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Flow and Lewis Number Effects on Flame Quenching and Stability in Cold-Wall Channels

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The study investigates the critical conditions for flame propagation in channels with cold walls. We analyse the impact of the Lewis number and flow amplitude (A) on the minimum channel width required to sustain a premixed flame. The investigation spans a wide range of Lewis numbers, encompassing both aiding and opposing flow conditions. Results are presented for both variable and constant density models. A combined numerical approach, involving stationary and time-dependent simulations, is employed to determine quenching distances and solution stability.

We find that smaller Lewis numbers and aiding flows ($A<0$) facilitate flame propagation in narrower channels, while opposing flows ($A>0$) tend to destabilize the flame, promoting asymmetric solutions. For sufficiently large positive values of A, the quenching distance is determined by asymmetric solutions, rather than the typical symmetric ones. When the constant density assumption is adopted, the flames are found to be more sensitive to changes in the flow amplitude A, and less sensitive to changes in the Lewis number.