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Variety of flow regimes in Taylor-Couette-Poiseuille flow

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Taylor-Couette-Poiseuille (TCP) flow was studied in a wide range of Taylor numbers and low axial Reynolds numbers. The experimental set-up was characterized by a radius ratio of 0.8 and an aspect ratio of 44. The electrodiffusion method with a three-segment probe and an array of simple probes was used for mapping the components of wall shear rate at the outer fixed cylinder. The filling experiments were carried out consisting in adjusting the rotation rate of the inner cylinder and then filling the annular gap with liquid at the prescribed flow rate. Flow patterns were registered using a movie camera. Taylor vortex flow, wavy vortex flow, helical flow having screw opposite to the basic Couette Poiseuille (CT) flow and moving in the direction of the Poiseuille flow, steady and moving helical flow having screw coinciding with the basic CP flow and wavy helical flow was observed at low Taylor numbers. Laminar wavy vortex flow with 2, 3 and 4 waves was observed at moderate Taylor numbers. Vortices with turbulent flow either with straight or wavy boundaries and turbulent helical flow with screw coinciding with the basic flow and axial movement opposite to the axial basic flow were observed at higher Taylor numbers. Different time histories of axial and azimuthal wall shear rate components correspond to each flow pattern. The axial and azimuthal celerity of flow patterns and their size were evaluated from limiting diffusion currents and movies.