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THERMAL NATURAL CONVECTION ANALYSIS OF COOLING FIN BY VARYING ITS PATTERN

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Abstract

In the present work, three types of airfoil shape have been considered for analysis using ANSYS fluent Computational Fluid Dynamics software. Several types of angle of attack and Reynolds numbers have been used to evaluate the flow and heat transfer characteristics of the airfoil and it has been found that due to increasing angle of attack and Reynolds numbers heat transfer and flow characteristics such as heat transfer coefficient, Nusselt numbers and turbulent kinetic energy are increasing and the friction factor decreases, which increases the life of the airfoil. Finally, this work has been found that the S835 highest feature have been found that the S835 is the highest heat transfer and flow characteristics, which is full for the future applications.

Keywords: *Airfoil; CFD Analysis; NACA, Heat Transfer; Flow Characteristics.*

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1. Introduction

Wind turbine blades are designed according to the aerofoil structure which is commonly used in the design of aero plane wings. 2-D aerofoil data can thus be applied. The reason for this study was to focus the ripple conditions not to be kept up throughout wind tunnel tests. NACA 4412 airfoil and analysed its profile for consideration of an airplane wing at a speed of 340.29 m/sec for angles of attack of 0˚, 6, 12 and 16˚. k-ε turbulence model was assumed for Airflow [1]. The angle of twist was varied linearly along the length of the beam. Width and depth were also varied linearly along the beam span [2]. An aerodynamic design of the wind turbine blades is one of the main problems of wind industry, which has a significant impact for getting maximum power out of wind [3]. The rotor blade of the wind turbine is one of the important components, the airfoil sections needs to be developed in order to meet global energy requirements. The blade of the wind turbine is consisting of imaginary airfoil that can be divided into three regions: root region, middle region, and tip region [4]. An until that time the airfoils chosen for existing wind turbines from NACA (National Advisory Committee for Aeronautics) were old NACA 23XX, NACA 44XX, NACA 63XXX, and NASA LS family airfoils, but those airfoils had poor stall characteristics, incompatible performance at varying Reynold numbers, degradation problems resulting from leading edge contamination, lower percentage drop lift coefficient, energy losses due to leading-edge roughness [5]. The optimal shape of the airfoil generates within the design constraints [6-9]. An attempt is made to investigate the pressure coefficient for NACA 4412 [10] and Lift and Drag forces for different Reynolds number and angle of attack for wind turbine blade airfoil of NACA 0012 profile [11].

2. Methodology

The lift that an airfoil generates depends on the density of the air, the velocity of the airflow, the viscosity and compressibility of the air, the surface area of the airfoil, the shape of the airfoil, and the angle of the airfoils angle of attack. However, dependence on the airfoils shape, the angle of attack, air viscosity and compressibility are very complex. Thus, they are characterized by a single variable in the lift equation, called the lift coefficient. Therefore, the lift equation is given by:

$$L = \frac{1}{2}\rho U^2 S C_L \tag{1}$$

The drag coefficient is generally found through testing in a wind tunnel, where the drag can be measured, and the drag coefficient is calculated by rearranging the drag equation:

$$D = \frac{1}{2}\rho U^2 A C_D \tag{2}$$

3. Modeling and Simulation

Computational fluid dynamics (CFD) simulation software allows you to predict, with confidence, the impact of fluid flows on your product throughout design and manufacturing as well as during end use.

3.1 Model the Geometry

In this step model the geometry of product with the help of Creo Parametric software. The airfoil shapes are shown in Figure 1 is not to designed completely and takes a part of shape (C-Shaped) boundary system and design this product in Creo Parametric as shown in below Figure 1.

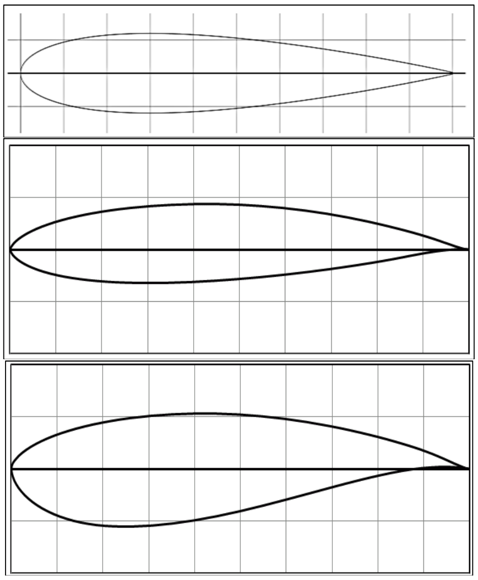


Figure 1. Airfoil configuration used in the numerical simulation of NACA00123, S834 and S835

3.2 Generate Mesh

After modeling the product in Creo parametric import this file to ANSYS fluent and generate a mesh in the model.

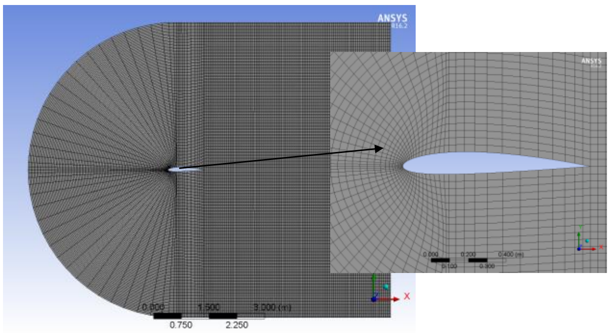


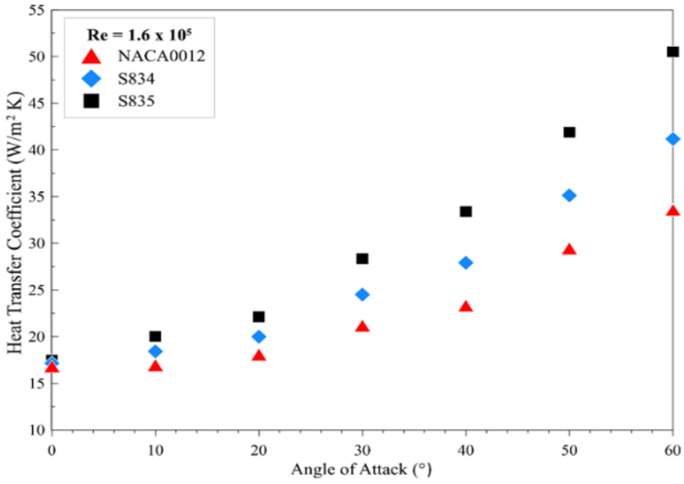
Fig. 2 Meshed view of NACA0012 airfoil configurations

3.3 Boundary Condition

In this step, the boundary condition has been applied in airfoil shape viz. inlet, outlet, top and bottom wall and airfoil wall etc. In present work, the heat transfer characteristics has been done under 1000 w/m2 of heat flux condition for all conditions.

4. Results and Discussions

In the current work, three types of airfalls have been used in order to by simulate and optimize. In this work, the characteristics of the flow and heat are mentioned with different types of angle of attack and Reynolds numbers. In present work, the heat transfer characteristics has been done under 1000 w/m2 of heat flux condition for all conditions. Neglecting radiating heat loss from the surface of the air foil.



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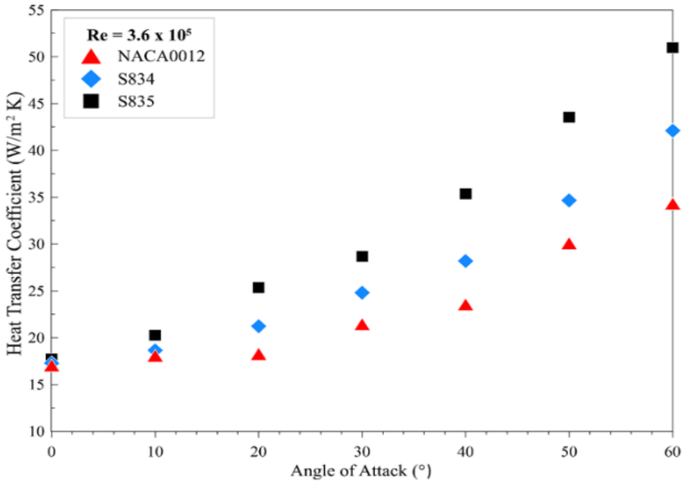
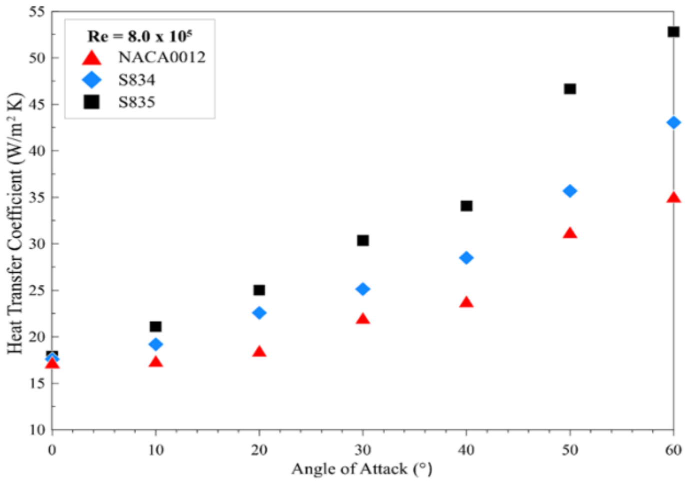
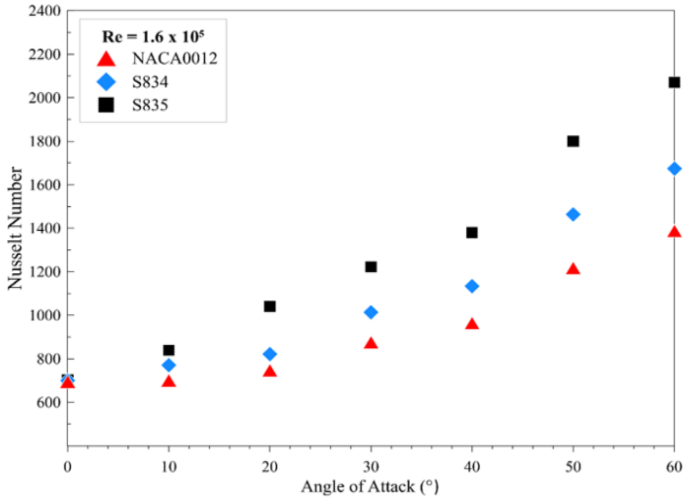


(b)

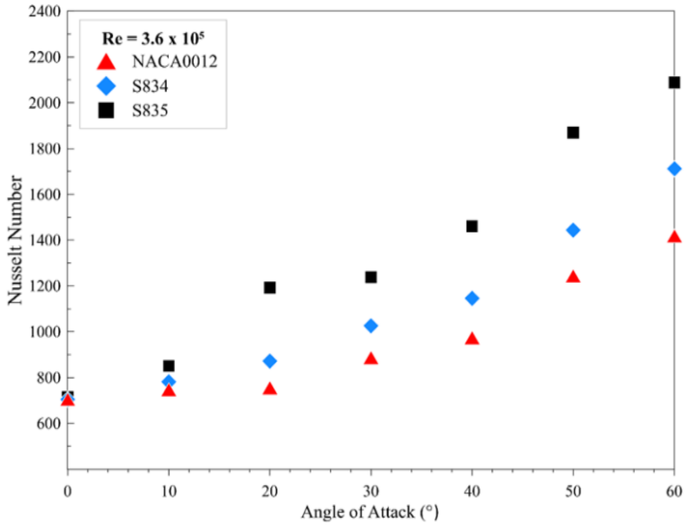


(c)

Figure 2. Variation of heat transfer coefficient with angle of attacks at different airfoil i.e. NACA0012, S834 and S835 (a= Re = 1.6 x 10^5) (b= Re = 3.6 x 10^5) (c= Re= 8.0 x 105)



(a)



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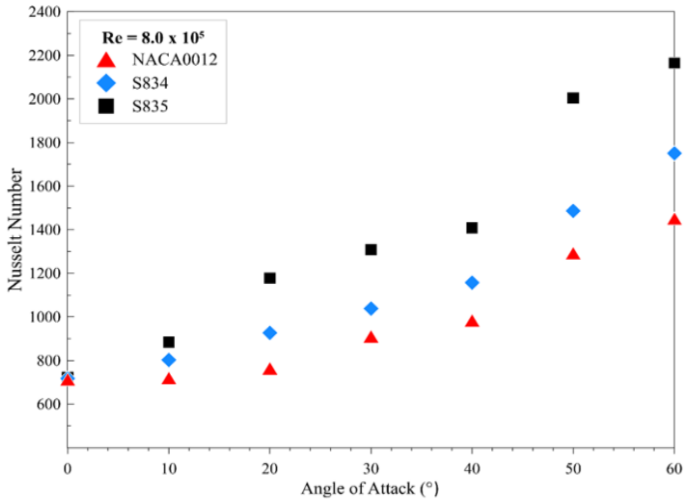

(c)

Figure 3. Variation of Nusselt number with angle of attacks at different airfoil i.e. NACA0012, S834 and S835 (a= Re = 1.6 x 10^5) (b= Re = 3.6 x 10^5) (c= Re= 8.0 x 105)

From Figure 2 and Figure 3 depicted that the variation of heat transfer coefficient and Nusselt number respectively. It has been observed that the heat transfer coefficient increases with the increase in the angle of attack, and this is the maximum at the high 60° angle of attack, as well as the heat transfer coefficient, which increases on the increase of the Reynolds number as shown in Figure 7 and Figure 8. Maximum heat transfer coefficient has been found in 835 airfoil shape. And the increases in angle of attack and Reynolds number, the Nusselt number increases which increase the performance and characteristics of airfoil because the larger number of Nusselt number corresponds to high active convection with turbulent flow and it enhance of heat transfer due to convection over conduction alone. Then the maximum Nusselt number has been found in 835 airfoil shape.

5. Conclusion & Future Scope

The designing optimal airfoil for wind turbine blades are challenging because increased size of the blades needs more strength, load carrying performances, thermal characteristics and flow characteristics. The present work, based on the CFD analysis of the flow over airfoil the following conclusions have been drawn:

- The present work with draw effect the heat transfer and flow characteristics and optimized the airfoil curve shape for the same.
- It has been observed that the, during validation of work in the available literature found good agreement between them and the work in proceed for further analysis.
- In the present work, the three types of airfoil shapes have been investigated which data is taken from the airfoil database to the analysis i.e. NACA0012, S834 and S835. In this analysis, many ranges of angle of attacks (0° to 60°) and Reynolds number (1.6 x 10^5, 3.6 x 10^5, and 8.0 x 10^5) have been used to get the characteristics of the airfoil so that they can get better results. After this analysis, it was found that the angle of attack and Reynolds numbers increases, the heat transfer and flow characteristics like heat transfer coefficient, Nusselt number turbulent kinetic energy, lift-drag ratio increases and losses like friction factor or pressure difference

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