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Elastic turbulence of polymer solutions at low Re in a straight channel LAETITIA MARTINIE, JULIEN BEAUMONT, HUGUES BODIGUEL, Laboratoire du futur (UMR 5258), HAMID KELLAY, LOMA (UMR 5798), ANNIE COLIN, Laboratoire du futur (UMR 5258) — At low Reynolds number (Re<1), elastic turbulence develops in polymer solutions flowing in curvilinear flows for Weissenberg numbers Wi beyond a given threshold Wic. Unlike inertial turbulence (Re>>1), elastic turbulence is due to their normal stress anisotropy [Groisman and Steinberg, Nature, 2000]. It has only been shown very recently, both theoretically [Morozov and van Saarlos, Phys. Report, 2007] and experimentally [Bonn et al., PRE 2011], that elastic turbulence could also occur in rectilinear flows, provided that the perturbation amplitude is sufficiently high. In this work, we aim to characterize the consequences of this turbulence on the velocity profile and the flow rate-pressure relationship of high molecular weight Polyaccrylamide solutions flowing in a straight channel. By varying both flow rate and polymer concentration, we are able to explore a wide range of Wi. Flows driven by a controlled pressure in a microfluidic straight channel are characterized using particle image velocimetry. For Wi < Wic, the measured velocity field is well accounted for by the bulk flow curve of the shear thinning fluid. For Wi > Wic, this prediction is not valid anymore and a high level of fluctuations is observed. In addition, velocity profiles can be described by a logarithmic behavior in areas where the fluid is highly sheared, similarly to what is observed in inertial turbulence in a rectilinear geometry. A model based on an Olroyd B fluid behavior has been developed to explain the experimental profiles observed.

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