Stability of premixed gaseous flames propagating in Hele-Shaw cells

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Abstract

The stability of a premixed flame propagation between two closely spaced parallel plates (e.g., a Hele-Shaw cell) is investigated. The first effort on the problem was due to Joulin and Sivashinsky (1994), who expanded the classical hydrodynamic Darrieus-Landau model by including the wall effect through an Euler-Darcy law for the flow field in the frame of the flame sheet approximation. As a result, instabilities associated with the transport process in the flame were neglected. The present work performs the linear stability analysis of a steady planar flame propagating between two adiabatic parallel plates by including the Darrieus-Landau (due to density change across the flame front), Rayleigh-Taylor (due to buoyant forces) and diffusive-thermal (due to unequal rates of thermal to molecular diffusion) effects. The problem formulation is based on the asymptotic limit when the ratio of the plates separation to the thermal flame thickness is sufficiently small. The results of the linear stability analysis are compared with direct numerical simulations.

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