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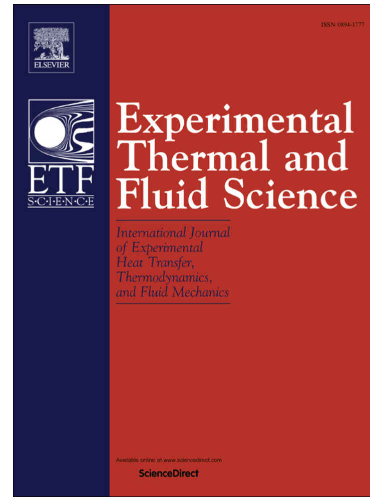

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On the flow organization of a chevron synthetic jet

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Abstract

In the present study, the flow fields generated by two synthetic jets with a chevron and a conventional circular nozzle exits are studied and compared. For both configurations, the devices are operated at the same input electrical power, thus leading to Reynolds and Strouhal numbers equal to 5600 and 0.115 (for the circular exit) and 6000 and 0.106 (for the chevron exit). Phase-locked stereoscopic particle image velocimetry measurements are used to reconstruct the three-dimensional coherent vortex structures. Time-averaged and phase-averaged mean and turbulent statistics are analysed and discussed. The flow field strongly depends on the exit geometry. In presence of the chevron exit, the conventional vortex ring issued through the circular nozzle exit, is replaced by a non-circular vortex ring with additional streamwise vortices. The mutual interaction between these structures prevents the axis-switching of the non-circular vortex ring during its convection. These streamwise vortices disappear convecting downstream and the vortex ring assumes a circular shape. Comparing the two configurations, the chevron exit generates a larger time-averaged streamwise velocity along the centreline but with lower turbulent kinetic energy intensity. Differences are also present between the notch and the apex planes of the chevron exit. In the notch plane, both the time-averaged axial velocity component profile in the spanwise direction and the shear-layer width are wider than in the apex plane. Furthermore, the presence of the streamwise vortices causes a flow motion towards the jet axis in the apex plane and an opposite motion in the notch plane.

Nomenclature

D	nozzle exit section diameter, m
f	oscillating frequency of the membrane, Hz
$f_{\#}$	numerical aperture
f_2	acquisition frequency, Hz
k	natural number
L_0	stroke length, m
N	number of the instantaneous vector fields for a given phase angle