Furkan Kodakoglu, Mohammed AlKhabbaz, Olatunde Abidakun, V'yacheslav Akkerman, Department of Mechanical and Aerospace Engineering, West Virginia University, Morgantown, WV 26506. Effect of wall conditions and Lewis number on finger-shaped flame acceleration in channels.

While the phenomenon of finger flame acceleration (FFA) has been investigated extensively, the previous analytical and computational studies employed numerous simplifying assumptions such as free-slip, adiabatic walls of a pipe and equidiffusive burning, which are not the cases in the practical reality. The present work reduces such a gap between the research and practice. Specifically, the impacts of various wall boundary conditions and the Lewis number (the thermal-to-mass diffusivities ratio) Le on FFA are scrutinized by means of computational simulations of the reacting flow equations, with fully-compressible hydrodynamics, transport properties (thermal conduction, diffusion and viscosity) and Arrhenius chemical kinetics. An extensive parametric study is undertaken, with the evolutions of the locus and velocity of the flame tip as well as of the flame surface area and the burning rate identified. Among the wall conditions, various isothermal (cold/preheated) and mechanistic (slip/non-slip) boundaries are compared. It is shown that side walls provide a minor impact on FFA, which differs from another acceleration mechanism where wall friction plays a greater role. The latter result can be explained by the fact that FFA occurs far from the walls, i.e. along the centerline and before the flame skirt contacts the side walls. As for the role of Le, it is demonstrated that the Le > 1 flames are intrinsically thickened and thereby propagate slower than the equidiffusive (Le = 1) flames, though the difference is minor. In contrast, the Le < 1 flames propagate faster due to the onset of the diffusional-thermal instability.

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