Effect of turbulence intensity on an ultra-low Reynolds number airfoil wake

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Abstract

The work investigates the effect of the turbulence intensity $T_u$ of the oncoming flow on the wake of an NACA 0012 airfoil at chord-based Reynolds numbers, i.e., $Re = 5300$ and 20000. $T_u$ was varied from 0.6% to 6.0%. While the lift and drag coefficients ($C_L$ and $C_D$) of the airfoil were estimated using a load cell, the flow was measured using the laser-induced fluorescence (LIF) flow visualization and particle image velocimeter (PIV) techniques. It has been found that at $Re = 5300$ the airfoil stall is absent for $T_u = 0.6\%$ but evident for $T_u = 6.0\%$. Accordingly, the drag and list coefficients exhibit a marked difference. As airfoil angle of attack varies, three distinct types of shear layers over the airfoil are identified and characterized for $Re = 5300$ and $T_u = 0.6\%$ but four for higher $Re$ or $T_u$. The critical $Re$ at which the separation bubble starts to occur reduces with higher $T_u$. The effect of increasing $T_u$ on flow bears similarity to that of increasing $Re$, though difference does occur.