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Effect of passive Air Jet Vortex Generator on performance around NACA 0012

F. Tejero*, P. Doerffer†, O. Szulc†

* † Institute of Fluid-Flow Machinery Polish Academy of Sciences
Fiszera 14, 80-952 Gdańsk, Poland
{fernando, doerffer, osmark}@imp.gda.pl

ABSTRACT

A numerical study of air jet vortex generator (AJVG) to delay or suppress flow separation is presented in this paper. The main goal of vortex generators is to change the properties of the boundary layer in order to control the flow and reattach it to the wall.

The proposed technology has been studied for a long time. Wallis and Stuart presented this new concept [1, 2] in 60's. Furthermore, different researchers around the world have compared measurements in wind tunnels with numerical simulations [3-5]. It is well known that the efficiency of AJVG is highly dependence on a lot of parameters such as: skew and pitch angle, mass-flow or main velocity.

Many researchers agree with the effectiveness of AJVG on airfoils for low Mach numbers (up to M=0.3-0.4). For these flow conditions there is an increase of lift coefficient and critical angle of attack with minimal drag penalty. When the Mach number is increased some publications [5] claim a very effective influence of AJVG but some [6] claim that the aerodynamic response of the airfoil decreases significantly. This phenomenon is important not only for wings but also for helicopter rotors (M=0.7-0.9).

Numerical simulations presented in this papers are for M=0.8 (in the range of velocity near the tip of helicopter rotors) and Reynolds number equal to $9 \cdot 10^6$. Due to these, the values are comparable to the conditions during the flight of a helicopter. Grid is prepared in such a way that the air jet is blown with total conditions of the farfield. Considered system is therefore passive.

Numerical results show that the proposed technology can modify the boundary layer also for high Mach number flows. There are areas of maximum and minimum stagnation pressure which means that the flow is twisted and high vorticity areas appear.

Figure 1 shows the behavior of the main flow due to the influence of the air jet vortex generator. Streamlines show how the vortex is formed. Stagnation pressure contour plots show how much space the vortex takes. Moreover, Figure 2 presents the distribution of friction coefficient (C_f) on the upper wall of the airfoil. The C_f distribution changes dramatically when AJVG is used. There is a delay of flow separation which brings an increase of the aerodynamic response of the airfoil.

C_L-C_D polars for both configurations (with and without AJVG) will be showed in the paper and the improvement of efficiency for this technology on airfoils for high Mach number will be proven.

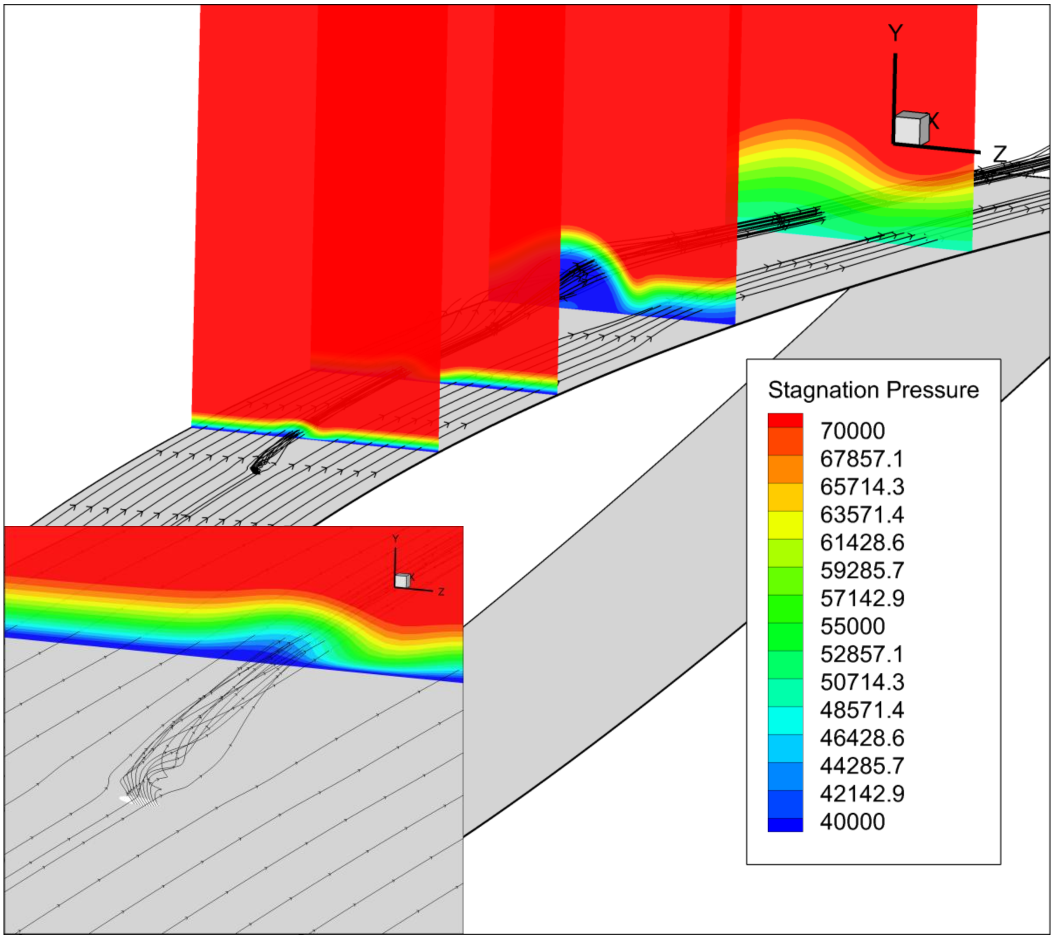

Figure 1. Streamlines and stagnation pressure maps for different sections

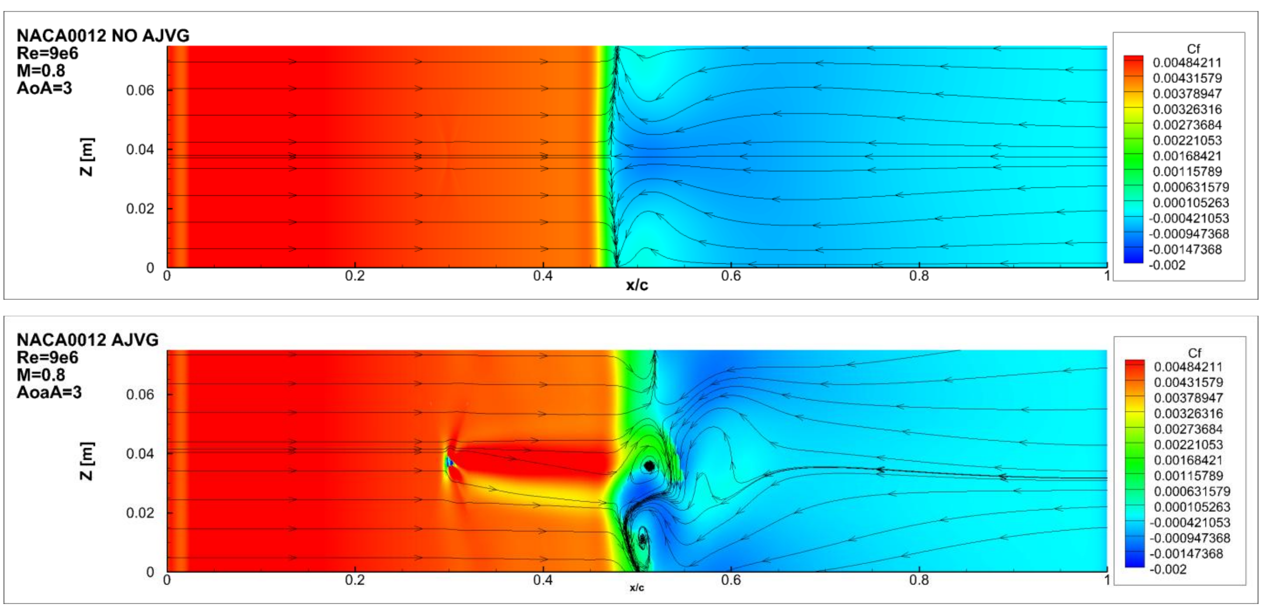

Figure 2. Comparison of influence for AJVG technology

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