Stability of a layered flow where a reaction induces viscosity stratification

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Channel/pipe flows can be significantly stabilized or destabilized by a slight viscosity stratification[1]. Thus the study of viscosity stratified flows is ubiquitous as it possesses vast geophysical, environmental, and industrial applications[2]. At the same time, chemical reactions are known to modify the physical property of a solution, like its viscosity or density, which leads to Chemo-hydrodynamic instabilities[3]. Moreover, the linear stability analysis (LSA) of such chemical reactions is performed in Darcy's convection regime[4]. However, Kelvin-Helmholtz instability (KHI) was recently encountered while a simple A+ B→C reaction modified the viscosity in a Navier-Stokes equations-driven channel flow[5]. Following the Quasi-Steady-State-Approximations, we formulate the linear stability problem of such a system. We take a layered flow where the reactants A and B meet around a horizontal flat interface to produce a product, C, of different viscosity. Dispersion curves obtained from LSA reveal that the flow is more unstable if the product's viscosity is less than reactants compared to a more viscous product. The same is noticed from the non-linear simulations, too. A complete parametric study and control of the flow dynamics will be discussed in this talk.

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