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Linear stability analysis of Clarke-Riley diffusion flames DANIEL GOMEZ-LENDINEZ, Universidad Carlos III de Madrid, WILFRIED COENEN, ANTONIO L SANCHEZ, University of California San Diego — The buoyancy-driven laminar flow associated with the Burke-Schumann diffusion flame developing from the edge of a semi-infinite horizontal fuel surface burning in a quiescent oxidizing atmosphere displays a self-similar structure, first described by Clarke and Riley (Journal of Fluid Mechanics, 74:415–431). Their analysis was performed for unity reactant Lewis numbers, with the viscosity and thermal conductivity taken to be linearly proportional to the temperature. Our work extends this seminal work by considering fuels with non-unity Lewis numbers and gas mixtures with a realistic power-law dependence of the different transport properties. The problem is formulated in terms of chemistry-free, Shvab-Zel'dovich, linear combinations of the temperature and reactant mass fractions, not changed directly by the reactions, as conserved scalars. The resulting self-similar base-flow solution is used in a linear stability analysis to determine the critical value of the boundary-layer thickness—measured by the local Grashof number—at which the flow becomes unstable, leading to the development of Görtler-like streamwise vortices. The analysis provides the dependence of the critical Grashof number on the relevant flame parameters.

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