roof ventilator, batteries, and connected loads. The results demonstrate the potential of these innovative systems to generate electricity and contribute to reducing environmental pollution.

Keywords: Turbo-Ventilator

I. INTRODUCTION

The quest for green and sustainable energy sources has gained significant momentum worldwide, driven by the need to mitigate pollution and reduce greenhouse gas emissions. Wind energy has emerged as a promising renewable resource, offering a clean and abundant source of power. Wind turbines, which harness the kinetic energy of the wind to generate electricity, have become a cornerstone of the wind power industry.

This paper focuses on the design and performance of wind turbines, specifically examining two distinct configurations: the horizontal-axis wind turbine (HAWT) and the vertical-axis wind turbine (VAWT). The HAWT, widely known as the Danish wind turbine, has been the prevailing design due to its stability, controllability, and access to stronger winds at greater heights. On the other hand, the VAWT, characterized by its egg beater shape, offers specific structural advantages but is less commonly employed in modern wind turbine installations.

Advantages of the HAWT include its ability to optimize blade angle for maximum wind energy capture, stability provided by the blades' positioning relative to the turbine's center of gravity, and cost-effectiveness due to higher production volume. However, challenges arise when operating near the ground or in turbulent wind conditions, as smoother and more laminar wind flows are required. Additionally, the transportation and installation of tall towers and long blades necessitate specialized procedures.

In parallel to wind turbine advancements, there is growing interest in integrating renewable energy generation into existing infrastructure. One such application is the utilization of roof ventilators as both air circulation systems and sources of electrical energy. By implementing innovative modifications, such as the addition of fins to enhance spinning speed, roof ventilators can serve a dual purpose: providing improved air ventilation and generating electricity. This approach presents an opportunity to harness the natural warmth in crowded spaces and convert it into usable electrical energy, offering benefits such as reduced energy costs and enhanced sustainability.

1.1 Objective:

- To generate electricity from turbo ventilator.

1.2 Applications of Wind Energy in India:

Wind energy has gained significant momentum as a renewable energy source in India, contributing to the country's efforts to reduce greenhouse gas emissions and meet its growing energy demands. The favourable geographical conditions and increasing government support have propelled the deployment of wind turbines across the nation. The applications of wind energy in India encompass various sectors and have significant implications for sustainable development.

Power Generation:

The primary application of wind energy in India is electricity generation. Wind farms, consisting of multiple wind turbines, are established in suitable locations across the country, particularly in coastal regions, hilly terrains, and open plains with high wind speeds. These wind farms contribute to the national power grid, augmenting the overall electricity supply and reducing the dependence on conventional fossil fuel-based power generation. The generated wind energy is clean, renewable, and helps in meeting the increasing electricity demands of industries, residential areas, and commercial establishments.

Industrial Applications:

Wind energy is increasingly utilized in industrial applications in India. Industries with high energy demands, such as manufacturing plants, textile mills, and chemical factories, are integrating wind turbines into their energy infrastructure. These on-site wind turbines supplement the grid power supply, offsetting electricity costs and reducing the carbon footprint of industrial operations. Additionally, industries can benefit from favourable government policies that promote the installation of wind power systems and provide incentives for renewable energy adoption.

Research and Development:

Wind energy in India also fuels research and development initiatives. Universities, research institutions, and industry players are actively engaged in studying and improving wind turbine technology, blade design, wind resource assessment, and grid integration. These research efforts aim to enhance the efficiency, reliability, and cost-effectiveness of wind energy systems. Furthermore, the research and development sector contribute to job creation, knowledge transfer, and technological advancements, supporting India's transition towards a sustainable and self-reliant energy sector.

In conclusion, wind energy in India finds diverse applications ranging from power generation and rural electrification to hybrid power systems, industrial applications, and research and development initiatives. These applications contribute to India's renewable energy goals, reduce greenhouse gas emissions, foster sustainable development, and improve energy access in both urban and rural areas. The utilization of wind energy aligns with the country's commitment to clean and sustainable energy sources, driving the transition towards a greener and more resilient energy future.

Turbo ventilator

A turbo ventilator, also known as a roof ventilator or wind-driven ventilator, is a device used to facilitate ventilation and air circulation in enclosed spaces. It operates by harnessing wind energy to create airflow. The ventilator consists of a rotating head with curved vanes or fins designed to capture the wind's energy and convert it into rotational motion. As the rotor rotates, it creates a pressure difference that draws out hot air and pollutants while drawing in fresh air from the outside. Turbo ventilators require no external power source and are environmentally friendly. They improve thermal comfort, reduce humidity, and prevent the growth of harmful microorganisms. They are cost-effective, easy to install, and require minimal maintenance. In summary, turbo ventilators utilize wind energy to enhance ventilation and create a healthier and more comfortable indoor environment.

Generator:

The DC generator is an electrical machine which converts mechanical energy in to electrical energy by using the principles of magnetic induction. All dc generators have two parts, one part called the “Stator”, as it is stationary, and the other part which moves or rotates called the “Rotor”.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 2, June 2023

Generally, for a dc generator design, the magnetic field is on the stator and the power generating coil winding is on the rotor.

Determine Power Requirements: Identify the desired output power of the generator, including voltage and current ratings, based on the intended application and load requirements.

Magnetic Circuit Design: Design the generator's magnetic circuit, including the stator and rotor, to generate a strong and uniform magnetic field. Select appropriate magnetic materials, determine the number of poles, and optimize the air gap between the stator and rotor for efficient flux linkage.

Armature Winding Design: Design the armature winding, considering factors such as the number of turns, wire gauge, and winding configuration (lap or wave winding). Proper insulation and arrangement of armature coils are crucial for reliable performance.

Commutation System Design: The commutation system ensures the conversion of alternating current induced in the armature winding to direct current output. Design considerations include selecting suitable commutator materials, brush design, and brush-to-commutator contact geometry to minimize sparking and ensure smooth commutation.

Cooling and Ventilation: Incorporate effective cooling mechanisms to dissipate heat generated during operation. Design appropriate cooling channels or fins and ensure proper ventilation to maintain the generator's temperature within acceptable limits.

Efficiency Optimization: Minimize losses in the generator through proper selection of materials and design choices. Reduce copper losses in the windings by using conductors with low resistance and optimizing the winding layout. Minimize core losses through proper selection of magnetic materials and reducing magnetic flux leakage.

Voltage Regulation: Implement voltage regulation mechanisms to maintain a stable output voltage under varying load conditions. This can involve using automatic voltage regulators (AVRs), compensating windings, or other voltage control techniques.

Mechanical Design: Consider the mechanical aspects of the generator, including rotor balancing, shaft design, bearing selection, and overall structural integrity to ensure smooth and reliable operation.

Testing and Optimization: Perform thorough testing and analysis of the prototype generator to evaluate its performance, efficiency, and reliability. Make necessary adjustments and optimizations based on the test results.

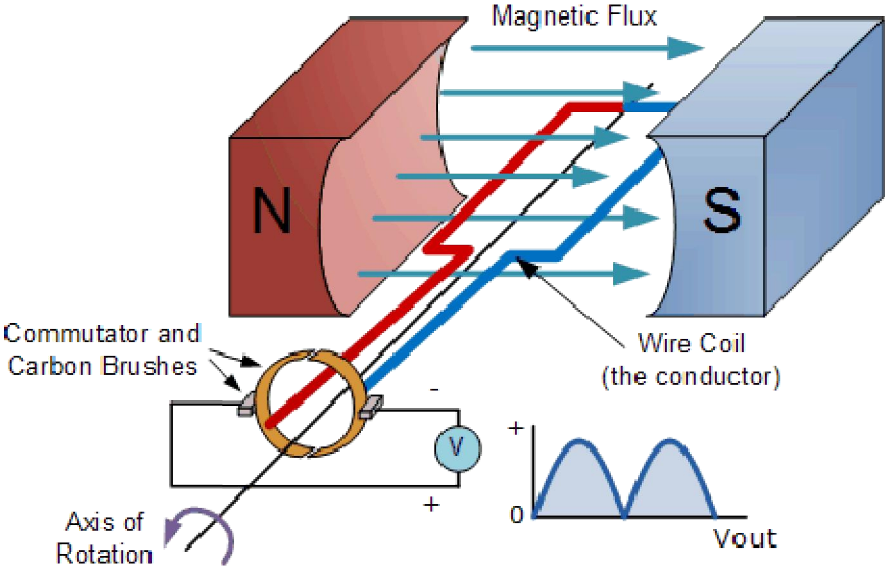

Fig.1: Principle of Generator

Generator Specification:

Technical Data	Units	Values
Nominal Power	**W**	20
Nominal Voltage	**V**	24

Copyright to IJARSCT
www.ijarsct.co.in
DOI: 10.48175/IJARSCT-11302

No load speed	**RPM**	4064
No load Current	**A**	0.11
Nominal speed	**RPM**	3000
Nominal continuous torque(s1)	**Nm**	0.057
Nominal continuous current(s1)	**A**	1.06
Max. Intermittent Torque(s3)	**Nm**	0.09
Stall current	**A**	4.64
Stall torque	**Nm**	0.27
Stack length	**mm**	34
Max. efficiency	**%**	77
Terminal Resistance	**ohm**	5.170
Terminal Inductance	**mH**	-
Speed constant	**RPM/V**	165
Torque constant	**Nm/A**	0.06
Speed torque gradient	**RPM/Nm**	15200
Rotor Inertia	**gcm^2**	110
Ambient Temperature	**^0C**	40
Radial load	**N[mm]**	350[15]
No of Poles		2
Weight	**kg**	0.5
IP Rating		IP54
Enclosure		Enclosed
Insulation Class		F
Reversible		Yes

Table 1 : Generator Specifications

Pulley:

A pulley is a mechanical device consisting of a wheel with a groove and a rope or belt that runs along the groove. It is utilized to change the direction of a force and transmit power between objects. By applying force to one end of the rope or belt, the pulley rotates, causing movement or lifting of a load connected to the other end. Pulleys are designed based on the principle of mechanical advantage, enabling the user to exert less force when moving heavy loads. They can be found in various configurations, including single pulleys, block and tackle systems, and complex setups with multiple ropes and pulleys. We have used Pulley with the Diameter of 172mm.

Fig. 2 : Pulley

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 2, June 2023

II. METHODOLOGY

The research process of applying a roof ventilator for electricity generation involves the following steps:

Designing the air ventilation ball for electricity generation: The concept focuses on modifying a 24-inch diameter ventilated ball to accommodate an 18-watt DC generator. The design aims for simplicity and cost-effectiveness while ensuring that the ventilated holes remain open. The DC generator is connected to the ventilated ball and an external battery charger to supply electric current to a Light Emitting Diode (LED) lamp.

Installation of the DC generator: The DC generator is placed inside the air ventilation ball, positioned close to the axis. A gear system with a 1:4 ratio is employed to allow the movement of the electric generator axis when the wind blows the ventilation balls.

Enhancing the electric voltage generation: Initial results indicate that the air ventilation balls do not generate sufficient electric voltage for the battery charger. To address this, a DC step-up converter is introduced to boost the electric voltage. The DC step-up converter utilizes an Astable Multivibrator Circuit powered by the LM555 Timer Integrated Circuit (IC) to generate a square wave signal. This signal is then biased to a transistor to convert the DC voltage from the generator into the square wave signal. The high voltage square wave signal is generated using a Step-up Transformer and subsequently converted back to DC voltage using a Bridge diode.

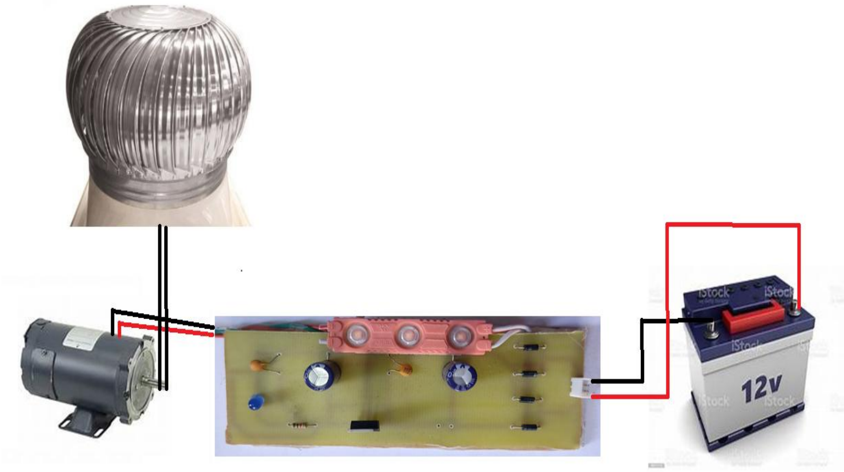

Fig. 2 : Working Diagram

Flow chart:

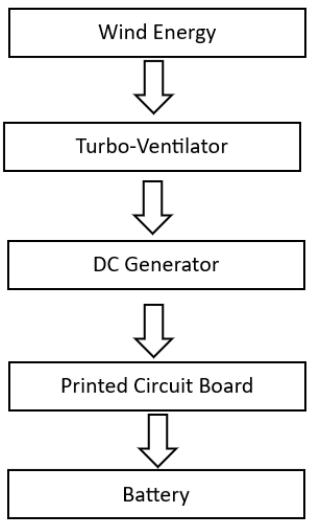

Fig. 3 : Flow Chart

Copyright to IJARSCT
www.ijarsct.co.in
DOI: 10.48175/IJARSCT-11302

IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

Impact Factor: 7.301

Volume 3, Issue 2, June 2023

Electricity generation:

AC generators have the capability to produce DC power through the use of rectification, which can be achieved electronically using diodes that allow current flow in one direction. For instance, the alternator in an automobile is an AC generator that utilizes a set of diodes to rectify its output. Similarly, small residential wind turbines, which employ AC generators, often employ rectification techniques to convert the output into DC power. By utilizing DC power from the wind turbine, it eliminates the necessity of regulating its speed to generate power at 60 Hz and enables the turbine to operate at the most efficient speed for power production. Although we do not possess a generator for demonstration purposes in the classroom due to their large size and cost, we do have several small, affordable electric motors available in the Electric Motors II lab. These electric motors, as they operate in reverse, provide valuable insights into the functioning of generators.

III. FUTURE SCOPE

- Advanced Design Optimization: Conduct research to optimize the design of turbo ventilators for increased electricity generation efficiency.
- Energy Storage Integration: Explore the integration of energy storage technologies for efficient utilization of excess electricity generated by turbo ventilators.
- Grid Integration and Power Management: Develop systems for seamless integration with the existing power grid infrastructure and efficient power distribution.
- Scalability and Cost Reduction: Focus on scaling up the production of turbo ventilators and implementing cost-effective manufacturing processes.
- Environmental Impact Assessment: Conduct comprehensive assessments to evaluate the environmental benefits and potential carbon footprint reduction of turbo ventilators

IV. RESULT

Sr. No.	Speed [RPM]	Voltage (V)
1	150	5
2	175	8
3	200	10
4	250	13
5	300	16

Table 2 : Result Analysis

After conducting an extensive survey and taking measurements, our research findings indicate that a single ventilator can generate an average voltage of 12-13V for high-velocity winds and 8-10V for low-velocity winds. The output can reach a maximum of 17V from a single system. To charge the battery effectively, we have determined that 1 dynamo is required. These turbines can be easily integrated into the ventilator structure, enabling the system to incorporate a heat-sucking mechanism and a voltage output port.

Due to the intermittent nature of battery charging, which depends on the frequency of wind available, it will take a considerable amount of time, approximately 3-5 hours, for the battery to reach full charge.

V. CONCLUSION

Now it can be concluded that rooftop ventilators with integrated DC generators have shown promising results in generating electricity from wind energy. The practical experiments and calculations demonstrated successful electricity generation, with output voltages ranging from 4V to 18V and power outputs of up to 1.26W. The adaptability of air ventilation balls and the addition of extra fins have also proven effective in increasing the speed and efficiency of the ventilators, resulting in higher voltage outputs and the ability to power LED lamps. The power generation roof ventilator system has shown its potential to provide better air ventilation while harnessing wind energy for electricity generation. Further optimization in design, torque, and integration with storage systems can enhance the performance and scalability of these systems. Overall, these studies highlight the viability and practical applicability of rooftop ventilators as a sustainable and efficient source of electricity generation.

REFERENCES

[1] Department of Energy Development and Promotion. (2009). Wind energy potential in Thailand. Alternative Energy Journal, April, 86-114. Division of Renewable Energy, Electricity Generating Authority of Thailand. (2014). Wind power. Retrieved December 14, 2014from http:// www3.egat.co.th/re/egat_wind/pdf_wind/ wind_energy.pdf

[2] Backward-Curved Fan. http://www.remco.co.uk/products/bcf.asp

[3] http://www.ivt.ntnu.no/offshore2/?page_id=391