STEREO PIV AND LDA MEASUREMENTS AT THE AXIAL FAN OUTLET

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KEYWORDS:

Main subjects: Experimental fluid mechanics, flow visualization
Fluid: incompressible flow
Visualization method(s): particle image velocimetry
Other keywords: swirl flow, turbulence

ABSTRACT: Turbulent swirl flow in the field of hydraulic machines and systems occupies attention of many researchers in laboratories and industry, as it has significant influence on energy consumption and fan design. Physical understanding of this phenomenon would enlighten many unsolved problems and help developing new turbulent numerical models for CFD analysis. Distribution and mutual influences of the time averaged and fluctuation velocity fields to each other have been investigated in this paper. Experimental test rig is consisted of circular pipe 27.74·D long, where D=0.4m is pipe inner diameter. Specially designed axial fan, which generates Rankine's type swirl, is positioned at the test rig inlet following profiled free-bell mouth inlet. Stereo particle image velocimetry (SPIV) and one-component laser Doppler anemometry (LDA) measurements have been conducted in the measuring section x/D=3.35 from the test rig inlet. SPIV measurements have been performed in the specified cross-section by use of the TSI system with 15Hz dual Nd:Yag laser (power 30mJ/pulse, wavelength 532nm) and two 12-bit CCD cameras with resolution of 1660x1200 pixels. Olive oil atomizer which generates particles with average size 0.6μm was used for flow seeding. Measurements were performed in backscatter mode. Dantec model Flow Explorer Mini LDA with 300mm focus, wavelength 660nm, laser power 35mW and measurement volume 0.1x0.1x1mm was used for LDA measurements. It works in backscattered mode, also. Fog generator Z-3000II Antari, with water based fluid, was used for flow seeding. In this way, sampling rate bigger then 25 kHz for circumferential component was possible. In this paper is presented vortex core dynamics for five Reynolds numbers defined with five equally distributed fan rotation numbers in the interval n=500 till 2500rpm. Measuring repeatability was obtained for both SPIV measuring cases, with laser frequency 2 Hz (Fig.1a and b) and 7Hz, for each regime, with respectively 400 and 99 taken pictures. Distribution of the statistical moments of higher order and correlation, determined on the basis of LDA measurements, gives better understanding of the turbulent swirl velocity field. Visualization with Nd:Yag laser, 32fps camera and paraffin oil has been performed in the cross section x/D=26.31 (Fig.1c) for better understanding of the vortex core dynamics.

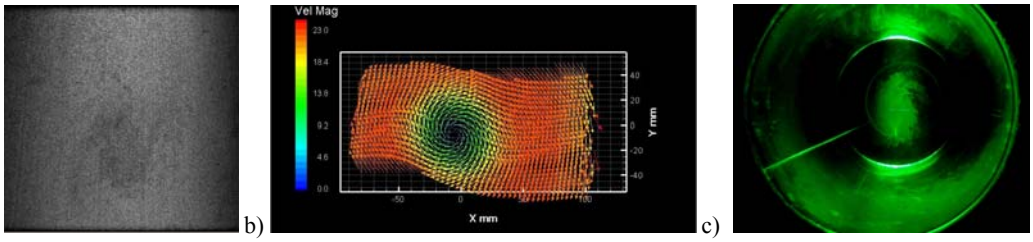

Fig. 1 a) SPIV flow visualization and quantification, b) time averaged velocity field and c) Nd:Yag laser visualization.

References

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