EXPERIMENTAL AND NUMERICAL STUDY OF IMPINGING FLAPPING JET ON A V-SHAPED PLATE

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The objective of this project is to investigate experimentally and numerically the flapping motion of a planar jet impinging on a V-shaped plate. This topic has been studied for several decades, but up to today no detailed description of this unsteady physical phenomena has been completely provided.

The problem of flapping jet occurs in many industrial problems, e.g. cooling of electronics and moving metal strips as well as thermal anti-icing systems in airfoils.

Therefore this study is focussed on the analysis of the 2D flow characteristics, in terms of velocity and pressure distribution on the V-shaped plate. The methodology consists in obtaining an experimental database to be compared to CFD simulation to assess validation of the numerical tool.

The pressure distribution on the walls is measured by pressure transducers connected to taps drilled on the concave plate. The flapping frequency deduced from pressure measurement agrees quite well with hotwire measurements and data found in literature.

Flow behaviour has also been investigated by means of PIV technique. Stereoscopic PIV has been applied to describe the unsteady jet flow statistically.

It is shown that the flapping jet behaves as a whole jet column which exhibits a prominent characteristic frequency f, which depends mainly on the exit jet velocity u and the stand-off distance L between the apex of the V-shaped plate and the nozzle exit. The flapping is characterised by a constant Strouhal number Sr, the value which depends on the nozzle-V-plate geometry.

For Computational Fluid Dynamics, mesh grids have been created with Gambit and simulations have been performed with Fluent in unsteady case with k-ε and LES turbulence models, respectively. Figure 1 and 2 allows comparison of an instantaneous velocity field between PIV results and CFD simulation.

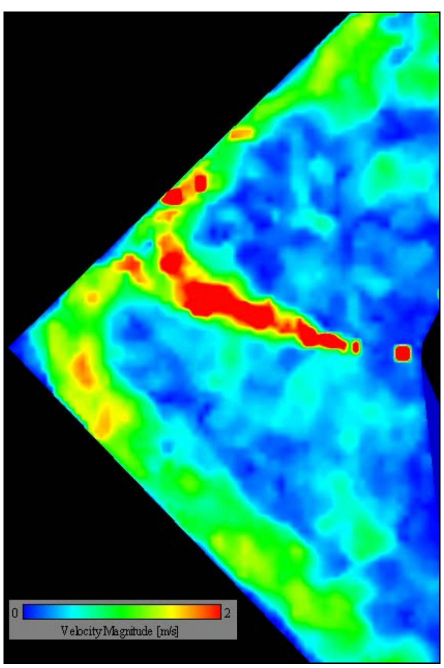

Figure 1: Experimental velocity field by PIV

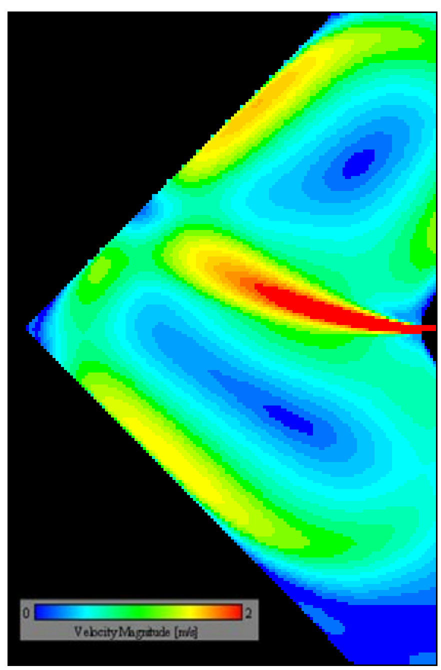

Figure 2: CFD velocity field by k-ε model