Experimental observations of convective and absolute instabilities in a rotating Hagen-Poiseuille flow

- BIFD2011 -

Shrestha, K.†, Parras, L.†, del Pino C.* and Sanmiguel-Rojas, E.‡

* † Escuela Técnica Superior de Ingenieros Industriales (ETSII)
Universidad de Málaga, Campus Teatinos, 29006 Málaga, Spain
e-mail: cpino@uma.es, web page: http://www.fluidmal.uma.es

‡ Escuela Politécnica Superior
Universidad de Jaén, Campus de las Lagunillas, 23071 Jaén, Spain

ABSTRACT

A spatial, viscous and linear stability analysis of Poiseuille pipe flow with superimposed solid body rotation was considered in [1]. In this work a neutral curve for the transition from stable to convectively unstable state was given. In addition, once this base flow was unstable, the onset of the absolute instabilities was later extended to cover all values of the parameters: Reynolds number Re, swirl parameter L, azimuthal wave number n, and axial wave number α. Furthermore, this theoretical work was supplemented with three dimensional numerical simulations [2]. Then, a good agreement was found in relation to the theoretical neutral curves. The flow rate oscillations and the nonlinear waves structures were also analyzed in detail.

In the present work, we complement the previous works ([1], [2]). Thus, we show the experimental results of the instabilities present in a developed Hagen-Poiseuille flow with a imposed rigid body rotation. To that end, we base our results in qualitative data by means of visualizations. We found a very good agreement agreement in the Re-L plane between the experimental and the theoretical data for the onset of convective hydrodynamic instabilities. Besides, the transition from convective to absolute instabilities is also studied experimentally. In this region, different and complex structures were observed in a range of Reynolds numbers that belongs to a laminar regime (up to 600). We also present the analysis of these visualizations in a space-time domain to obtain quantitative data, so the wavelengths and the frequencies are also estimated by a Fast Fourier Transformation in two dimensions. The comparison with the theoretical values is in good agreement too.

REFERENCES

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