Design and Analysis of Ducted Wind Turbine for Roof-top Installation

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Abstract

Small-scale wind turbines are useful in urban areas as a source of electricity, where the main focus is towards producing optimum power in a limited area with a low wind velocity. Shrouding of a wind turbine with a proper shape is found to be an effective method to augment wind velocity. The present work aims to power one room of an average house in a typical tier two city in India. A duct is designed for rooftop installation by referring to the wind availability data for an average height of 10m. A 2-Dimensional numerical scheme is developed to optimize the shape of the duct using ANSYS Fluent. The SST k-w turbulence model is used to capture the velocity fluctuations. Optimized shape of the duct is a convergent-divergent section, with the wind turbine placed at the throat. It is found that the convergent section does not have a significant effect on the wind velocity at the throat, but helps in directing the path. Introducing divergent section increases the wind velocity and achieves an average velocity increment of 1.32, which is close to the designed theoretical value 1.4. Output power is obtained by selection of proper airfoil and generator. Introduction of vortex generator at the divergent end offers an additional 15% increase in wind velocity at the throat, which is 10% higher than the designed theoretical ratio.

Keywords

Wind turbine, Duct, CFD, Vortex generators and Renewable energy.

Acknowledgements

The authors would like to thank Dr. Shireesh Kedare(IIT Bombay), Dr. H.B. Chaudhary (Electrical Department, VJTI), Dr. A.V. Deshpande (Mechanical Department, VJTI) and Professor S. S. Barve (Mechanical Department, VJTI) for their timely help towards clarifying conceptual and theoretical aspects of the present work.

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