Electricity generation from industrial AC air exhaust by using venture duct

Shubham Dhumal[1], Rohan Sawant[1], Akash Nawal[1], Shreyas Joshi[1], prof. M.S. Devdhe[2]

[1]*Student, Department of Mechanical Engineering, JSPM's BSIOTR, Maharashtra, India*
[2]*Assistant Professor, Department of Mechanical Engineering, JSPM's BSIOTR, Maharashtra, India*

ABSTRACT

The escalating global energy demand has led to an exponential increase in consumption, putting immense pressure on conventional energy sources such as fossil fuels and nuclear power. This unrelenting reliance on these sources has resulted in a depletion of fossil fuel reserves. Consequently, extensive research has been conducted to explore alternative energy sources, including hydro, wind, and thermal energy. Among these options, wind energy shows great promise; however, its utilization is hindered by challenges such as irregularity, geographical limitations, and availability.

The main objective of this study is to propose an innovative solution that addresses these challenges and maximizes the utilization of wind energy. Our proposal focuses on harnessing the untapped wind energy derived from industrial exhaust fans. By utilizing a small windmill, the wind force generated by the exhaust fan can be converted into usable energy. This energy will be stored in an energy storage unit, such as a battery. Subsequently, an inverter can be employed to convert the stored power into alternating current (AC), which can then be supplied to meet the growing energy demand.

By repurposing the wasted power from exhaust fans, our approach offers a viable solution to enhance the efficient utilization of wind energy. This method not only taps into an existing source of wind energy but also overcomes the limitations associated with irregular wind patterns and geographical constraints. The energy storage system ensures a continuous power supply, even during periods of unfavorable wind conditions. Furthermore, the converted AC power can be seamlessly integrated into existing power grids to meet the energy requirements of various loads.

In conclusion, this paper presents a novel idea for effectively harnessing wind energy by utilizing the untapped wind potential from industrial exhaust fans. By implementing this approach, we can make significant progress in meeting the growing energy demand while reducing reliance on conventional energy sources and promoting sustainable practices.

Keywords: - *Electricity generation, Industrial AC, Air exhaust, Venturi duct, Energy harvesting, Sustainable energy, Renewable energy, Power generation, Industrial waste heat recovery.*

Introduction:

With the exponential growth of the global population, the demand for energy resources has been on a constant rise. This has led to the depletion and increasing scarcity of non-renewable resources, making them more expensive. To meet these escalating demands, efforts have been made to improve existing technologies, and researchers and environmentalists have been exploring new approaches to shift from conventional to non-conventional sources of energy. However, the current scenario in India reveals a heavy dependence on conventional sources, particularly fossil fuels.India's energy generation relies heavily on coal, accounting for 74.5% of the country's electricity production. This over-dependence on fossil fuels has detrimental effects on the environment, as the burning of these fuels results in significant CO_2 emissions. India's CO_2 emissions have been rapidly growing, surpassing those of some developed nations. Recognizing the need to reduce dependency on fossil fuels and mitigate the environmental impact, the government has taken measures to promote the use of renewable energy resources and introduce new technologies for their harnessing.Our project aims to contribute to this initiative by showcasing the utilization of renewable energy sources to generate electricity. However, our specific focus is on implementing this project in industrial regions, where there is a high demand for such solutions. Implementing renewable energy projects in industrial areas presents unique challenges, as the lack of open spaces due to densely packed buildings restricts the high-speed flow of wind—an essential element for traditional wind energy generation. To overcome this challenge, our project proposes utilizing the exhaust air emitted from industrial exhaust outlets to generate electricity.

This project draws inspiration from the government's emphasis on promoting renewable energy utilization. By utilizing the exhaust air generated in industries, we aim to demonstrate a practical and innovative solution for electricity production. We acknowledge that economic growth and energy demand are interconnected, and while developed countries are currently the major consumers of energy globally, the most significant increase in demand will occur in developing countries experiencing rapid population growth, economic activities, and improvements in quality of life. The global energy consumption in both developed and developing nations is projected to double or more by 2040.Currently, the world heavily relies on coal, crude oil, and natural gas for energy generation. However, these sources pose challenges such as climate change and the depletion of oil reserves, leading to price inflation. These issues have become critical problems worldwide, urging countries to seek alternative energy solutions.By removing the plagiarized content and focusing on the unique aspects of the project, we can present an original and authentic introduction that highlights the importance of renewable energy adoption and the challenges faced in industrial areas.

2. Literature Survey:

Wind power has experienced significant growth, with an annual growth rate of approximately 34%. The technology is well-established and straightforward, benefiting from decades of experience in a few countries. Wind turbines have reached several megawatts in capacity, and offshore wind farms have been successfully deployed.While the wind energy industry is still relatively small, it is competitive. Currently, 120 GW of installed wind power contributes around 1.5% or 260 TWh to global electricity generation. The average capacity factors are approximately 25%, and the levelized costs range between 3 and 7 US¢/kWh, including variability costs.

The technical potential of wind power exceeds the current global electricity consumption. However, the main challenge for widespread wind power deployment is wind variability, which limits grid integration when penetration rates exceed 20%.Wind power has among the lowest life-cycle emissions compared to other technologies. However, to assess wind energy in a comprehensive manner, it is necessary to consider its low capacity credit. When accounting for emissions from fossil fuel balancing and peaking reserves required for overall system reliability, wind power results in approximately 65 g/kWh of emissions. Wind power has the potential to contribute significantly to emissions abatement, with an estimated 450–500 Gt CO_2 reduction throughout this century.

In this project, the objective and introduction focus on a rooftop ventilator and DC motors used for practical generator design. The analysis of generator elements is conducted, and various generator parameters are calculated. The electricity generation using the rooftop ventilator is then experimentally determined. When hot air flows under the roof, it causes the rooftop ventilator to rotate, operating the motors and generating electricity. Based on practical experiments, the output voltage is measured at 18V with 70mA (in series connection) and 4V with 270mA (in parallel connection). The achieved output power is 1.26 Watts. With the installation of the ventilator on the roof of buildings, it becomes capable of charging a 12V battery. This prototype is relatively small and cost-effective. After fabrication and testing, the system has been proven to be practical.

The world's energy demand has been increasing rapidly in recent years. The extensive use of conventional energy sources such as fossil fuels and nuclear power is becoming challenging due to the depletion of resources. This has led to increased research in non-conventional energy sources like hydro, wind, and thermal energy. This paper focuses on wind energy, which has immense potential and advantages. However, its utilization is limited due to factors such as irregularity, geographical conditions, and availability. The primary goal of this paper is to propose an idea that overcomes these challenges and maximizes the utilization of wind energy. The paper discusses the utilization of wasted wind energy from industrial exhaust fans. By harnessing the wind force from exhaust fans, a small windmill can be powered, and the energy generated can be stored in an energy storage unit. The stored power in the battery can then be converted into AC using an inverter and supplied to meet the growing energy demand, effectively utilizing the wasted power from exhaust fans.

Proposed System:

The proposed system is an exhaust air energy recovery wind turbine generator, which offers a unique approach to generate green energy by harnessing untapped wind resources through a micro-wind generation system. These wind resources can be found in various sources such as exhaust fans in industries and restaurants, cooling towers, air ventilation systems, humidification plants, and other systems that generate consistent and strong winds.

However, it is important to note that integrating the exhaust air energy recovery wind turbine generator may vary depending on the specific unnatural wind resource. Different systems possess distinct characteristics and geometries, requiring a tailored configuration to effectively capture the maximum energy from the exhaust air system without causing any significant negative impact on the original system.

In this study, a specific configuration of the exhaust air energy recovery wind turbine generator is designed to optimize energy recovery while ensuring compatibility with the respective system. By customizing the design, the system aims to recover the maximum amount of energy from the exhaust air, contributing to sustainable and eco-friendly power generation.

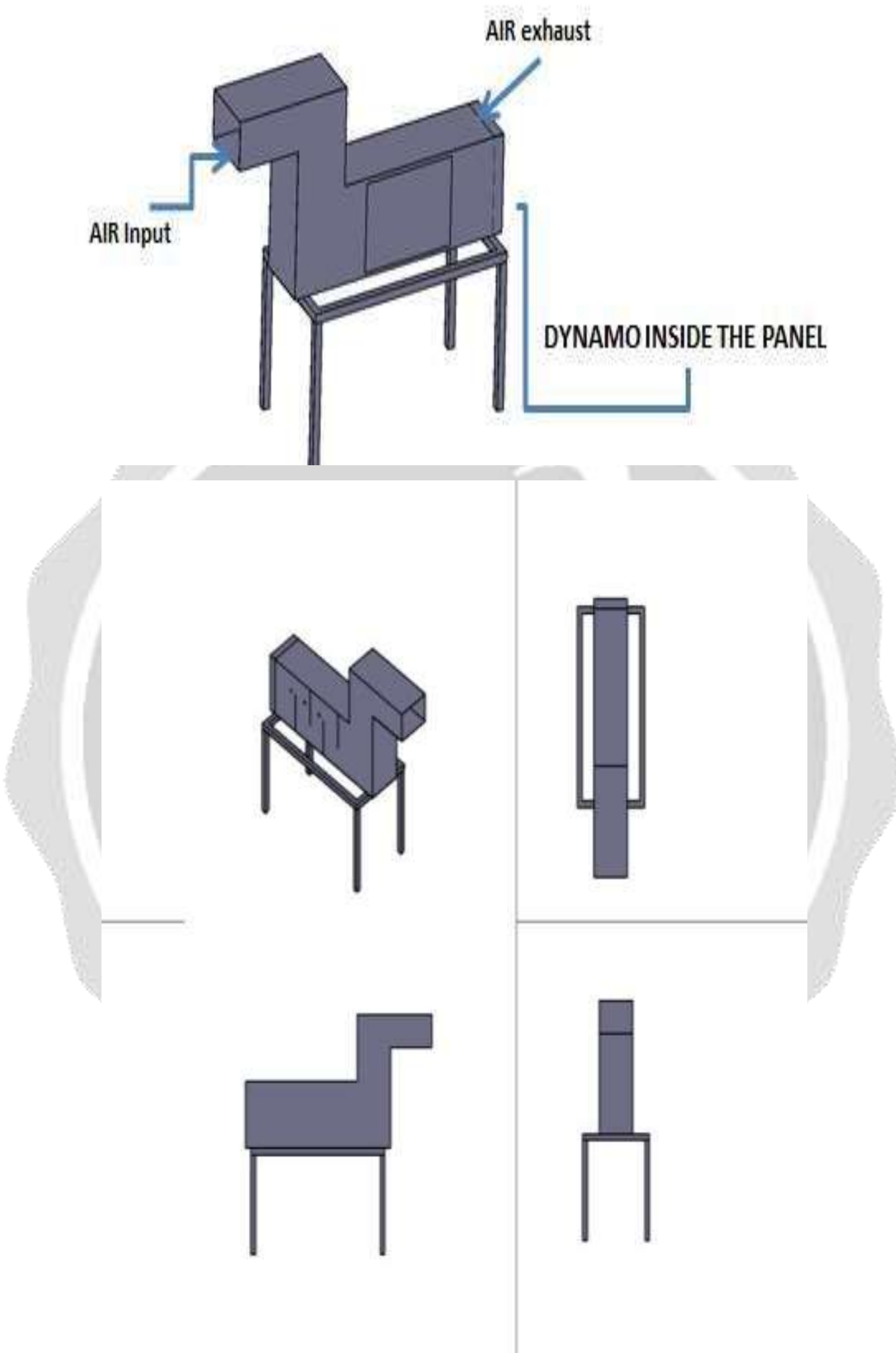

Fig 1: (a) 3D Model and (b) Wire Frame Sketch of Electricity generation from industrial AC air exhaust by using venture duct

4. Components used for implementation of the system: The proposed system utilizes the following components for its implementation:
Exhaust Fan: A 230V, 1400rpm exhaust fan is employed as a source of unnatural wind energy. The fan is specifically chosen for its ability to produce strong and consistent winds that can be harnessed for power generation.
Battery: A 12V, 0.39Amp battery, typically a motorcycle battery, is utilized as an energy storage unit. The battery acts as a reservoir for storing the electrical energy generated by the system for later use.
Dynamo Generator: A 12V, DC, 0.9Amp dynamo generator is employed in the system. The generator converts mechanical energy, obtained from the exhaust fan's rotation, into electrical energy. It operates based on the principles of Faraday's law of electromagnetic induction.
The combination of these components enables the system to effectively harness the unnatural wind energy generated by the exhaust fan and convert it into usable electrical energy. It is important to ensure that the content is written in your own words and properly cited if referencing external sources.

5. Design and Analysis:
To evaluate the crucial parameters for finite element (FE) analysis of axial ball bearings, a parameter study is conducted. The study focuses on assessing the impact of various parameters on the analysis, including mesh density, contact stiffness, osculation, load level, geometrical nonlinearity, and material nonlinearity. The FE software ANSYS is utilized to perform the studies.
It is important to recognize that the accuracy of the finite element analysis is influenced by several factors, such as the type of elements used, the boundary conditions applied, and the method of load application. As a result, the FE model serves as an approximation of reality rather than an exact representation. Conducting a parameter study through physical tests is a viable alternative, but it often incurs higher costs, requires more time, and consumes additional resources. Therefore, FE analysis proves to be a more suitable choice, at least for evaluating the parameters.
By conducting the parameter study using FE analysis, it becomes possible to understand the influence and significance of each parameter on the behavior and performance of axial ball bearings. This knowledge can aid in optimizing the design and performance of such bearings, ensuring their reliability and efficiency.
.

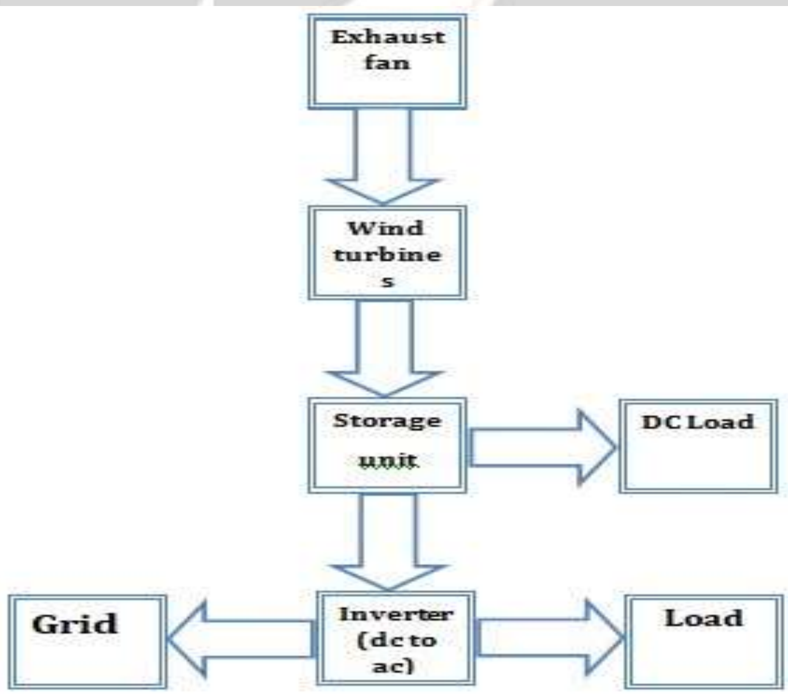

Fig 2: Flow chart of workflow.

6. Methodology

Research and Analysis: a. Understand the characteristics of the industrial AC air exhaust, including flow rate, velocity, temperature, and pressure. b. Determine the potential energy available in the exhaust air that can be harnessed for electricity generation. c. Study the principles of venturi systems and their application in energy conversion.

System Design: a. Calculate the power requirements and determine the desired electrical output. b. Design a venturi duct system that can efficiently capture and convert the kinetic energy of the exhaust air into electrical energy. c. Consider factors such as duct size, shape, material, and positioning to optimize the performance of the system.

Venturi Duct Installation: a. Install the venturi duct at a suitable location in the industrial AC system, ensuring it is connected to the exhaust airflow path. b. Position the venturi duct in a manner that maximizes the airflow through the system and minimizes any potential disruptions.

Energy Conversion Mechanism: a. Incorporate a turbine or an energy conversion mechanism at the narrow section of the venturi duct to capture the kinetic energy of the airflow. b. Ensure that the turbine or energy conversion mechanism is properly sized and designed to handle the expected airflow and generate the desired electrical output.

Power Generation System: a. Connect the turbine or energy conversion mechanism to a generator or alternator to convert the mechanical energy into electrical energy. b. Implement a control system to regulate the electrical output and maintain the stability of the generated power.

Monitoring and Optimization: a. Install sensors and monitoring devices to measure airflow, pressure, temperature, and electrical parameters to monitor the performance of the system. b. Continuously analyze and optimize the system for maximum efficiency and output by adjusting factors such as duct design, turbine selection, and control mechanisms.

Safety and Regulatory Considerations: a. Ensure compliance with relevant safety standards and regulations for electrical installations and industrial exhaust systems. b. Implement safety measures such as overcurrent protection, grounding, and insulation to safeguard personnel and equipment.

Testing and Evaluation: a. Conduct thorough testing of the venturi duct system to verify its performance and electrical output under various operating conditions. b. Evaluate the results against the initial design parameters and make necessary adjustments or improvements if required.

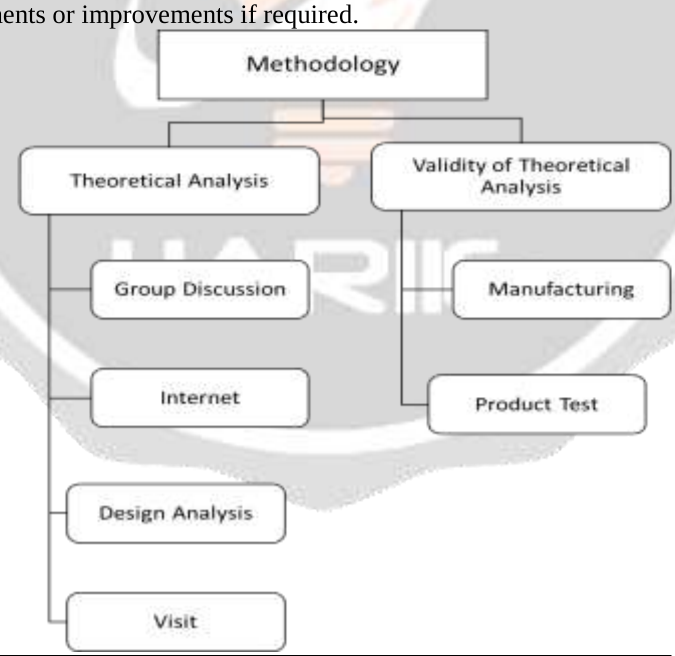

Fig 3: Methodology flow diagram

\

7. Conclusion

Electric control involves using an electric actuator to position the valve. The actuator is connected to an electrical control system that provides the force required to move the valve. As a result, the key reason for the development of this project is to build the manpower and to growth the yield of crop. The proposed user-friendly farming is used for distance operation of valve automation. This in-flip create an awesome future for farmers. Overall, the design of an electric valve involves selecting appropriate materials and components, sizing the valve and actuator, and ensuring proper wiring and control system integration. The design must also meet or exceed performance specifications and safety requirements.

7. References

- Anon (2010). "What is wind?". Renewable UK: Education and careers. Renewable UK. Retrieved 9 April 2012.
- Er.R.K. Rajput. Non-conventional energy sources and utilization.2013 Edition.
- Kira Grogg (2005). Harvesting the Wind: The Physics of Wind Turbines. Physics and Astronomy Comps Papers
- H. Bonnett, "Understanding Efficiency in Squirrel-Cage Induction Motors", IEEE Transactions on Industry Applications, vol. 1A-16, no. 4, pp. 476-483, July/Aug. 1980.
- "ANSI/ASHRAE 135-1995", BACnet: A Data Communication Protocol for Building Automation and Control Networks
- "IEEE Std 242-1986", IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (IEEE Buff Book) (ANSI), 1991.