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Shear-induced instabilities for autocatalytic reaction fronts involving different diffusivities

Reaction fronts involving a substrate and an autocatalytic reactant can become unstable if they have different diffusivities. This diffusion-driven instability takes place if the ratio between the diffusion coefficients is greater than a critical threshold. In the case of cubic autocatalysis, the critical diffusivity ratio between the substrate and the autocatalyst is equal to δ=2.3. In this presentation, we study the stability of flat propagating fronts in a shear flow. The shear-flow model consists of two layers moving relative to one another with constant velocity. The reaction front travels in the same direction as the velocity. We carry out a linear stability analysis by introducing small perturbations of fixed wavelength in the transverse direction. This allows us to compute the corresponding growth rate for each perturbation. We find that shear flow enhances the front instability when the original diffusivity ratio δ exceeds the value of three. These results compare well with a single-layer model using the effective diffusivities due to Taylor dispersion.

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