Flow passive control on the NACA airfoils. Experimental and numerical study

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ABSTRACT

The flow control can be used to influence the transition, change the turbulent intensity, influence the detachment in aim to reduce drag and increase lift, optimize energy exchanges, improve comfort and reduce aerodynamic noise. Passive control is the less expensive and the quickest solution to implement, with promising results in the boundary layer separation delay [1, 2, 3]. Vortex generators (VGs) are known to enhance the aerodynamic performances and the most efficiency are the Lin's ones V-shaped when their height is less than the boundary layer thickness [2].

The present work focuses on the control of incipient separation at the upper NACA airfoils by means of VGs with delta shape, and that through the aerodynamic performances. The parietal wall pressure field distribution was measured. A numerical simulation of the three dimensional flow was also undertaken with a CFD software (Fluent).

The airfoils considered are the Naca 4412 and the Naca 0015; the chord length is 150 *mm* and the depth is equal to 200 *mm*. Both airfoils are equipped with pressure taps laid out with the suction face for the measurement of the pressure field. Lift and drag forces were measured by way of an aerodynamic balance connected to the acquisition chain. All the experiments were performed in a Deltalab™ type open circuit. The turbulence rate is fixed by a grid at the entry of 5×5 mm^2. The length and the wind tunnel section are respectively 100 *cm* and 30×30cm^2.

The studied vortex generators are small delta wings placed on line on the suction face of the airfoil, at different locations from the leading edge. The choice of the delta wing configuration type resides in the fact that the delta wing generates two strong vortices at the leading edges which bring momentum in the flow. Different apex angles and heights were considered taking account in the boundary layer thickness which was first numerically calculated.

The obtained results are analyzed versus several parameters such as spacing, the height, the apex angle, and the relative incidence angle of VGs as well as their position according to the chord length. They show an increase in the maximum lift at about 20% and a delay in stall of 2 degrees for the most efficiency apex which equals 45 degrees. On the other hand; the parietal pressure field shows a depression increase near le leading edge in the presence of the VGs. The experimental and numerical results are in a good agreement.

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