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Numerical Investigation of the Flow Around Multi-Element Airfoils

Authors : Taylan Ozturk, Osama Maklad

Abstract : This study examines the aerodynamic and flow properties of a multi-element airfoil using computational fluid dynamics (CFD) research. This computational analysis aims to optimize slat design concerning lift-drag coefficients and to determine the ideal gap size between the main airfoil and the front flap. It examines the influence of varying angles of attack and the effects of varied Reynolds numbers. A NACA 2412 airfoil, equipped with custom-designed front and rear flaps, was modeled in SolidWorks and simulated in ANSYS Fluent utilizing the k-ω SST turbulence model. This study quantifies lift and drag coefficients, turbulent kinetic energy, and vorticity magnitude across various configurations. The results clearly indicate that the slat-optimized design geometry featuring a 4 mm gap provides the best performance regarding both lift and drag, with maximum efficiency achieved at a 4-degree angle of attack. Furthermore, the results indicate the initiation of stall conditions beyond 20 degrees and demonstrate how an increase in Reynolds numbers influences flow separation and turbulence patterns. In addition, the maximum L/D ratio which is 36.18 achieved. These findings enhance the comprehension of multi-element airfoil behavior, directly impacting aircraft design and operation, particularly in high-lift situations.

Keywords : multi-element airfoil, CFD simulation, aerodynamic characteristics, Reynolds number analysis
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