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Linear Stability Analysis of Couette Flow with a Porous Wall

NILS TILTON, LUCA CORTELEZZI, McGill University — It is well known that plane Couette flow in a channel with perfectly smooth, impermeable walls is linearly stable for all Reynolds numbers. Little attention has been given in literature to the stability of plane Couette flow when at least one of the walls is porous. In this study, we consider a channel delimited by an impermeable moving wall, which drives the flow, and a stationary, rigid, homogeneous, isotropic, porous block. We perform a three-dimensional linear stability analysis of the fully developed laminar flow in both the channel and the porous block. We restrict the study to sufficiently small permeabilities in order to neglect inertial effects in the porous flow. We solve the coupled linear stability problem, arising from the adjacent channel and porous flows, using a spectral collocation technique. The linear stability analysis takes account of the coupling between the two disturbance fields through boundary conditions recently derived by Ochoa-Tapia and Whitaker (*Int. J. Heat Mass Transfer*, **38**, 1995). We find that Couette flow over a permeable wall is no longer absolutely stable. While the critical Reynolds number tends to infinity as the permeability tends to zero, it decreases drastically for higher permeabilities. We also find a new channel mode and new class of modes in the porous region. We compare and discuss these results in terms of the recently published results of a three-dimensional linear stability analysis of a channel flow with porous walls (Tilton and Cortelezzi, *Phys. Fluids* **18**, 051702, 2006).

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