Abstract Submitted
for the DFD10 Meeting of
The American Physical Society

Taylor–Couette–Poiseuille flow with a permeable inner cylinder[1]
NILS TILTON, DENIS MARTINAND, Universites Aix-Marseille, ERIC SERRE, CNRS, RICHARD LUEPTOW, Northwestern University — We consider laminar Taylor–Couette–Poiseuille flow between an outer, fixed, impermeable cylinder and a concentric, inner, rotating, permeable cylinder with radial suction. Due to centrifugal instabilities the steady flow transitions to Taylor vortex flow. This system is used in filtration because the vortices wash contaminants away from the permeable cylinder. The coupling between the axial pressure drop driving the annular Poiseuille flow, and the transmembrane pressure driving the suction induces axial variations of the velocity field of the subcritical flow, which can evolve from suction to injection (cross flow reversal) or consume the whole axial flow (axial flow exhaustion). Moreover, the stability of this flow departs from that of Taylor–Couette flow. We propose an asymptotic solution to the subcritical flow assuming slow axial variations of the velocity and pressure fields. The transmembrane suction and pressure are coupled through Darcy's law. This solution is then used as a base flow to study the appearance of instabilities in the form of global modes. The analytical results for the subcritical and supercritical flows are then compared with dedicated 3-D spectral direct numerical simulations implementing Darcy's law on the inner cylinder.

[1]Work supported by ANR program No. ANR-08-BLAN-0184-03.

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Date submitted: 27 Jul 2010 Electronic form version 1.4