

CFD Investigation of Fluid Flow Over Aerofoil With and Without Dimple

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Research

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Abstract

This work labels the effect of dimples on aerodynamic performance of an airfoil. NACA 0018 having a uniform cross section has been evaluated in this study. Eclipse dimpled airfoil is tested and compared with plain airfoil and with the airfoil in the literature [23,24]. Flows taken into consideration are subsonic. The CAD model is drawn in Solid works 2016, while the simulations are performed in Ansys 18.3. A 2-D CFD investigation is performed on both models using k-w turbulence model, subsequently the better one is selected based on the results. 3D analysis is performed on a segment of airfoil having one dimple. Lift and drag coefficients are calculated for various angles of attack. This investigation tells that dimples affect the aerodynamics of airfoil, particularly for various angle of attacks. For smaller angle of attacks, plain airfoil showed less drag and higher lift, but totally different trend is achieved with increasing angle of attack whereas 20° was found to be the optimum angle. The findings proved that dimples on the surface delay the separation of boundary layer by generating additional turbulence on the surface and consequently reduce the formation of wake, which in turn decreases drag significantly.

Full Text

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Figures

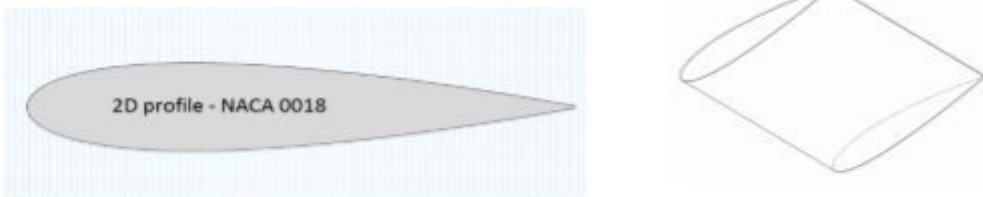


Figure 1

2D NACA-0018 profile

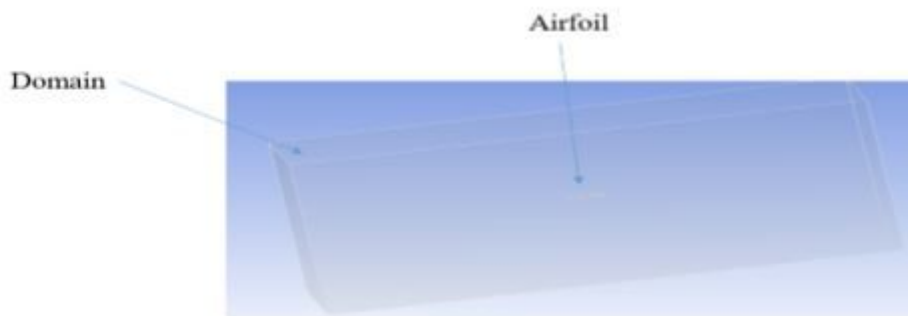


Figure 2

3D model used in simulation with boundaries and domain



Figure 3

Airfoil with eclipse dimple

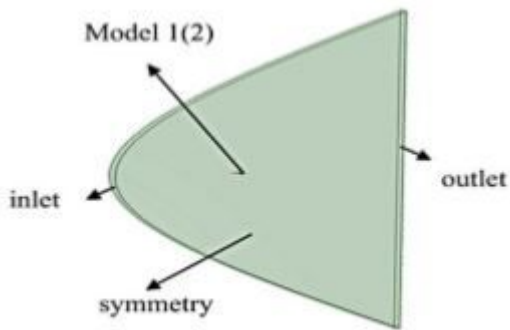


Figure 4

Calculation domain

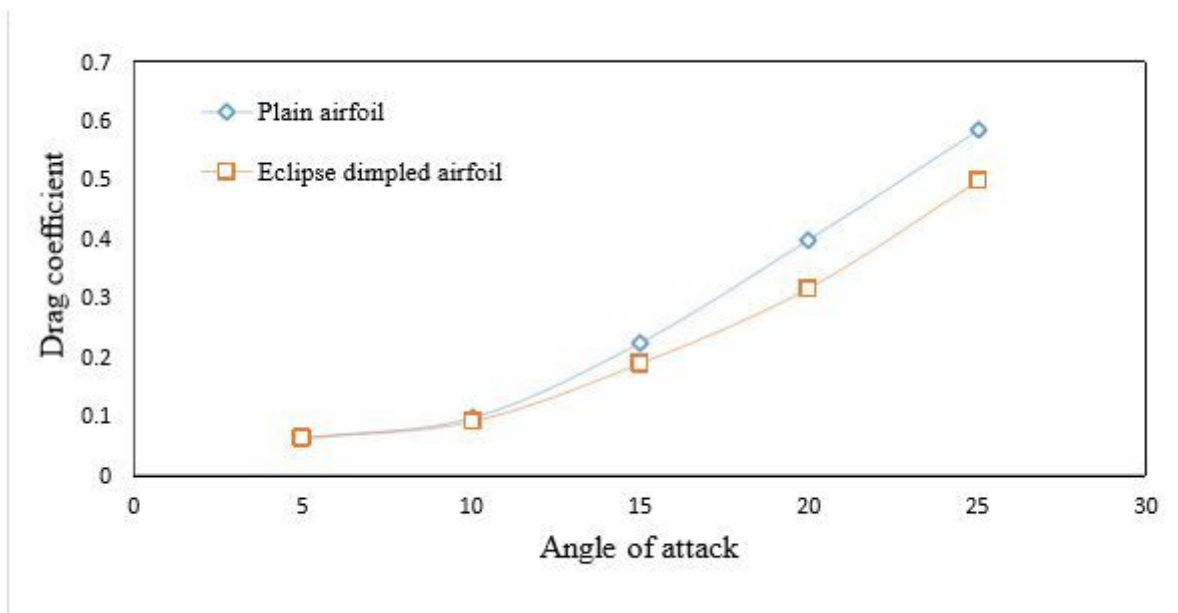


Figure 5

AoA vs drag coefficient for plain and dimpled profiles

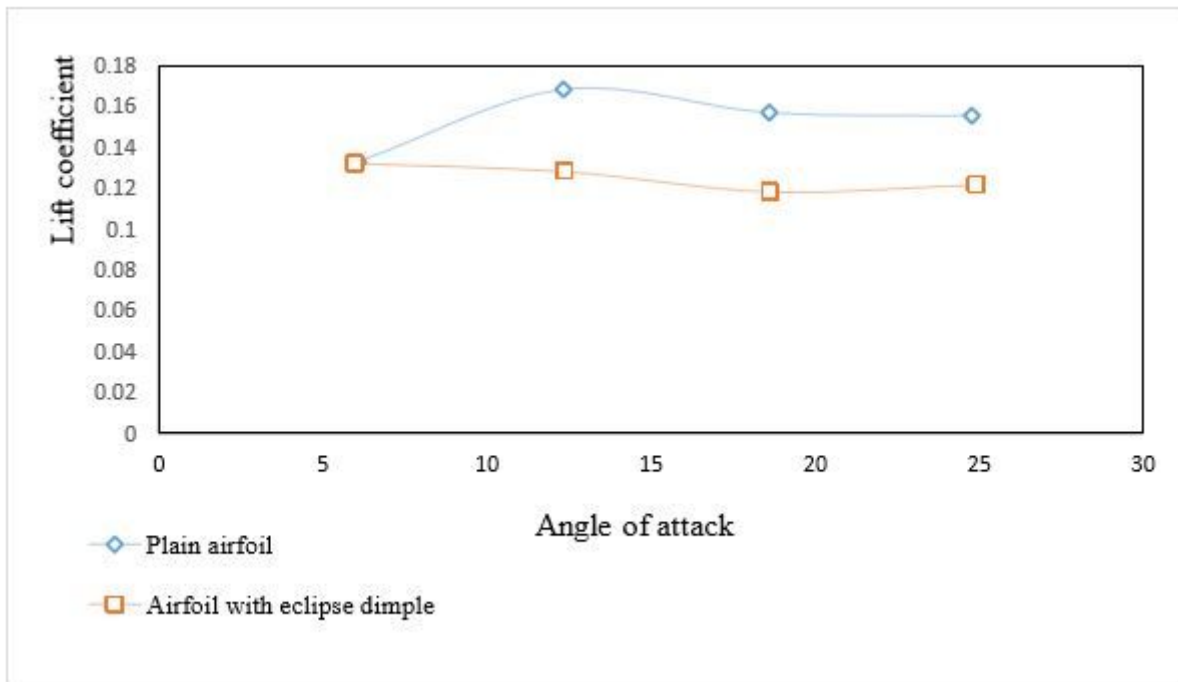
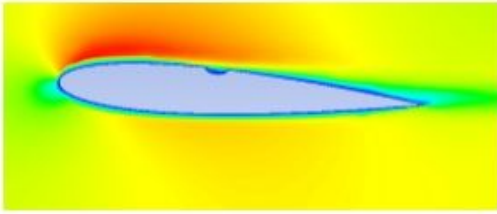


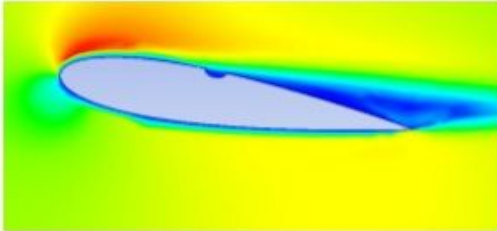
Figure 6

AoA vs Lift coefficient for plain and dimpled profiles

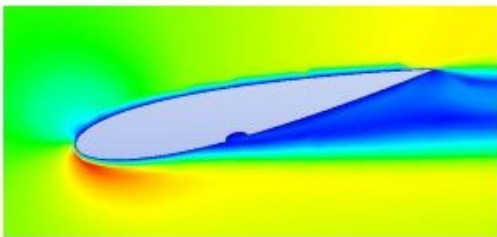
5-degree AoA



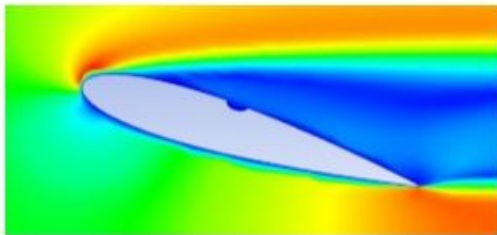
10-degree AoA



15-degree AoA



20-degree AoA



25-degree AoA

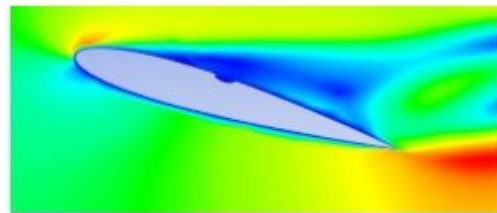
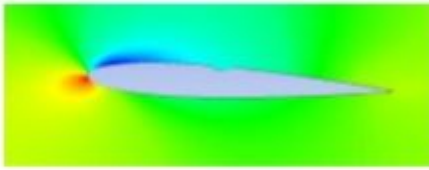


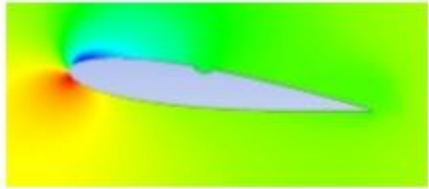
Figure 7

Velocity contours of Eclipse dimpled airfoil at different angles of attack

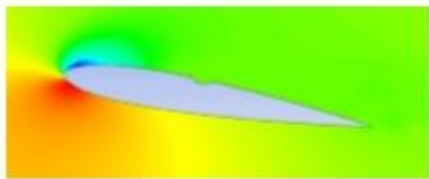
5-degree AoA



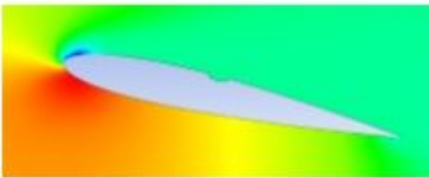
10-degree AoA



15-degree AoA



20-degree AoA



25-degree AoA

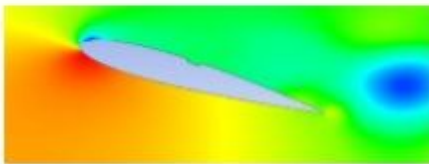


Figure 8

Pressure contours of Eclipse dimpled airfoil at different angles of attack

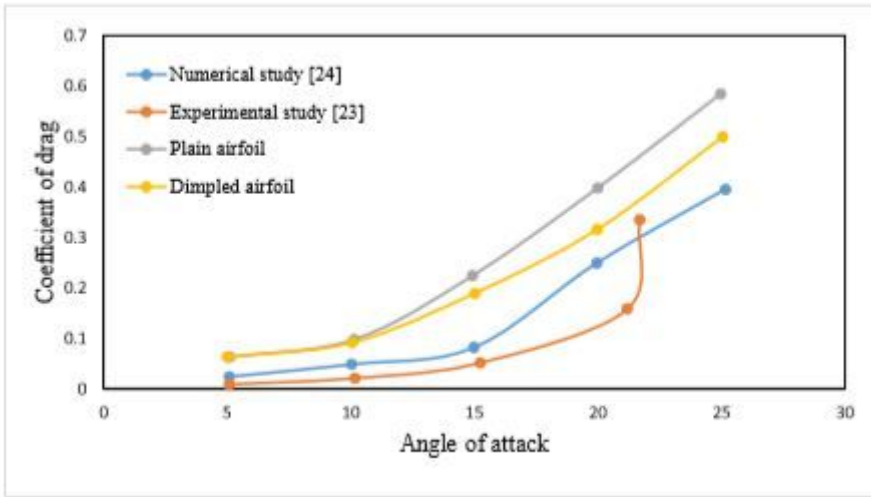


Figure 9

Comparison with literature