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29th August 2013

master's thesis – experimental

Corner-Vortex Characterization in Open and Closed Square Ducts

Background

Flow through non-circular (straight) ducts and flumes is characterized by secondary vortices (Prandtl's second kind). Generally, the maintenance of such vortical structures implies energy consumption, thus leading to an increased pressure drag. Furthermore, this secondary flow results in wall-shear-stress variations along the wetted perimeter or can cause sediment motion in river beds, for instance. Consequently, detailed knowledge of these phenomena is of prime importance for successful flow control in ducts and flumes such as drag reduction and flow mixing.

Content of the Thesis

The experimental investigations of open and closed duct geometries are performed by means of stereoscopic Particle Image Velocimetry (SPIV) for varying Reynolds numbers (see Figure 1). The obtained raw data is processed with the Matlab-based open-source code OSIV. As such, 3D-velocity information is calculated from the recorded particle displacements. Spatial distributions of mean quantities such as average velocity, root-mean-square values (rms) and Reynolds stresses are determined for the resulting velocity distributions. Further post-processing by means of Proper Orthogonal Decomposition (POD) provides a modal basis of contained flow patterns. The analysis of such patterns (POD-modes) allows to identify coherent structures from the rms-value distributions. Additionally, in case of a comparative analysis of open and closed ducts an evaluation of similarities between the two considered geometries is possible.

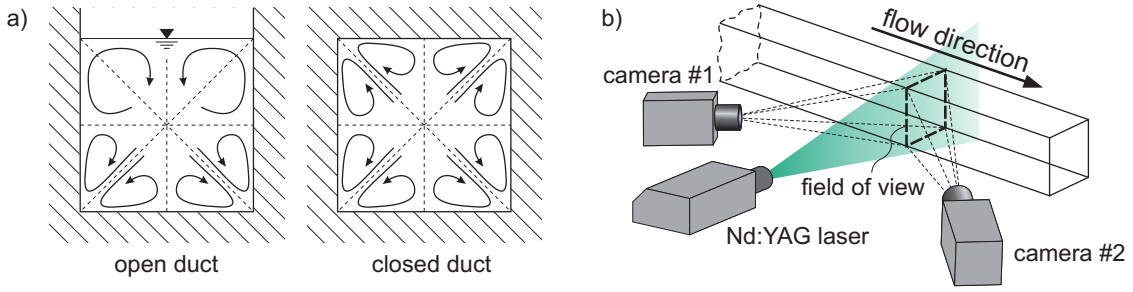

Figure 1: Sketch of (a) the considered cases and (b) the experimental setup in the water tunnel.

Requirements

good knowledge of fluid mechanics,
programming with Matlab

Beneficial Skills

basic knowledge about turbulent flows,
experience with flow-measurement techniques

Time Frame: immediately

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