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Numerical Study of Laminar Separation Bubble Over an Airfoil Using γ-ReθT SST Turbulence Model on Moderate Reynolds Number

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Abstract : A parametric study has been conducted to analyse the flow around S809 airfoil of wind turbine in order to better understand the characteristics and effects of laminar separation bubble (LSB) on aerodynamic design for maximizing wind turbine efficiency. Numerical simulations were performed at low Reynolds number by solving the Unsteady Reynolds Averaged Navier-Stokes (URANS) equations based on C-type structural mesh and using γ-Reθt turbulence model. Two-dimensional study was conducted for the chord Reynolds number of 1×105 and angles of attack (AoA) between 0 and 20.15 degrees. The simulation results obtained for the aerodynamic coefficients at various angles of attack (AoA) were compared with XFoil results. A sensitivity study was performed to examine the effects of Reynolds number and free-stream turbulence intensity on the location and length of laminar separation bubble and aerodynamic performances of wind turbine. The results show that increasing the Reynolds number leads to a delay in the laminar separation on the upper surface of the airfoil. The increase in Reynolds number leads to an accelerate transition process and the turbulent reattachment point move closer to the leading edge owing to an earlier reattachment of the turbulent shear layer. This leads to a considerable reduction in the length of the separation bubble as the Reynolds number is increased. The increase of the level of free-stream turbulence intensity leads to a decrease in separation bubble length and an increase the lift coefficient while having negligible effects on the stall angle. When the AoA increased, the bubble on the suction airfoil surface was found to moves upstream to leading edge of the airfoil that causes earlier laminar separation.

Keywords : laminar separation bubble, turbulence intensity, S809 airfoil, transition model, Reynolds number
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