

Examination of the Details of 2D Vorticity Generation Around the Airfoil During Starting and Stopping Phases

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Abstract

This paper presents a numerical study of vorticity generation around a 2D airfoil during the starting and stopping phases of motion. The study focuses on a single NACA0012 airfoil of unit chord where the two-dimensional Navier-Stokes equations are solved using a spectral element DNS code. Results for a small range of low Reynolds numbers from 1,000 to 50,000 will be examined and the results for a zero-lift angle of attack compared to an angle of attack of four degrees. Vorticity production at the surface and the evolution of leading edge and trailing edge vortex shedding will be analysed. Fast vorticity and slow vorticity generation will be investigated by considering impulsively started and uniformly accelerated viscous flows. In addition, the contribution of the two vorticity generation mechanisms, tangential pressure gradients from the fluid side and acceleration of the surface from the wall side, will be compared. Analysis of the results suggest different generation mechanisms dominate different areas on the airfoil surface and observed pair of leading edge vortices and trailing edge vortex. Calculation of the circulation of these vortices allows the vorticity production to be related to the overall lift production.

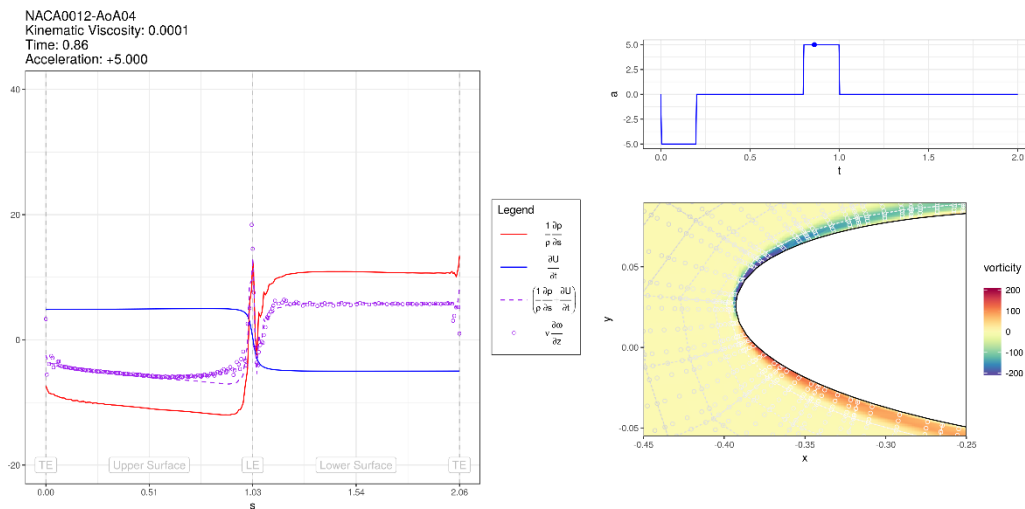


Figure 1: Vorticity production around a NACA0012 airfoil at 4 degrees angle of attack in impulsively started flow.

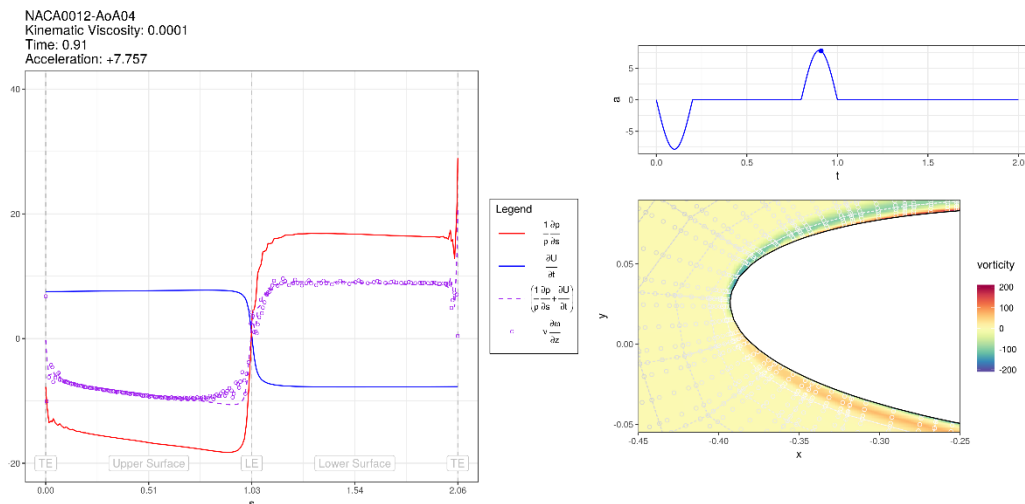


Figure 2: Vorticity production around a NACA0012 airfoil at 4 degrees angle of attack in non-impulsively started flow.

Themes: Aerodynamics, Fluid Structure Interaction, Jets and Wakes