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INVESTIGATION OF AN OPTIMUM MODEL OF SHROUDED WIND TURBINE FOR MALABAR COLLEGE OF ENGINEERING AND TECHNOLOGY USING CFD ANALYSIS

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ABSTRACT

The use of renewable energy is important due to the increasing energy demand. Wind energy is the carbon free and rapidly expanding renewable energy. Inserting diffuser ducts around a wind turbine is a method to augment its power generation. The output power of a wind turbine can be significantly improved if we can harness the fluid dynamics surrounding a structure to increase the wind speed, specifically if we can catch and concentrate the wind energy locally. This paper proposes an optimized model of shrouded wind turbine for Malabar College of Engineering and Technology, Thrissur. The advantages of shrouded turbines are an increased production capacity and reduced cut-in speed and noise pollution. This work evaluates the wind speed of selected site and a suitable model is created using Computerize Flow Dynamics (CFD) analysis. The analysis and modelling done with ANSYS workbench. The resulted model assures harvesting wind energy for the proposed site, helps in reducing energy costs.

Keywords: Diffuser, Shrouded wind turbine, CFD (Computer Fluid Dynamics), Duct

1. INTRODUCTION

According to the definition in 2-61400-IEC, wind turbines with a rotor swept area less than 200m2 and produces about 50kW energy are defined as small wind turbines. Wind turbines surrounded by a duct or shroud are called shrouded wind turbines which makes it more efficient. Small turbines must be built with the ability to function in challenging circumstances. Turbines must be promoted in metropolitan settings, but their safety must be guaranteed and they must not inconvenience the general population. It is important to consider how well a building can endure the vibrations caused by the turbine rotor, and the turbine should look as natural as possible in its surroundings. The modest wind-shrouded turbines can offer a few answers to the concerns described. Beyond basic necessities for households, emerging nations have an increasing need for energy to support the provision of water, healthcare, and education. Due to these factors, a country's lack of access to electricity is one of the most obvious signs that it is in poverty. Fossil fuels are a resource that are soon running out, and the process of turning them into power emits greenhouse gases and has a severe impact on both the quality and availability of water. Nuclear energy also carries risks because it continuously emits hazardous radiation and has been associated with an increase in cancer cases. Growing efforts have been made in recent decades to obtain energy from more environmentally friendly sources, such as solar panels and hydropower projects. These sources require either sophisticated machinery or specialized materials to build, despite being less harmful to the environment and population health. So, easily constructable or accessible micro wind turbines are welcomed. A shroud around a bare turbine acts as more productive.In stalling shrouded wind turbines in urban and rural areas provide an atmosphere of dependability on renewable energy source and the wind energy can be utilized maximum for our energy needs even for low wind speeds.

2. METHODOLOGY

The work primarily aims at proposing an optimized model of shrouded wind turbines for Malabar College of Engineering and Technology. For this wind velocity study of the selected site is done. the data was collected from Indian Meteorological Department and Kerala Disaster Management Department. The wind directions and wind speeds are analyzed. Seasonal and monthly variations of wind speed are studied. The most recorded values, the lowest and highest values are selected. Computer Flow Design analysis done using the software Ansys Workbench to evaluate the suitable dimensions. The steps of analysis include drawing geometry, meshing, setup solution and results.

Geometry

For this, a basic geometry is drawn with assumptions that the inlet diameter be 1m, fan positioned at the center portion of the duct. The blade length taken as 250mm, rotor diameter 50mm, width of blade 20mm, and 4 blades are provided for the fan. Basic geometry drawn in Ansys workbench is shown in fig 1.

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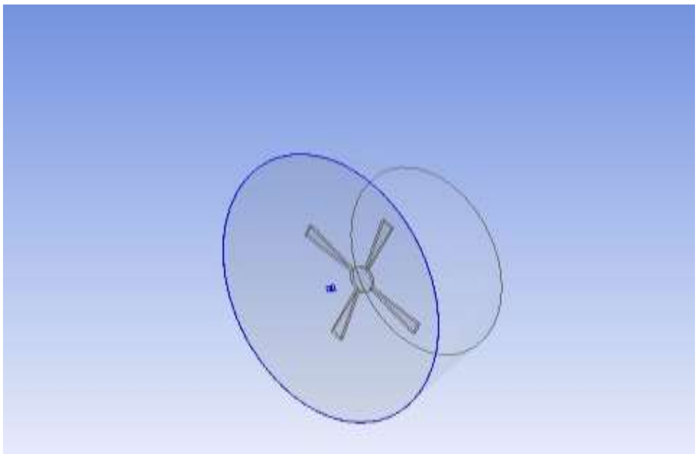

Fig 1- Geometry of Shrouded Wind Turbine

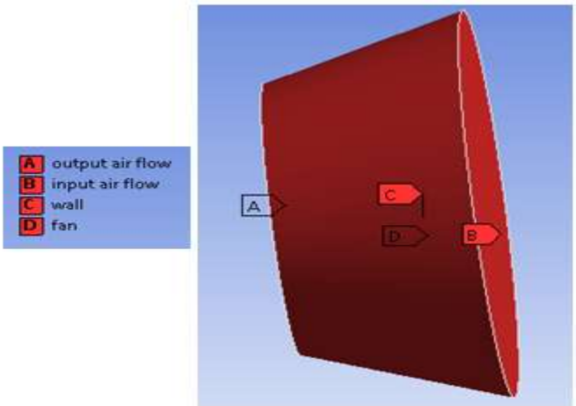

Fig 2- Setting up

Meshing

Tetrahedron meshes are formed which have four vertices, six edges, and four triangular faces enclosing them. Most of the time, an automatic tetrahedral volume mesh generation is possible. The created profile mesh contains 2810 nodes and 14614 elements. Boundary conditions can be assigned as follows: Select the front phase, right click and create name as ‘inlet’. Follow the same procedure to name back circle as outlet, then fan and wall.

Setup

Setup of boundary conditions done by assigning ‘inlet = inlet velocity’ and ‘outlet = outlet pressure’. We normally take outlet pressure as zero. Now run for the solution. CFD analysis done for the basic profile created by allowing selected input air flow velocitied to pass through the duct and output is evaluated. Analysis done to find out an optimum length, optimum diameter and better fan positioning.

3. RESULTS AND DISCUSSIONS

As per the data analysis, only in the Palghat Gap region, where winds come primarily from the east from November to March and from the west the rest of the year, are winds over the State seasonal. In other regions of the state, mountain winds and differential heating of land and water masses together control wind flow primarily. Throughout the year, winds have westerly components during the day and easterly components at night. In general, winds are weak at night and very powerful in the afternoons when the thermal circulation is most developed. The data here reveals that the highest wind speed was noted during winter season (December to February) which coincides with Vrischikakaattu season followed by south-west monsoon (June- September). The wind speed during south-west monsoon period was 4.9 m/s. Summer (March- May) recorded a wind speed of 4.3 m/s while the least speed was noticed during post monsoon period (October- November). Vrischikakkattu is a seasonal wind blowing in certain regions of Thrissur and Palakkad districts. The easterly wind as it passes through the Palghat gap of the Western Ghats gains momentum and blows with greater speed. The wind speed of Vrischikakkkattu is more in January and followed by December.Thus, input velocities for CFD analysis taken as 4.4, 4.6, 4.7, 4.8, 5.4, 5.7 and 5.9 m/s. Analysis results were assessed in terms of output velocity and turbulent factor. Maximum velocity output and minimum turbulence intensity factor provides best results. The analysis results for length, fan position and diameter are provided in fig 3,4 and 6 respectively.

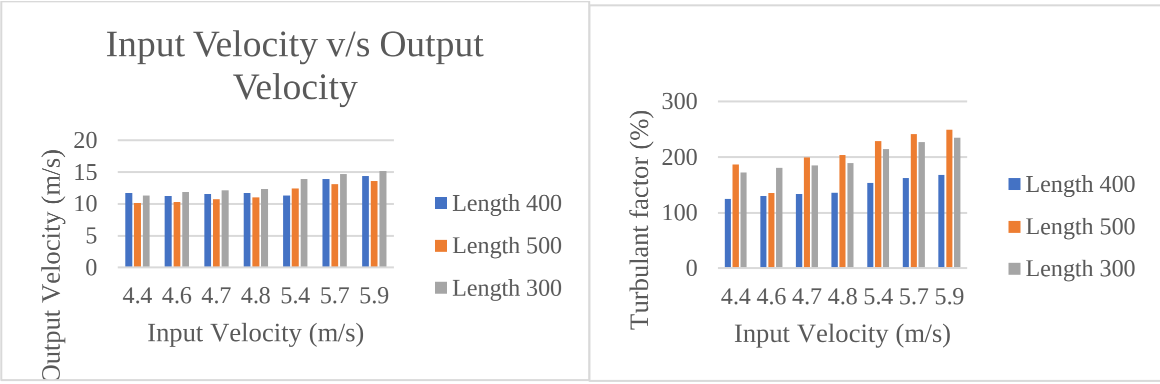

Fig 3- Results for optimum length

The analysis for optimum length is done for three selected lengths of shroud, 300mm, 400mm and 500mm. From the results it is taken as 400mm. To obtain better position to fix a fan, five positions were analyzed, 190mm, 181mm, 200mm, 210mm, and 222mm. The results show almost similar pattern, so analysis conducted for lower velocities too. From the data collected, it was noted the minimum recorded velocity is 0.1 m/s and the average velocity is 2.7m/s. Results shown in fig 5 and from the graph clearly understood that 200mm, at center portion of the shroud is found as the better position for maximum yield.

Fig 6, the results of analysis for optimum diameter is illustrated which points 1m diameter provides better results.

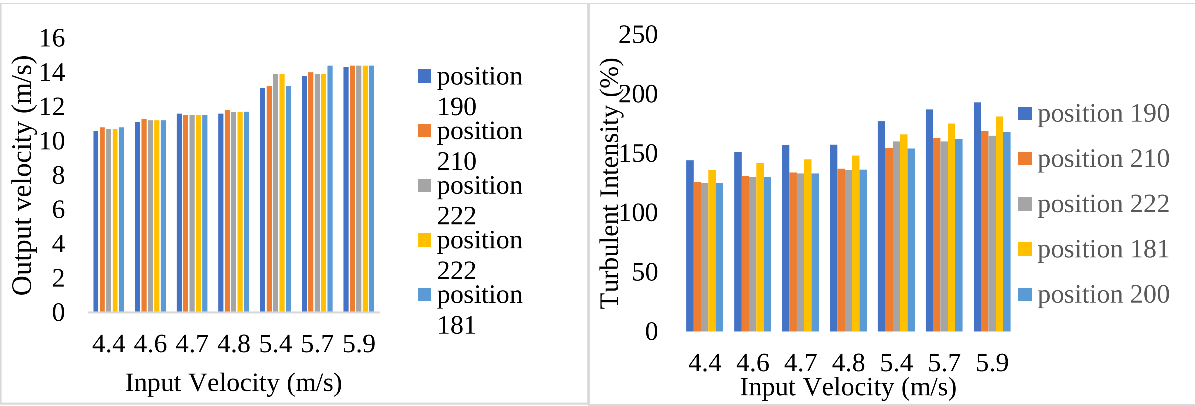

Fig 4- Results for better fan position

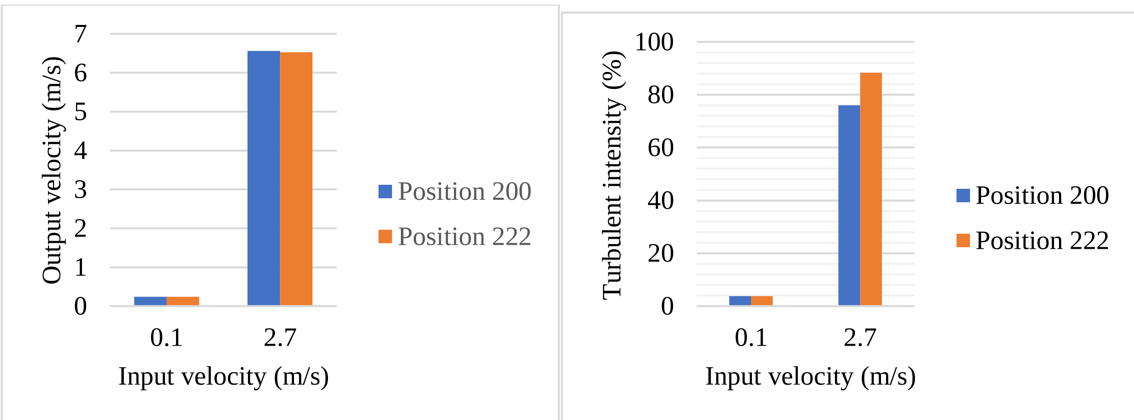

Fig 5- Results for better fan position for lower velocities

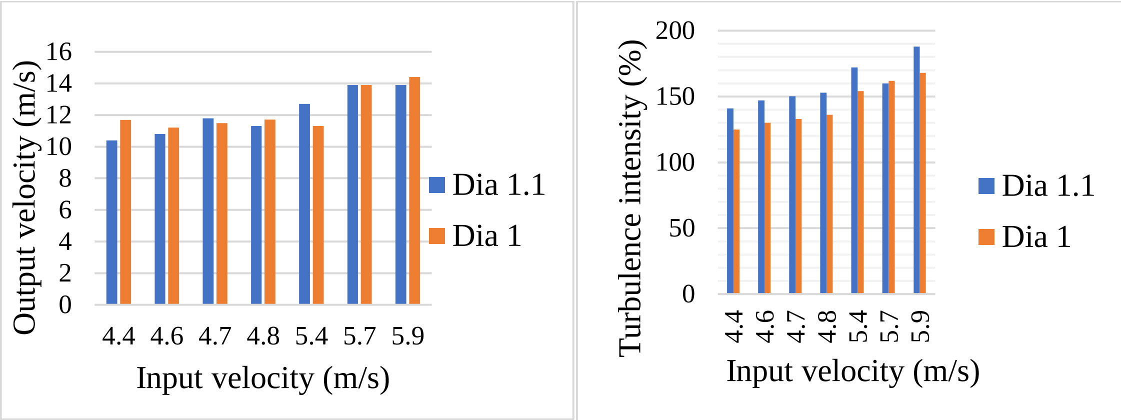

Fig 6- Results for optimum diameter

4. CONCLUSIONS

Kerala is a land with vast wind wealth. Using a shroud around a bare turbine elevates the power production. A miniature wind turbine with the right dimensions can be used in Kerala for the entire month.

This project investigated one approach to improve the utility of small wind turbines. The design of the shroud was accomplished through CFD modeling in ANSYS Fluent by isolating geometric factors and determining their influence on the performance. The most influential factor on the performance of the shroud was determined to be the length of the diffuser. According to the results of CFD analysis, a basic shrouded turbine with a 400mm long and 1m inlet diameter in which fan positioned at the center of the shroud found as suitable for Malabar College of Engineering and Technology, Desamangalam, Thrissur. The assumptions taken for creating basic geometry were proved as correct. Shrouded wind turbines are a better option to harvest the wind energy resources of Kerala.

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5. REFERENCES

[1] Nemat Keramat Siavash et al, An Innovative Variable Shroud For Micro Wind Turbines, Renewable Energy- an international Journal, Vol 142 Nov 2019, ISSN 0960-1481

[2] Belloni C, Willden R, Houlsby G, An Investigation of Ducted and Open- centre tidal turbines employing CFD-embedded BEM , Energy Conversion and Management Vol 21, issue 01, 2017

[3] Hu and Wang, Effect of Placing a diffuser around a wind turbine, Wind Energy: An International Journal for Progress and Applications in Wind Power Conversion Technology207-213, 2015

[4] Albin Roy, Aman Shine, Athul P U, Abraham Antony, 2022, The Performance Of Shrouded Wind Turbine Using Cycle Dynamo , IRJET vol 9, issue 7.

[5] El-Zahaby, Aly M., A.E. Kabeel et al. (2017). CFD Analysis of Flow Fields for Shrouded Wind Turbine's Diffuser Model With Different Flange Angles. Alexandria Engineering Journal 56, 171-179.

[6] Kannan, T. Saravana, Saad A.M., dan Y.H. Kenny Lau. (2013). Design and Flow Velocity Simulation of Diffuser Augmented Wind Turbine Using CFD. Journal of Engineering and Science and Technology Vol. 8 No.4 (2013) 372-384.

[7] Riyanto, Nugroho Agung Pambudi, Rusdi Febriyanto, Nova Dany, Bayu Rudiyanto; 2018, The performance of Shrouded wind turbines at Low Wind speed condition, 10th international conference on Applied Energy, Hong Kong,

[8] Abe, Ken-Ichi dan Yuji Ohya. (2004). An Investigation of Flow Fields Around Flanged Diffuser Using CFD. Journal of Wind Engineering and Industrial Aerodynamics 92, 315–330.

[9] Ohya, Y. and Karasudani, T., 2010. A shrouded wind turbine generating high output power with wind-lens technology. Energies, 3(4), pp.634-649.

[10] Alquraishi, B.A., Asmuin, N.Z., Mohd, S., Abd Al-Wahid, W.A. and Mohammed, A.N., 2019. Review on Diffuser Augmented Wind Turbine (DAWT). International Journal of Integrated Engineering, 11