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IMPACT OF A TWIN JET'S INITIAL TRANSVERSE INCLINATION ON ITS DYNAMIC EVOLUTION WITHIN A COOL CROSSFLOW

*** A. Radhouane[1], N. Mahjoub Said[1], H. Mhiri[1], G. Le Palec[2] and P. Bournot[2]**

[1] Ecole Nationale d'ingénieurs de Monastir
Route de Ouardanine, 5000, Monastir, Tunisie.
radhouane_amina@yahoo.fr

[2] Technopôle Château Gombert
60, rue joliot curie, 13453 Marseille,
France

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ABSTRACT

Jets in crossflow find application in various industrial applications such as film cooling, stacks exhaust, rivers waste, V/STOL aircraft, etc… studying such flowfields aims especially to improve the efficiency of the corresponding applications and to reduce the environmental damages they may result in.

Many authors examined the single and multiple jets' configurations within crossflows but too few concentrated on the twin jets in crossflow's one. Zieger and Wooler [1] belong to the pioneering researchers that concentrated on a double jet configuration exhausting normally into a crossflow. The considered jets were aligned both tandem and side by side and were explored by means of a physical elaborated model. The most recent work is that of Kolar et al. [2] where they carried out a brief survey of the recent studies focusing on ''twin jets in crossflow'' (TJICF). A particular emphasis was put on the new velocity-field analysis based on kinematic decomposition techniques.

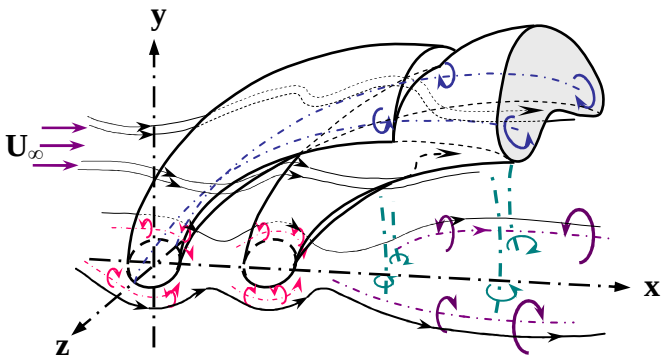

Fig.1: Visualization of the different vortices engendered from the twin jets' interaction with the environing crossflow

In this paper we will conduct a numerical study of a double jet emitted into a cool crossflow in order to follow their progressive mutual evolution, their interaction and the

different structures they engender. A complex resulting flowfield is obtained, and accurate predictions of the flow dynamics, heat and mass transfer has been proved difficult to obtain, particularly in the near field of the injected jets. In fact, the introduction of the jets among the crossflow brings structural changes manifested by four main vortices (Fig.1): the horseshoe vortex, the wake vortices, the shear layer vortices, the contrarotating vortex pair (CVP), the ring like vortices; others may appear also and that under special conditions. These features and others are affected by several parameters such as the jets nozzles' spacing, the jets height, etc... In this paper we will essentially treat the jets' inclination and its impact on the resulting flowfield characteristics.

A three dimensional numerical model of the handled configuration is conceived and simulated by the resolution of the Navier Stokes equations and the use of the RSM second order turbulent closure model. Then a non uniform meshing, particularly refined near the nozzles' exit, was applied to the model. The initial adopted geometric configuration consisted in two circular similar jets, three diameters spaced in the crossflow's direction, with a transverse inclination of 60° (Fig.2).

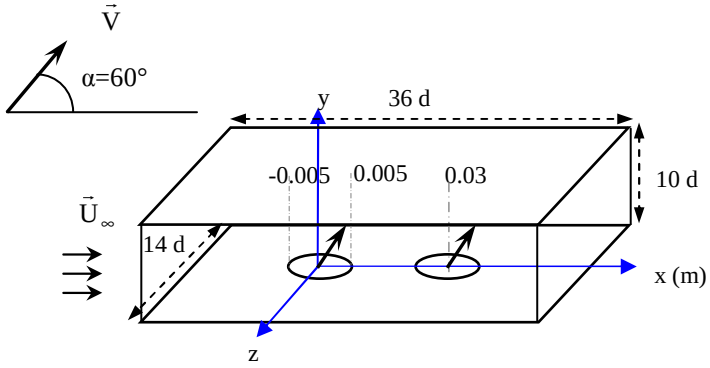

Fig. 2: Spatial disposition of the twin jets' nozzles among the total domain

The confrontation of the calculated and experimentally measured longitudinal and vertical velocity components gave a good level of agreement. After validation, we could represent the different velocity components' distributions as well as the thermal and mass distribution behaviors and the effects the variation of the injection inclination brings on them.

The main result to draw is that a lower initial inclination guides the jets rather downstream and retains them close to the injection plate; in the cooling case this can be advantageous in order to homogenize the injection plate temperature when the plate undergoes high heat fluxes.

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