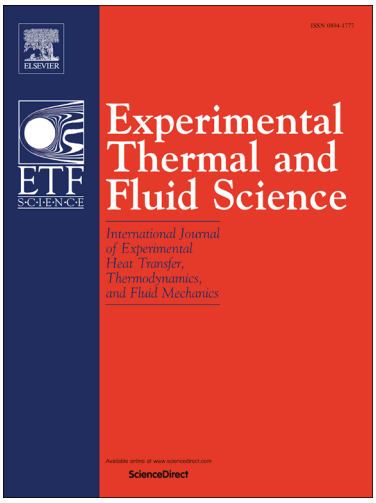

Mid-Wake Wing Tip Vortex Dynamics with Active Flow Control

Marouen Dghim, Mohsen Ferchichi, Hachimi Fellouah

PII: S0894-1777(18)30881-1
DOI: https://doi.org/10.1016/j.expthermflusci.2018.05.011
Reference: ETF 9476

To appear in: *Experimental Thermal and Fluid Science*

Received Date: 24 July 2017
Revised Date: 10 May 2018
Accepted Date: 12 May 2018

Please cite this article as: M. Dghim, M. Ferchichi, H. Fellouah, Mid-Wake Wing Tip Vortex Dynamics with Active Flow Control, *Experimental Thermal and Fluid Science* (2018), doi: https://doi.org/10.1016/j.expthermflusci.2018.05.011

Mid-Wake Wing Tip Vortex Dynamics with Active Flow Control

Marouen Dghim[a,b,*], Mohsen Ferchichi[b], Hachimi Fellouah[a]

[a] *Department of Mechanical Engineering*
Université de Sherbrooke
2500 bould de l'Université, Sherbrooke, QC, Canada, J1K 2R1
[b] *Department of Mechanical and Aerospace Engineering*
Royal Military College of Canada
PO Box 17000 Station Forces, Kingston, ON, Canada ,K7K 7B4

Abstract

The development of a wing tip vortex under the effect of synthetic jet (SJ) actuation was examined for a rectangular, square-tipped wing having a NACA 0012 airfoil using hotwire anemometry at a chord Reynolds number $Re_c = 8 \times 10^4$. Three control configurations were considered for a comparative study, namely case C1 with momentum coefficient $C_\mu = 0.004$ and an actuation frequency $F^+ = 0.96$, case C2 with $C_\mu = 0.04$ and $F^+ = 0.96$ and case C3 with $C_\mu = 0.04$ and $F^+ = 0.29$. Under case C3, the vortex was stretched into an ellipsoid shape with a nearly 60% decrease in the peak circumferential velocity and the core axial vorticity. The vortex core radius largely broadened suggesting that the lower frequency control configuration allowed the synthetic jet to travel larger distances into the vortex bringing turbulent structures within its core. This resulted in an increased mixing and subsequently a more diffuse vortex. Measurements of the vortex development in the near and mid-wake regions (up to $x/c = 5$) showed that the circumferential velocity was largely reduced under the effect of the SJ actuation. The enhanced turbulent mixing at the inner region of the vortex resulted in an accelerated outward diffusion of its core even under non-optimal control configurations.

Keywords: Synthetic Jet Actuation, Wing tip Vortex, Turbulence

Nomenclature

A_j Synthetic jet slot area, m^2

A_w Half-wing planform area, m^2

*Corresponding author
Email address: marouen.dghim@usherbrooke.ca (Marouen Dghim)