An Investigation of Jet-Assisted Surface-Mounted Actuators in Laminar and Turbulent Boundary Layers

Mertzlufft, Lilly (School: Burnt Hills-Ballston Lake High School)

Flow control offers an appealing method to improve efficiency, stability, and performance of aerodynamic bodies. Jet Assisted Surface Mounted Actuators (JASMAs), a form of hybrid (active and passive) flow control, were investigated using Planar Particle Image Velocimetry (2D PIV) with all data taken at the mid-span of the JASMA. Four different JASMAs were studied; three with a height of 12mm with a synthetic jet orifice pitch of 0°, 20° and 45°, and a 6mm JASMA with an orifice pitch angle of 0°. Data was taken within laminar and turbulent boundary layers with two blowing ratios (Cb) per boundary layer; Cb=1.0 and Cb=1.5 within the laminar boundary layer at a JASMA diameter-based Reynolds number of 8.11x10^3, and Cb=0.25 and Cb=0.5 within the turbulent boundary layer at a JASMA diameter-based Reynolds number of 2.43 x10^4. Within the laminar cases, the synthetic jet aided in accelerating the region of reverse flow behind the JASMA and assisted in reattaching separated flow along the leading edge of the JASMA. Within the turbulent boundary layer, the Cb=0.25 showed no effect from the synthetic jet on the static pins' structures, while the Cb=0.5 cases appeared to accelerate flow in the reverse flow region. Furthermore, phase-locked sets of data revealed a global phenomenon in laminar cases, indicating the synthetic jet affects both downstream and upstream flow, and possibly the shedding of the arch-vortex. This data provides support for the use of JASMAs in improving aerodynamic properties.

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