

Experimental study on the flow characteristics of streamwise inclined jet in crossflow

N. Mahjoub Saïd¹, J. Stefanini², P. Bournot³, S. Darreau², P. Caminat³

1: Faculté des Sciences de Monastir, Tunisia
 2: TSI France, Marseille, France
 3: UNIMECA, Marseille, France

Keywords: PIV, Inclined Jet

The introduction of a jet of fluid transversely into a moving stream is a basic configuration which finds application in many engineering fields. Examples include vertical takeoff and landing engineering, film cooling of gas turbine blades and environmental problems such as pollutant dispersion from chimneys or the discharge of effluents into the ocean. Enhancement of the mixing rate between jet and crossflow can lead to significant improvements in many performance aspects. Because of the great practical significance, numerous experimental and theoretical studies have been carried out on the jet -in-a-crossflow problem.

The jet in a crossflow is a flow with a wide range of applications owing to its ability to mix two streams of fluid efficiently. It is characterized by a strong three-dimensional flow field, complex interactions between two streams of fluids (i.e. jet fluid and crossflow fluid) and several interacting flow regions (i.e. the crossflow, the jet, the wake behind the jet, the pipe/ orifice flow and the wall boundary layer).

The ultimate objective of this work is to study the effects of different velocity ratios and Reynolds numbers. The jet was injected at different velocity. The three velocity components and the complete turbulent stress tensor have been calculated around and behind the jet. A topological map of the flow field is presented.

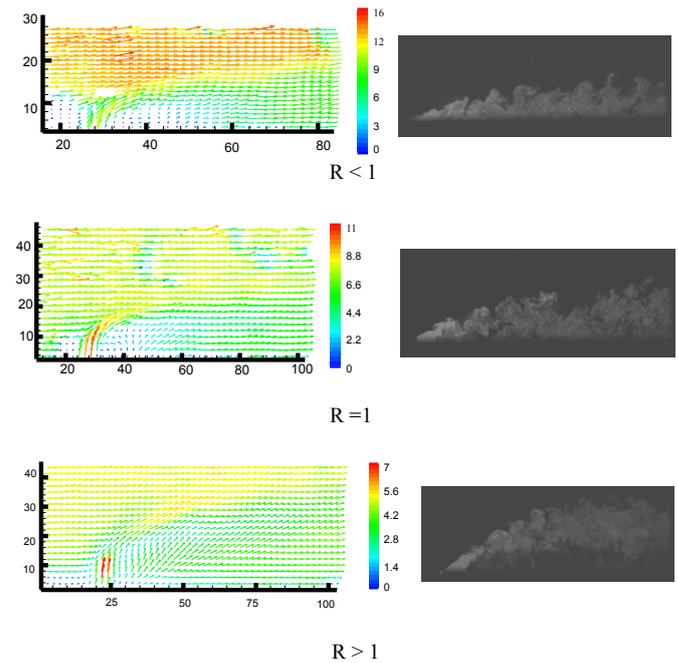
The prominent feature of the flowfield is that the jet fluid is deflected in the direction of the crossflow as its cross section quickly assumes a kidney shape, dominated by a pair of counter-rotating vortices. A mixing layer develops on the periphery of the jet as the potential core of the jet ends as a cone, slightly bent in the direction of the crossflow.

In order to understand the flow patterns of a plume issued from an inclined jet into a crossflow at large plume-to-wind velocity ratios, we conducted a series of experiments using a Particle Image Velocimetry (PIV) technique. The visualized flow patterns and measured velocities on the vertical symmetric plane are presented to illuminate the interactions between the crossflow, plume, and inclined jet.

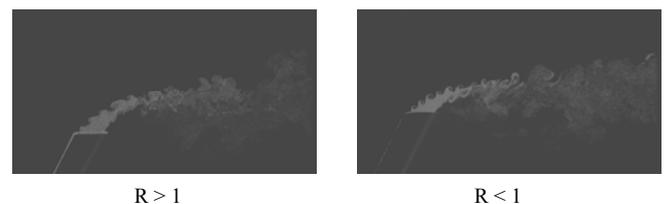
The paper presents a three-dimensional experimental study of inclined circular turbulent jet issuing transversely into a uniform air stream. The dynamic field of a turbulent jet issuing transversely with velocity v_0 into a uniform air flow with velocity u_∞ are examined as functions of the ratio $R = v_0/u_\infty$. We examined the behavior of the flow in its various regions.

The complex geometry of these structures in the wake of the plume as well as their interaction with the plume as it bends over after emission is discussed. In this paper we describe the Kelvin-Helmholtz vortex structures. According to R values, the development of Kelvin-Helmholtz peripheral instabilities is noticed. The spacing between

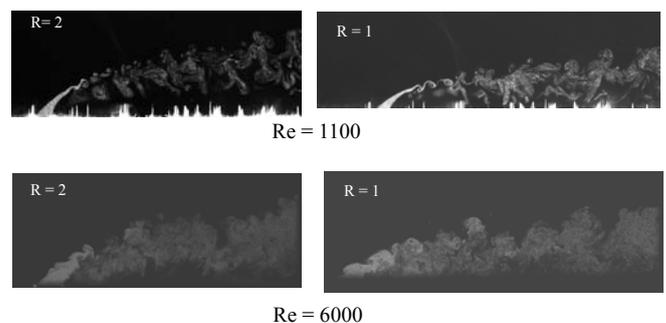
vortices can be regular. The pattern's rotational direction is imposed by the value of R .



Mean velocity field, Evolution structure



Kelvin-Helmholtz structures



The effects of the Reynolds number