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Hot Wire Anemometry and Numerical Simulation Applied to the Investigation of the Turbulence in a Gap Flow

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Internal turbulent flow that develops in channels with narrow gaps may give rise to large vortices that dominate the gap vicinity yield a fashion movement in the time history traces of velocity fluctuation. Such quasi-periodic flow field also produces an important spanwise velocity component that is the main responsible for exchanging mass, momentum and energy between adjacent subchannels connected by narrow gaps [1]. Reliable description on such phenomena, in terms of average fields and the flow dynamics, is quite relevant to predict the, for instance, the convective heat transfer, or even, vortices inducing vibration in package of rod disposed in arrays. This work is aimed to characterize the structure of the turbulence in a rectangular channel containing a single rod bundle $D = 60\ mm$. The work was carried out numerical and experimentally. In the experimental campaign a single rod bumble, as long as $33.30\ D$, is placed in a rectangular channel. The rod is carefully located near the channel's top wall forming a narrow gap, $d = 0.10\ D$, between the rod and the wall, which connects two main channels. We run our experiments using single straight hot-wire probes in order to obtain the velocity fluctuations and the mean average fields of turbulence intensity and axial velocity as well. The experimental work was performed under a Reynolds number $Re_{Dh} = 52{,}100$, based on the bulk velocity, U_{bulk}, the hydraulic-diameter, D_h, and the kinematic viscosity, ν of the fluid (air). The experimental data were compared with our numerical results. Numerical runs were obtained by using a commercial platform. To safe computational resources we choose to apply translational periodicity between the channel's inlet and outlet. Following the steps suggested by [2] the computational domain reached $16\ D_h$. To overcome the additional diffusivity that arises from the turbulence SST- k-ω was set. Due to the long time for reaching unchangeable average fields during the runs the numerical schemes run under the Reynolds number lower than experimental work, $Re_{Dh} = 8{,}000$. Fig. 1 (a) shows the numerical and experimental axial velocity time-traces. Both values are made dimensionless by using the bulk velocity, U_{bulk}. From the figures one can see the fashion movement in quasi-periodic pattern as numerical and experimental results. Through auto-correlation and PSD tools the main frequency and the Strouhal number were computed. The spectral values were *0.19 Hz* and *19.57 Hz* for numerical and experimental work. Such difference is attributed the higher bulk velocity in the experimental work. However, when the Strouhal number is computed, based on the bulk velocity U_{bulk}, the main frequency, f and the rod's diameter, D, both results are $St = 0.16$, Fig. 1(c)

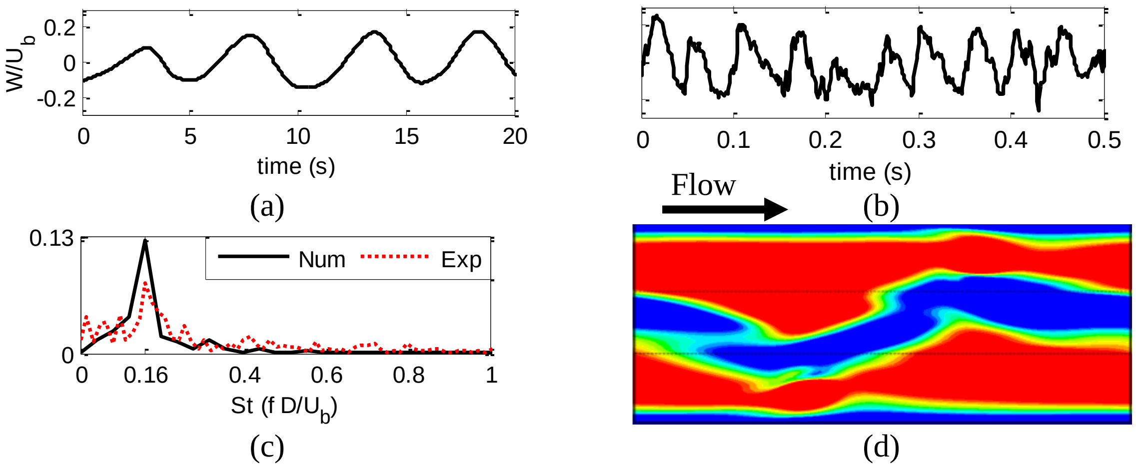

Figure 1- (a and b) Numerical and experimental axial velocity time-traces. (c) PSD of velocity time traces. (d) instantaneous numerical velocity field.

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