ISSN:2348-2079 Volume-7 Issue-2

IJIAREC

International Journal of Intellectual Advancements and Research in Engineering Computations

Comparative analysis of vertical axis wind turbine (VAWT) with a different aerodynamic model

S. Balakrishnan[1], V. P. Mouleeswaran[2], V. Ponvivek[2], S. Praveen[2], P. Praveenkumar[2]

[1]Assistant Professor, [2]UG Students

Department of Mechanical Engineeing, Nandha Engineering College, Erode - 52.

TamilNadu. India.

ABSTRACT

The present research aim to investigated the concept of J-shaped blade in a straight blade darrieus type VAWT in terms of output torque and power by employing high fidelity 3D numerical simulations. In this study, NACA0015 is the base airfoil and as been modified to generate the desired J-shaped profile. The result indicate improvement on torque and power coefficient. The aluminium blades are less cost and light weight when compared to carbon fibre and steel material. Among the advantages of this arrangements of gear box and generator can be placed close to the ground and the blade axis is perpendicular to the wind streamline. The aerofoil shape and manufacturing technique gives more lift, drag. The objective of this VAWT to generate electricity in urban areas with less setup cost. The main advantage is that, it is economically eco-friendly.

INTRODUCTION

In the recent years, wind energy has become one of the most economical renewable energy industries. Wind turbines harvest wind kinetic energy and convert into usable power. Vertical axis wind turbines have several advantages over the horizontal axis wind turbine. While the main components are located at the base of the turbine. This arrangement allows the generator and gear box to be located close to the ground, facilitating service and repair. VAWTs do not need to be pointed into the wind, which removes the need for wind sensing and orientation mechanisms. Major drawbacks for early designs (savonius, egg type and gyro mill) include the significant torque vibrations or ripple during each revolution, and large bending moments on the blades. A vertical axis wind turbine has its axis perpendicular to the wind streamlines and vertical to the ground. A more general term that includes this option "transverse axis wind turbine" or "cross flow wind turbine".

LITERATURE SURVEY

1. E. D. Berg et al, The research institutions have carried at extensive research activities and developed the numerous designs based on the aerodynamic models. The main aerodynamic models that have been used or performance prediction and design of straight-bladed Darrieus type VAWT. It has been found out that at present the most widely used models.
2. H. Dumitrescu et al, VAWT with diffuser and without diffuser arrangements are considered for the experimental analysis .Five diffusers were since provided around its blades of VAWT which will placed under a pentagon shaped fabricated structure. The output power of the diffuser based on the VAWT generators.

Author for correspondence:

Department of Mechanical Engineeing, Nandha Engineering College, Erode - 52. TamilNadu. India.

3. D. A. Spera and T. R. Richards, in this article structure implementation and optimum performance of the vertical axis wind turbine (VAWT) using magnetic levitation technology is articulated. The leading result ascending before traditional wind turbine can be demarcated as energy dissipation during rotation. Power is then generated with an axial flux generator which incorporates the utilization of permanent magnets and coils.
4. Environment Canada, One of the major issues in this fast moving world is to meet the demand of energy in the most economical and environmental friendly way. The research work on designing of a vertical axis wind turbines (VAWT) that gives the solution which is comparatively a cheap alternative of renewable energy. The wind turbine can charge up to 12v battery and being closely monitored and battery chargers automatically without any harmful emissions or drawbacks.
5. M.T. Iqbal, The sustainability of the fossil fuels while considering its rate of consumption has paved way for rediscovering the possible ways of converting and conversing one from of energy into another. This paper shows a unique design that recovers kinetic energy of the wind by allowing itself to appropriately align with the direction of the wind.
6. Aslam Bhutta et al, The VAWT along with the merits and demerits, the design technique employed for VAWT design have also been reviewed along with their results. It was learned that coefficient of the power (cp) for various configurations is different and can be optimized with reference to tip speed ratio; flow field around the blade can also be investigated with the help of these design techniques for the safe operation.

CFD MODEL

Computational fluid dynamics (CFD) is the use of applied mathematics, physics and computational software to visualize how a fluid flows as well as how the gas or liquid affects objects as it flows past. Computational fluid dynamics is based on the Navier-stokes equations.

In the current study, multiple reference frame (MRF) coordinate has been utilized to separate stationary and rotary domains. The simulation of fluid flow over VAWT is studied by solving the unsteady Reynoles-Averaged Navier-Stokes equations [1-3].

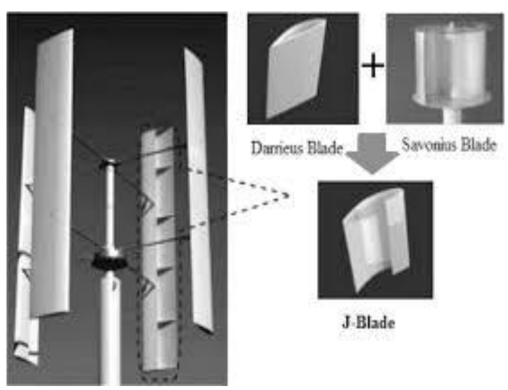


Fig. 1 Darrieus VAWT with J- Shaped blade

Numerical method

A series of high fidelity 3D simulation were carried out by computational fluid dynamic software, with the aim of a comparison between the conventional blade and the j-shaped blade turbine in terms of performance. In the case of CFD simulation, with rotating parts a moving mesh approach known as sliding interface. The interior sliding domain rotates with a given rotational velocity for a specified tip speed ratio (TSR). The zero pressure gradient was employed for the outlet boundary of computational domain and pressure was set to atmospheric value. Also, the velocity gradient was considered to be zero [4].

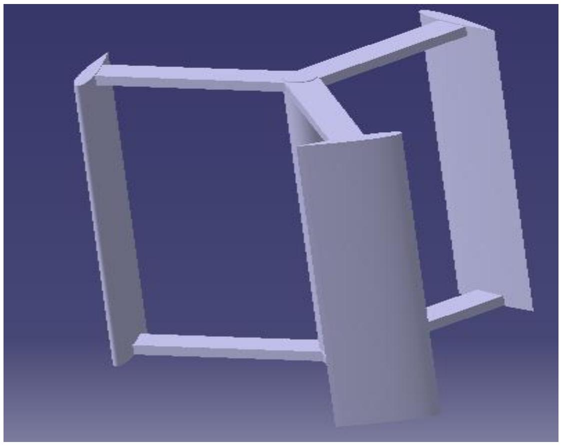
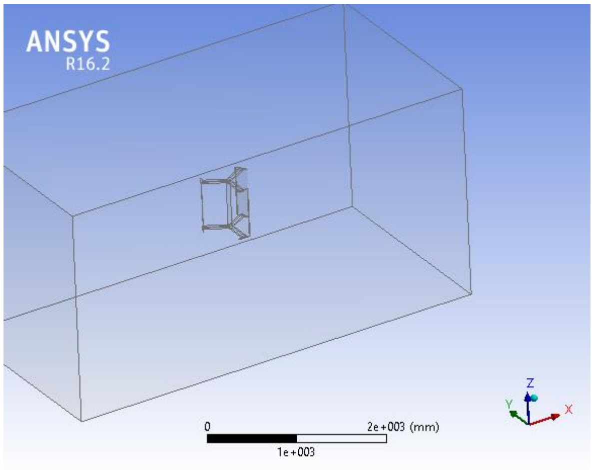


Fig. 2 The schematic representation of a Darrieus VAWT with and without J-shaped section

Geometry



ANSYS Design Modeler software is specifically designed for the creation and preparation of geometry for simulation. It's easy-to-use, fully parametric environment with direct, bidirectional links to all leading CAD packages acts as the geometry portal for all ANSYS products to provide a consistent geometry source for all engineering simulations [5].

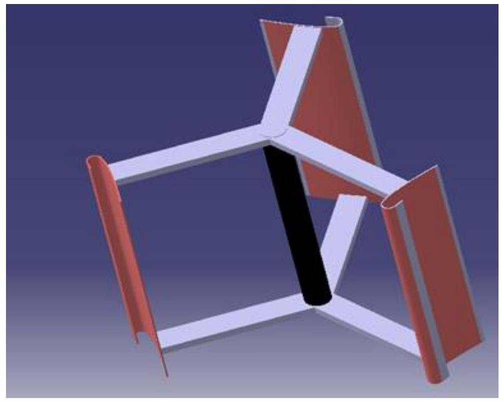


Fig. 3 Three dimensional computational domain

For the analysis purpose a box encloses is to be constructed at around the wing. All the input condition give only in this domain. After Import design creating enclose and make subtract from original body with imported body.

Meshing

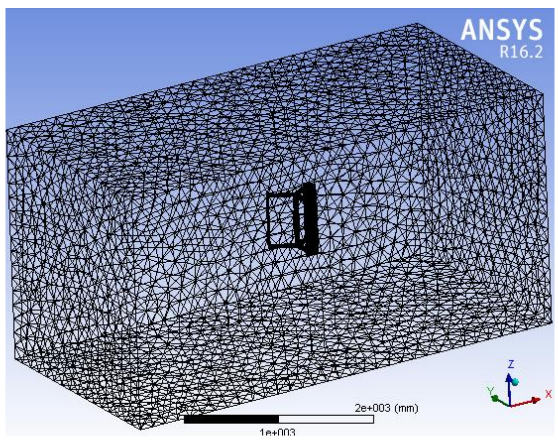


Table. 1 Main geometrical characteristics of the wind turbine

Number of Blade	**3**
Chord	150mm
Turbine Height	600mm
Airfoil	NACA0015

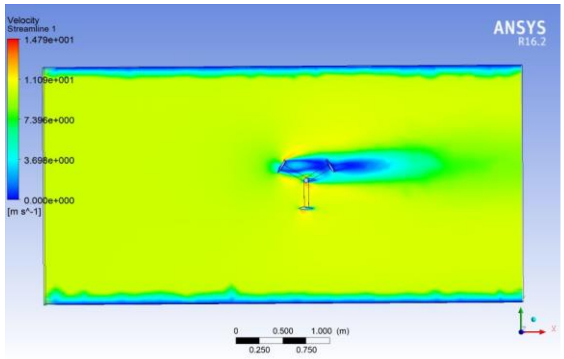
RESULT AND DISCUSSIONS

To reducing drag in subsonic aircraft through various shapes of vertex generator By using these devices we reducing more amount of drag in various aircraft. To design details will find out by various formula used in this project and find out project design parameter and importing into CFX. The result values will be comparing with other vertex shapes and find out minimum drag values.

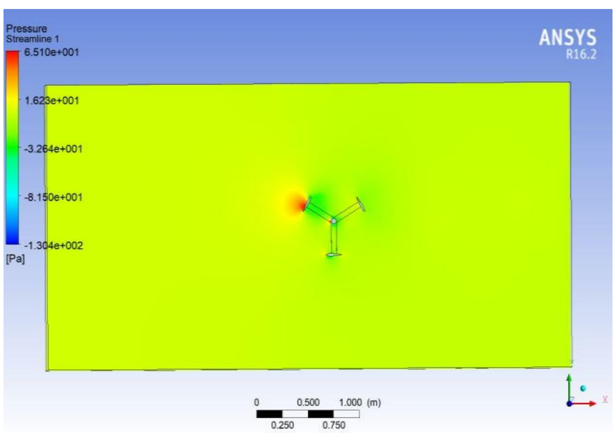
Flow field Analysis

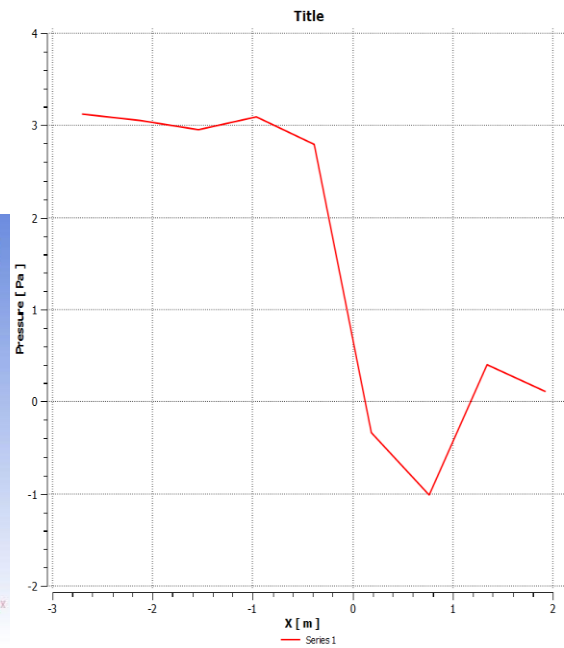
In FLUENT planes were created at different sections along the span of the blade and the relative velocity vectors were plotted. For a wind speed of 8m/s and using a tip speed ratio of 6 the results were shown below

Result For NACA0015

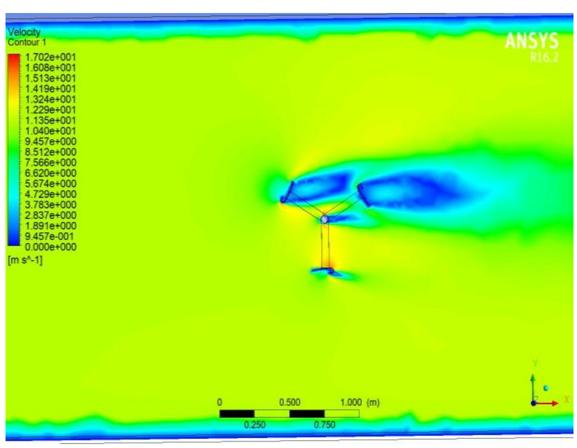


Pressure flow over blades



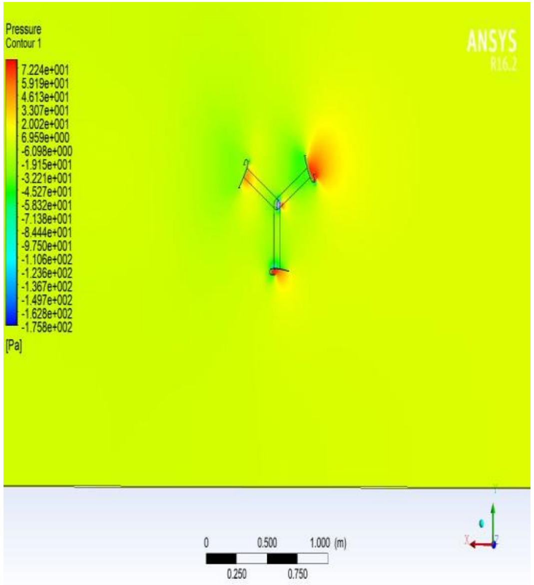


Result for J-Type Blade



Balakrishnan S et al., Inter. J. Int. Adv. & Res. In Engg. Comp., Vol.–07(02) 2019 [2783-2789]

Pressure flow over blade



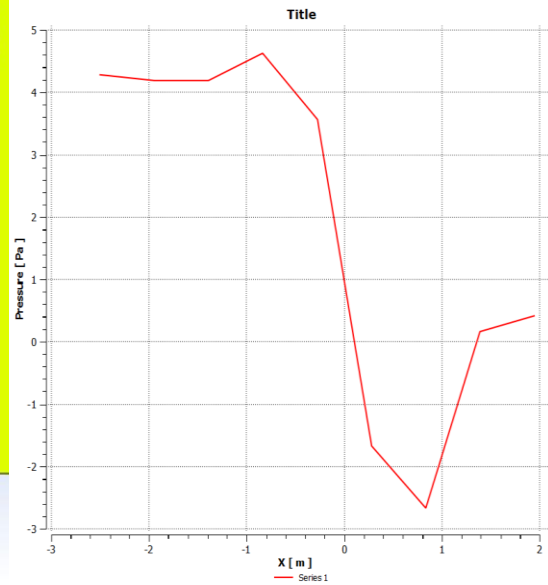
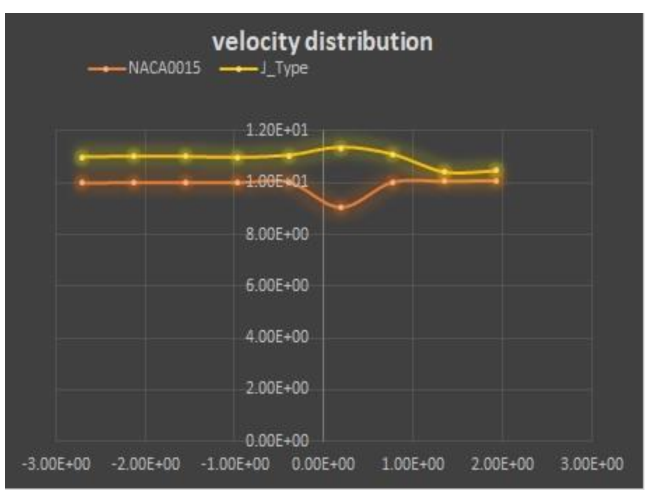


Table. 2 Force acted on both blades

Type of blade	Exist force	Upward force
J type	959N	0.18N
NACA0015	780N	0.12N

Velocity distribution for both blades



CONCLUSION

The current study is intended to introduce a new design for VAWT blade as to overcome the general drawbacks of such turbines, for instance the self starting issues combined with abundance of vorticities generated by the blades at high angle of attack. So, the new profile known as J-shaped profile, is designed by means of eliminating a friction in the conventional aerofoil. Then, a straight bladed darrieus type VAWT using the common aerofoil profile, NACA0015, and its J-Shaped profile is investigated through high fidelity 3D numerical simulation.

REFERENCES

[1]. E. D. Berg, D. T. Ashwill and J. H. Sutherland," A Retrospective of VAWT Design," Albuquerque, 2012.
[2]. H. Dumitrescu, V. Cardos, A. Dumitrache and F. Frunzulica, "Low Frequency Noise Prediction of Vertical Axis Wind Turbines," The Publishing House of the Romanian Academy, 2010.
[3]. D. A. Spera and T. R. Richards, "Modified Power Law Equations For Vertical Wind Profiles," US National Aeronatics and Space Administration, 1979.
[4]. Environment Canada, "Historical Climate Data," [Online]. Available: http://climate.weather.gc.ca/. [Accessed 2014 January 2014].
[5]. M. T. Iqbal, "A feasibility study of a zero energy home in Newfoundland," Pergamon, St. John's, 2003.