EXPERIMENTAL INVESTIGATIONS ON THE INFLUENCE OF ELASTICITY ON THE TAYLOR-COUETTE INSTABILITIES

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The work is concerned with experimental investigations on the stability of viscoelastic Taylor-Couette flow. The experimental apparatus consists of a concentric cylinder system with the inner cylinder rotating and the outer one at rest. In addition, the geometry used is a laboratory replica of a Taylor-Couette reactor being developed at Karlsruhe Institute of Technology. The main goal of the investigations is to evidence the effect of increasing elasticity (i.e. polymer concentration) on the inertial instability modes (i.e. for Newtonian fluids). Seven solutions of aqueous Polyacrylamide of different polymer concentrations are used in the experiments. Their rheological properties are measured by oscillatory shear tests in the linear viscoelasticity regime. The flow is evaluated using reflective particles visualization technique and through spectral analysis of reflected light from spatio-temporal diagrams. The flow stability is represented as the dependence of the Elasticity number (*El*) to the Reynolds number (*Re*). The mentioned dimensionless parameters are computed using the shear rate dependent viscosity function and the crossing between the storage and loss moduli as the polymer relaxation time. The results feature elastically influenced inertial-like patterns while for higher polymer concentrations novel instability modes develop in the gap. Thus, in the range of parameters investigated, four types of transition sequences were identified. For $El < 10^{-3}$ the flow features Newtonian-like instability modes, namely, the Taylor vortex flow (TVF), wavy vortex flow (WVF), modulated wavy vortices (MWV), chaotic wavy vortices (CWV), wavy turbulent vortices (WTV) and turbulent Taylor vortices (TTV) were identified during experiments. For $10^{-3} < El < 3 \cdot 10^{-3}$ the first modifications in the instability spectrum appear. After the TVF regime, a decrease in axial wavelength occurs, change that marks the transition to the Standing waves regime (SW), thus replacing WVF. With increasing *Re*, SW was followed by the appearance of two characteristic frequencies in the spectra, that is characteristic of MWV (wave and modulation frequencies). For $El > 3 \cdot 10^{-3}$ all supercritical Newtonian flows are eliminated from the spectra. In the limit of $El < 0.1$, the transition sequence becomes LCF - TVF - SW. In this case, an increase in axial wavelength with *Re* of SW is reported with increasing *Re*. A more significant change occurs for $El > 0.1$ where the Disordered oscillations (DO) appear in the flow right after TVF, and were maintained for the rest of the *El* - *Re* investigated. The DO regime is characterized by a relatively irregular pattern and a broad frequency spectra. Overall, the present investigations represent contributions to the literature of viscoelastic instabilities as well as to the development of an application, namely the afore mentioned Taylor-Couette reactor.