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Volume Reconstruction of an Impinging Jet Obtained from Stereoscopic-PIV Data Using POD

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Abstract

Ventilation and air conditioning systems are specified by the configuration of jets which may interact with sharp edges when travelling from the nozzle. These configurations could in some cases be a source of aerodynamic and acoustic discomfort. In order to solve this disadvantage, the volumetric flow dynamics involved in these configurations should be understood and controlled. The objectives of the present study is to reconstruct and analyse the volume using stereoscopic PIV measurements (SPIV). To do so, an experimental platform has been developed to generate a flow at different Reynolds numbers. The dynamics of these flows are investigated experimentally using the PIV technique. The kinematic fields of parallel planes are measured by SPIV acquisitions in order to study the corresponding fluid flow. The snapshot proper orthogonal decomposition technique (POD) is applied in order to obtain the most energetic modes of the jet. Three modes were sufficient to reconstruct each of the measured planes. A trigger signal was chosen to determine the phase of the planes which are unsynchronised. The volume is afterwards, obtained by an interpolation of the reconstructed planes. This reconstruction is highlighted in order to study the dynamics of the transverse vortices. Several vortex detection criteria have been tested to locate and analyse the vortex structures.

Keywords Impinging jet; Stereoscopic; PIV; Snapshot POD; Volume reconstruction

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1. Introduction

Impinging jets upon a solid wall are an important class of fluid flow configurations. They are of high importance in many engineering applications, particularly those concentrating on heating, cooling or drying. One of the configurations studied is the circular impinging jets that were studied by El Hassan et al. ([1] & [2]). Another application of these jets is the plane-impinging jets, which are widely used in ventilation systems in order to improve indoor air quality and energy consumption. Indoor air quality can be improved by adding grids to the ventilation system. Such a system can lead to a noisy configuration when an obstacle is present in the flow. These configurations appear noisy when the confinement and blowing conditions are conducive to the development of self-sustaining sounds loops. These feedback loops are born when the energy transfer between the dynamics of the flow and the sound field are optimal. Many studies discussed these acoustical loops obtained in plane jets impinging a slotted plate. The acoustic study of such a configuration was detailed by: Billon et al. [3] [4], Glesser et al. [5] and Assoum et al. [6] [7] [8] [9] [10]. In fact, Billon analysed the flow instabilities that produce a slot tone and the coupling between the slot tone and acoustical resonances of the flow supply duct. Glesser investigated the aero acoustical coupling of a jet-slot oscillator to the acoustic resonances of the flow-supply duct. On the other side, Assoum used another technique to study the plane jets impinging on a slotted plate. Assoum has treated experimentally this configuration using the time-resolved PIV technique allowing the measurement of the 2D velocity vector. He studied the plane dynamical phenomenon and its coupling with the acoustic field as in [8], as well as the relation of trajectories of the vortices with the acoustic level [7]. These studies were done with respect to three

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