FLOW STRUCTURE ANALYSIS CLOSE TO AIR JET VORTEX GENERATOR

Pawel Flaszynski

Gdańsk University of Technology, Mechanical Engineering Faculty
Narutowicza 11/12, 80-233, Gdańsk, Poland
e-mail: pflaszyn@pg.gda.pl

Streamwise vortices (SV) have been known already for a very long time to play an important role in flow control methods. Typical vortex generators (VG) are currently of the fixed type (vane type). But already in the 70's it was shown that air-jet vortex generators (AJVG – Fig.1) are of the same effectiveness as fixed VGs even in supersonic flows. In the 90's the research on AJVG was continued in subsonic flow regime [1][2]. In the case of internal flows, as in gas turbines, many devices of heat exchange control are used. Very often an injection of coolant through holes and slots is applied in gas turbines. It is proposed here to take into account that the cooling jets may be used for the flow control as well. Enhancement of mixing and simultaneous introduction of flow control may be reached by applying jets as streamwise vortex generators. Application of AJVG in turbomachinery needs very careful consideration because the flow structure in these machines is three-dimensional and very complex. Due to the flow complexity in turbomachinery passages, the basic study of the streamwise vortex generator and the interaction of the streamwise vortex with the horseshoe vortex have been already performed [3],[4]. Streamwise vortices generated by air jets can also be applied for the control of shock wave–boundary layer interaction, stabilization of the shock wave oscillations and reduction of the flow separation. Shock wave induced separation control by means of AJVG was also investigated within a framework of European Project UFAST [5]. The evolution of the generated streamwise vortex is sensitive to flow structure near the jet. In the paper, the analysis of the flow structure near the jet for different AJVG configurations is performed. Based on the CFD results (RANS and LES), the vortex structure upstream and downstream of the AJVG is visualized.

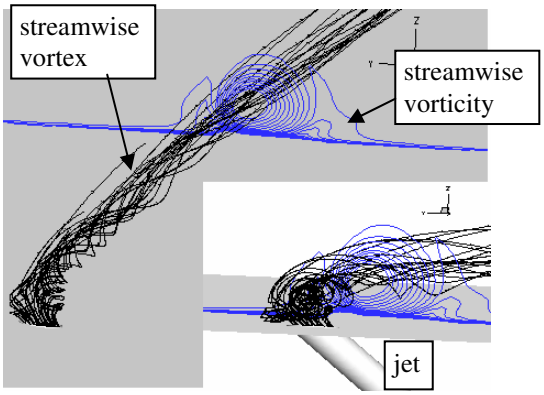

Fig.1 Air Jet Vortex Generator (AJVG)

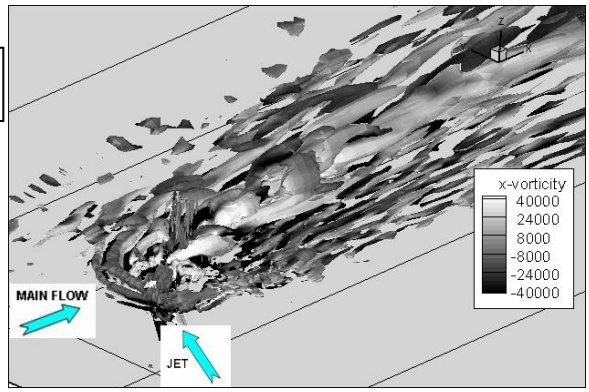

Fig.2 Vortices downstream of the AJVG (Large Eddy Simulations)

References

[1] COMPTON D.A., JOHNSTON J.P.: Streamwise Vortex Production by pitched and Skewed Jets in a Turbulent Boundary Layer. AIAA Journal, March 1992, vol. 30, no

[2] KUPPER CH., HENRY F.S.: Numerical Study of Air-Jet Vortex Generators in a Turbulent Boundary Layer. Applied Mathematical Modelling, 2003, vol. 27

[3] DOERFFER P., FLASZYNSKI P., MAGAGNATO F.: Streamwise Vortex Interaction with a Horseshoe Vortex. Journal of Thermal. Science, 2003, vol. 12 no. 4

[4] FLASZYŃSKI P., SZWABA R.: Experimental and numerical analysis of a streamwise vortex generator for subsonic flow. Chemical and Process Engineering, 2006, vol. 27 no.3

[5] SZWABA R, FLASZYŃSKI P. SZUMSKI J., TELEGA J. : Shock Wave – Boundary Layer Interaction Control by Air-Jet Streamwise Vortices, Proceedings of the 8th International Symposium on Experimental and computational Aerothermodynamics of Internal Flows, 2007, Vol.2, p.541-547