|| Volume 9 || Issue 5 || May 2025 || ISSN (Online) 2456-0774

INTERNATIONAL JOURNAL OF ADVANCE SCIENTIFIC RESEARCH AND ENGINEERING TRENDS

Bladeless Wind Turbine

Kamran Hussain Hadi Hussain Shaikh [1],Aryan Bendre[2], Kshitij Kadam[3] ,Jyotiraditya Wable[4]

Department of Mechanical Engineering Trinity College of engineering and research[1,2,3,4]

kamransk1512@gmail.com[1], aryan.bendre0711@gmail.com[2],kadamkshitij18@gmail.com[3] ,jyotiradityawable@gmail.com[4]

---***---

Abstract: The efficiency of renewable energy sources has increased dramatically in recent years, and wind power has been one of the biggest responsibilities. The growing demand for electricity has led several countries to turn to renewable energy sources, and wind power is one of the related energy sources, and the demand for wind turbines that produce energy efficiently has started to increase. It would be very useful to develop new wind turbines if they could mimic the properties that make photovoltaic one of the most important energy sources in the distributed energy sector. In terms of large-scale wind power, offshore technology (turbines installed at sea) is very promising. The aggressive nature of the marine environment, particularly the corrosion of moving mechanical plant parts, is one of the many problems encountered in marine areas.

If there is a device that can harvest wind energy without major maintenance, mechanical parts such as gears, bearings, etc. become an important advantage. The oscillations or vibrations produced by the wind are used to generate electric current. How Vortex Induced Vibration (VIV) works. Therefore, electricity is generated using permanent magnets and copper coils.

Keywords: *Renewable resources, Bladeless Wind Turbine, Vortex Induced Vibration*

---***---

I.INTRODUCTION:

In the 21st century, the main problem faced by various countries like India and China is the growing population with enormous electric energy demands which require excessive use of primary energy resources (coal and fossil fuels) to fulfill the energy demands with a destructive strike to the environment by the form of air pollution.

in such conditions where energy is the prominent key for development and a constant hole for the non-renewable surroundings such as solar energy, wind energy, tidal energy, etc. energy reserves, and with no other resources to cope with the energy requirement a massive energy deficiency is imminent. But due to more and more advancements in the sector of renewable energy, Society can generate clean energy

The research mainly focuses on the use of wind energy to generate electricity. Major products that use wind energy are wind turbines. The most basic picture for wind turbines is the three blades spinning and energy being generated with the help of a motor, the most recent advancement shows energy can be produced without any help of blades on the turbine or a bladeless wind turbine. The basic principle remains the same use of wind energy to produce electricity but producing much higher energy and with a different mechanism than the traditional way of energy generation. without harming and environment and can generate energy with the resources easily available in the the bladeless wind turbine uses the vibrational energy generated by the wind to produce energy. The bladeless wind turbine consists of a tapered frustum pole called the "mast" and a rod which connects the base and the mast to support and develop pulsation for the eddy currents which will be generated by the alternating system in the base of the turbine. When the wind current strikes the mast it produces a to and fro motion for the mast and one end of the mast is fixed and supported with the rod which is connected to the base to other end being free and subjected to shear force by the wind which will lead to oscillations. The Kinetic energy generated by the mast is transformed into electrical energy with the help of a Permanent Neodymium Magnets and Copper Coils. The way that the energy conversion system works is that when the air flows around the mast creating .The world is suffering severely from an energy crisis due to climate change, global warming and depleting oil reserves. According to British Petroleum, at current extraction rates, the world's oil reserves are estimated to last until 2072. Renewable energy devices now play a critical role in the development of countries around the world. Governments are investing heavily in the renewable energy sector to meet the current global energy demands with expectancy to reduce use of natural gas, coal and so forth vortices of air, when resonance occurs between the mast and the air it starts to oscillate leading to generation of electricity with the help of energy conversion system. Renewable energy sources have been receiving increasing attention in recent years due to their potential to address the energy crisis and reduce greenhouse gas emissions. Among the various forms of renewable energy, wind energy is one of the most promising sources. Traditional wind turbines have been used to harvest wind energy, but they have some limitations such as high noise levels, bird and bat collisions, and visual impacts. To overcome these limitations, researchers have been exploring Overall, these studies demonstrate the potential of alternative wind energy harvesting technologies such as bladeless wind turbines and VIV-based energy harvesting systems. The studies also highlight the importance of understanding fluid- structure interactions for designing efficient wind energy harvesting systems.

II. LITERACTURE SURVEY

Md. Abdul Kader Zilani1, Akter Hossen2," unconventional energy harvesting from wind velocity and viv resonance phenomenon by using bladeless wind turbine (blwt)"[1]As Present Electric power is mostly produced by using conventional fuel, which gradually increases the atmospheric temperature and pollutes the environment. That is why the majority of countries are aware of the destructive effect of using conventional fuel and corroborates their plan for achieving electric power from renewable energy source. Electrical Power generation from wind is now growing renewable energy harvesting source using wind turbine because of its higher efficiency. This thesis proposed a wind power production system on the coastal side by using vortex induced vibration of Bladeless wind turbine. In this turbine, when wind passes outside the circular mast, it creates a vortex-induced vibration in its body due to mast vortices. This displacement of the mast rotates a pulley with the help of a crankshaft. Then the rotation of the pulley rotates a dc generator to produce electricity. A prototype of the proposed turbine was designed to record the corresponding output. It has been observed that 2.93V and 2.38A were obtained for 4.1ms-1 wind velocity and 7.56V, 5.39A were obtained for 6.5ms-1 wind velocity across a variable resistive load. A comparison was also done comparing the existing output with the proposed one for measuring the efficiency. For the proposed model of BLWT, the maximum efficiency was obtained to be around 46%.

Anthony Adeyanju1* and D. Boucher," Theoretical Analysis of the Bladeless Wind Turbine Performance"[2] As Present A bladeless wind turbine utilizes vortex formation to extract energy from the wind. Vortex formation are small swirls of air which occur as a result of the geometric shape of the device. This study designed a bladeless wind turbine which incorporates a structural support at a distance offset from the center axis of the cylindrical mast. Springs were added to the final design as means to provide the stiffness required to obtain resonance with the vortex shedding frequency and to also assist in supporting the structure. The analysis was conducted at wind speeds 1m/s, 4m/s and 7m/s, where the geometrical properties of the device remained constant. MATLAB was used to analyze the equation of motion derived for the device. The variables of interest in the studies were mainly the angular acceleration, power coefficient and the resonant frequency. The results obtained showed that for wind speeds above and below the designed wind speed of 4m/s the angular velocity remained the same. Results of this model showed that high amplitudes occur only at resonance. Results showed that with the current power generating mechanism, the average efficiency attainable is approximately 2% at steady state. This is the theoretical efficiency which could be achieved based on the current model. It was discovered that for linearly tapered cylinders, increased oscillations occurred during the 'lock-in range' for a range of reduced velocities. The reduced velocity of the designed wind speed is approximately Vr = 5m/s. This value lies within the theoretical range lock in range where increased oscillations are expected to occur between reduced velocities of 4.75m/s and 8m/s.

N. Sai Charan1, A. Sai Vasudev," Design and Fabrication of Bladeless Wind Power Generation"[3] As Present India is now pursuing its goal of becoming an all-encompassing powerhouse. This suggests that in terms of economic development, it is at the top of the list of developing nations. As a result, the nation's energy requirement will rise quickly. The current energy generating methods are less cost-effective and environmentally unfriendly. They need significant upkeep expenses and investments. A turbine that is simple to construct, secure, quiet, cost-effective, and simple to operate is therefore urgently needed. The Bladeless wind turbine, which relies on the vortex shedding phenomenon, is one such turbine. This turbine is the ideal upgrade over the current standard turbine, which has several negative impacts. Our research intends to create a fuel-free wind turbine that can effectively replace conventional wind turbine since it is both environmentally benign and cost- effective. It makes use of a completely novel method for gathering wind energy. The hallow mast is made to vibrate at a resonant frequency, creating vortices that are later transformed into electrical energy using piezoelectric sensors. Because there are fewer moving components, there is no moving, sharp blades, the structure also provides better safety for birds flying about. Additionally, because less space is needed, more units may be put in for huge power generation.

Nithin Badri1, Vamshi Peddolla1, Hutchinson Gottumukkala1," Design and Analysis of Bladeless Wind Turbine"[4] As Present The idea of bladeless windmills is based on the vortex shedding effect hypothesis. A wind-powered generator with the fewest moving elements is the vortex bladeless windmill. The oscillation or vibration caused by the wind is used to generate the electric current. As a result, piezoelectric material or a linear alternator are used to generate electricity. In this project effort, we attempted to increase the vortex-induced vibrations of the turbine built of Epoxy Carbon UD (230GPa) by altering the design of the mast and base. The maximum deflection is 0.22775m (condition 7) at 10 m/s^2 acceleration.

Adel El-Shahat, Darian Keys, Lanre Ajala, Rami J. Haddad," Bladeless Wind Turbine" [5] As Present The objective of this project is to build an environmentally friendly wind turbine without any blades. This device will be a new innovative way to harvest wind energy with the use of little materials at a low cost. This will create power with a back and forth motion from the turbine, and the power that will be produced will be stored for later use. The turbine will produce a significant amount of power in a short amount of time. Unlike a regular turbine, this one doesn't use heavy machinery from large engines like a turbine or a rotor. Because this turbine gets its power from oscillations, it won't interfere with radio waves or with birds flying in its neighborhood.

III.PROBLEM STATEMENT

Traditional windmills demand strong winds. There aren't many places at this airspeed. Hence

- Windmills that operate at lower wind speeds are urgently needed.

- The price of the various components of a traditional windmill is quite costly per kilowatt, a typical windmill will cost between $2500 and $7500.
- The design of a wind turbine is challenging.
- A considerable amount of space is needed for a functional windmill. The volume swept by the blades of traditional windmills is greater.
- For wind farms with a capacity of 1 megawatt, the installation area is 60 acres. Additionally, they are deadly to birds.
- Low-frequency sounds they create are harmful to human health.

IV.METHODOLOGY

The development and evaluation of bladeless wind turbines involve a multidisciplinary approach encompassing engineering, physics, materials science, and environmental studies. The methodology for designing and testing bladeless wind turbines typically follows a series of iterative steps aimed at optimizing performance, reliability, and efficiency. The following outlines a generalized methodology for the development of bladeless wind turbines:

Conceptual Design: Define design objectives and performance metrics, such as power output, efficiency, and environmental impact. Conduct a thorough literature review to understand existing bladeless turbine designs, principles, and technologies. Generate conceptual designs based on innovative ideas, taking into account factors such as aerodynamics, structural mechanics, and electromechanical systems.

Computational Modeling and Simulation: Utilize computational fluid dynamics (CFD) simulations to analyze airflow patterns, vortex dynamics, and the interaction between the turbine and the surrounding environment. Employ finite element analysis (FEA) to assess structural integrity, mechanical response, and fatigue behavior under varying wind conditions. Validate and refine computational models through experimental data and iterative design improvements.

Prototype Development: Fabricate scaled-down prototypes based on the finalized design concepts, using suitable materials and manufacturing techniques. Incorporate sensors and instrumentation to monitor key parameters such as vibration amplitude, frequency, and electrical output. Conduct laboratory testing to evaluate prototype performance, including power generation capabilities, response to wind loading, and dynamic behavior.

Field Testing and Validation: Install prototype bladeless turbines at field sites with diverse wind conditions, such as open plains, coastal regions, or urban environments. Collect empirical data on turbine performance, including energy output, efficiency, and reliability over an extended period. Assess environmental impacts, such as noise levels, bird interactions, and visual aesthetics, through field observations and stakeholder feedback.

Performance Optimization and Scaling: Analyze test data and identify areas for improvement in turbine design, materials, or operational parameters. Iterate on the design based on feedback from field testing and computational simulations, aiming to enhance performance, durability, and cost-effectiveness. Explore opportunities for scaling up bladeless turbine technology to larger sizes and higher power capacities, while addressing challenges related to manufacturing, transportation, and installation.

Economic Analysis and Commercialization: Conduct a cost-benefit analysis to evaluate the economic feasibility of bladeless wind turbines compared to traditional wind energy systems. Explore potential markets and applications for bladeless turbines, considering factors such as energy demand, regulatory frameworks, and public acceptance. Develop strategies for commercialization, including partnerships with industry stakeholders, intellectual property protection, and marketing efforts to raise awareness and attract investment. By following a systematic methodology that combines theoretical analysis, experimental validation, and real world testing, researchers and engineers can advance the development of bladeless wind turbines toward practical deployment and widespread adoption as a sustainable energy solution.

DESIGN OF BLADE LESS POWER GENERATION

CAD Modeling

Analytical calculations were utilized to estimate the pieces dimensions, which were then employed in modeling. The CATIA V5 programs is used to produce the CAD model.

Any FEA analysis correctness is based on how well the modelling process and meshing number were executed. The CATIA V5 programme models the parts using the dimensions shown below

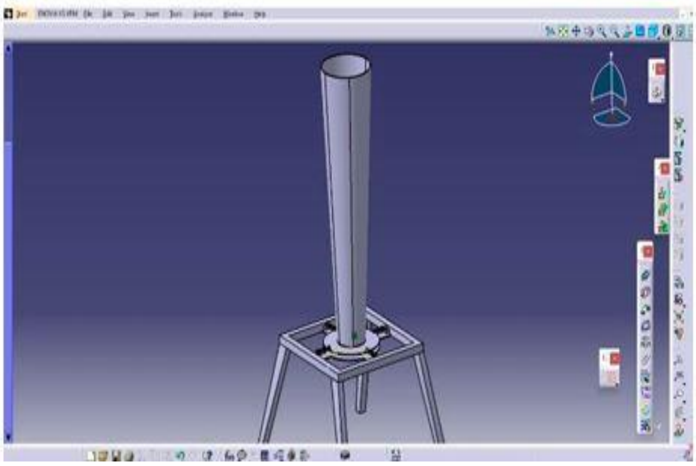

Fig -1: 3Dview of BLWPG CATIA assembly

Mast

The building is made of carbon and fiber glass and is lightweight. The conical-shaped portion is the component that oscillates in the middle. The smaller weight will cause the oscillations to be greater.

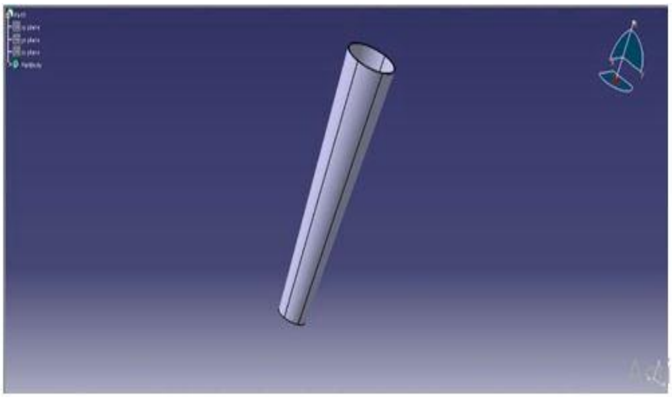

Fig -2: Isometric view of Mast

Disc Plate

Iron discs shaped into two circles are utilized. The piezoelectric chips are placed on one of the discs, while the other disc has a welded mast that is utilized to apply the generated stress to the piezoelectric chips uniformly.

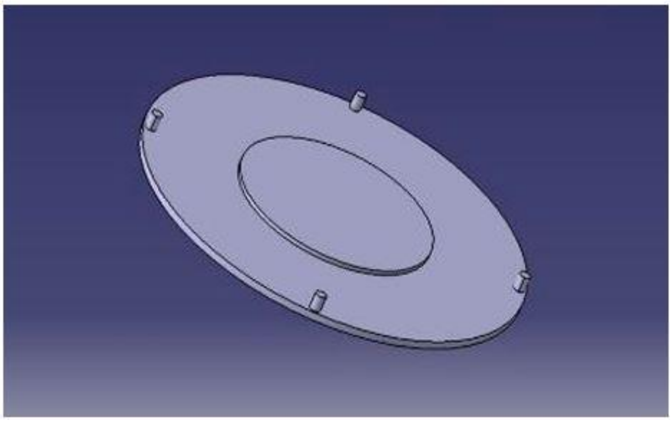

Fig -3: Isometric view of Disc

Spring

Four helical springs, one end of which is attached to the device's foundation and the other to the circular disc. They are employed to provide the mast both constraint motion and vibratory motion.

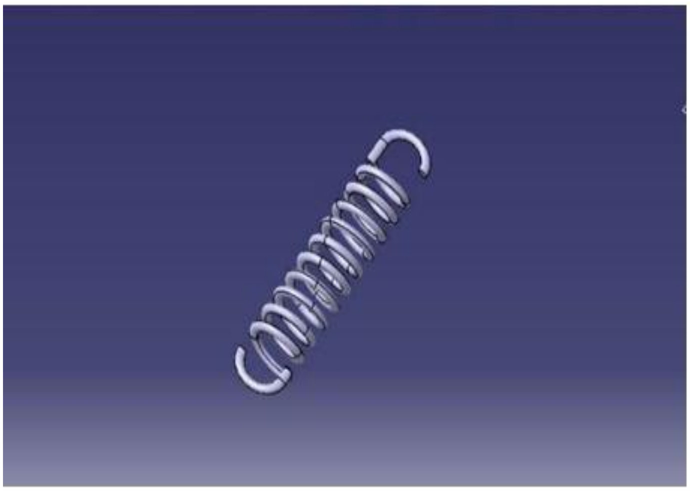

Fig-4: Isometric view of spring

V.CONCLUSION

All Bladeless wind turbines represent a promising innovation in the field of renewable energy, offering a novel approach to harnessing wind power while addressing some of the limitations associated with conventional blade-based turbines. Through our study, we have gained valuable insights into the performance, design considerations, and potential applications of bladeless turbine technology. Herein, we summarize the key findings and implications of our research:

Performance and Efficiency: Our analysis demonstrates that bladeless wind turbines have the potential to achieve competitive levels of power output and efficiency compared to traditional turbines. By leveraging vortex-induced vibrations (VIV) and electromagnetic induction mechanisms, bladeless turbines can effectively capture wind energy across a range of wind speeds and environmental conditions. Further optimization of turbine design, materials, and operational parameters is essential to maximize performance and enhance energy conversion efficiency.

Environmental Impact: Bladeless wind turbines offer several environmental benefits, including reduced noise pollution, minimized risk of bird strikes, and lower visual impact. The absence of rotating blades makes bladeless turbines more suitable for installation in residential areas, urban environments, and sensitive ecosystems, contributing to broader acceptance and adoption of wind energy technologies.

Structural Integrity and Reliability: Finite element analysis (FEA) indicates that bladeless turbines exhibit robust structural integrity and can withstand mechanical loads and vibrations without compromising stability or reliability. Ongoing research efforts are focused on optimizing turbine components and materials to enhance durability and longevity, ensuring long-term performance and operational sustainability.

Future Directions: The development of bladeless wind turbines is still in its early stages, and there remain opportunities for further innovation and advancement. Future research directions may include exploring new design concepts, improving aerodynamic efficiency, increasing scalability, and addressing challenges related to manufacturing, installation, and grid integration. Collaboration between academia, industry, and policymakers is essential to accelerate the commercialization and widespread adoption of bladeless turbine technology, contributing to global efforts to mitigate climate change and transition towards a sustainable energy future.

In conclusion, our study underscores the significant potential of bladeless wind turbines as a viable and environmentally friendly alternative to traditional wind energy systems. Through continued research and innovation, bladeless turbines can play a crucial role in diversifying the renewable energy portfolio and reducing reliance on fossil fuels, paving the way towards a cleaner, greener, and more sustainable energy landscape.

VI.REFERENCES:

1. A. El-Shahat, "Bladeless turbine as wind energy possible future technology", Natural Gas & Electricity Magazine, Wiley Periodicals, Inc, Volume 33, Issue 4, November 2016.
2. N. S J, "Power Generation by Vertical Axis Wind Turbine", International Journal of Emerging Research in Management &Technology, [online] Volume-4(Issue-7)Available at:https://www.researchgate.net/ publication/341113784_Power_Generation_by_Vertical_Ax is _Wind_Turbine.
3. C. V Long, "The interaction of bats (Microchiroptera) with wind turbines: bioacoustic and other investigations," pp. 1 200, 2011.
4. J.F. Manwell, J. G. McGowan, and A. L. Rogers, Wind Energy Explained, Theory, Design and Applications, John Wiley, 2009.
5. Y. Khalil, "Wind Power", Conference: Yale College and Yale Summer Session, 2002. Available: https://www.researchgate.net/publication/316552370_Wind _ Power.
6. G. Gohate, A. Khairkar, S. Jadhav, "Study of vortex induced vibrations for harvesting energy", International Journal for Innovative Research in Science & Technology, Volume 2, Issue 11, pp 374–378, April 2016.
7. O. Rishabh, B. Shubhankar, S.K. Vishal, "Bladeless wind power generation", International Journal of Scientific Development and Research, Volume 2, Issue 4, pp 163–167, April 2017.
8. J.C. Cajas, M. Zavala, G. Houzeaux, E. Casoni, M. Vazquez, C. Moulinec, Y. Fournier, "Fluid Structure Interaction in HPC Multi-code coupling", SIAM Journal of Scientific Computing, Volume 40, Number 6, pp. C677-C703, November 2018.
9. C.V. Okafor, "Finite element analysis of vortex induced responses of multistory rectangular building", European Journal of Engineering and Technology Research, Volume 3, Number 2, pp35–42, February 2018.
10. The Teslas turbine, Matej pobergas, Adviser: Pro. Dr. Redolf Podornik, Seminar (mach 2011)