AIRFOIL OPTIMISATION AT ULTRA-LOW REYNOLDS NUMBER

N. Varsha*, M.D. Deshpande**, M. Sivapragasam
Department of Automotive and Aeronautical Engineering
Faculty of Engineering and Technology
M.S. Ramaiah University of Applied Sciences
No. 470-P, 4th Phase, Peenya Industrial Area
Bangalore-560 058, India
Email : sivapragasam.aae.et@msruas.ac.in

*Present Address :
Department of Aeronautical Engineering
Acharya Institute of Technology
Bangalore-560 107, India

** Formerly Professor
M.S. Ramaiah University of Applied Sciences
Bangalore-560 058, India

Abstract

In recent times micro-air vehicles are utilised for various civilian and military applications. Because of their small size and low flight speeds they fly in the low Reynolds number (Re) regime. At such low Re the aerodynamic characteristics, most importantly the lift-to-drag ratio (C_l/C_d), are deteriorated. An improvement in (C_l/C_d) can lead to enhanced vehicle performance. The aerodynamic improvements can be achieved by optimising the wing profile geometry. In the present paper, optimisation of an airfoil is done to maximise (C_l/C_d) at Re = 1000. The upper and lower surfaces of a modified NACA 2408 airfoil are parametrised using the Akima interpolation method. The fixed-direction set method is used in optimising the airfoilaerodynamic performance with six control points each on the upper and lower surfaces. A corrugated airfoil, with a trapped vortex within it, is obtained as a result of this optimisation. Further, optimisation is carried out only on the upper surface of the corrugated airfoil with flat lower surface by increasing the number of control points from six to ten. $(C_l/C_d)_{max}$ is 3.718 for the baseline airfoil, while the final optimal airfoil resulted in $(C_l/C_d)_{max}$ of 4.670, a 25.6 % increase.

Keywords: Ultra-low Reynolds Number, Lift-to-drag Ratio, Aerodynamic Shape Optimisation, Fixed-direction Set Method, Corrugated Airfoil, Trapped Vortex