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Effect of thermal expansion on the stability of diffusion flames MOSHE MATALON, Northwestern University, PHILIPPE METZENER, Ecole Polytechnique Federale de Lausanne — In this talk we report on the effect of density variation on the stability of diffusion flames. Similar earlier studies have always invoked the constant-density approximation. Although we find that thermal expansion has a marked influence on flame instability, it does not play a crucial role as it does in premixed flames. Furthermore, thermal expansion has a different influence on the various modes of instability, affecting primarily the marginal state and the degree of the instability. If the overall effect of thermal expansion is characterized by the ratio $r = T_a/T_u$ of the stoichiometric and unburned temperatures the degree of instability for the onset of cells increases with increasing r, but decreases with increasing r for the onset of oscillations. The range of conditions leading to cellular flames is significantly broader than that predicted by the constant-density model, widening with increasing r. On the other hand, the range of conditions leading to flame oscillations, whether flat pulsations or oscillatory cells, is further limited by the influence of thermal expansion. The present analysis provides a comprehensive characterization of instabilities in diffusion flames while realistically accounting for density variations. It identifies the possible patterns that are likely to be observed as a result of differential and preferential diffusion, covering a whole range of parameters including the Lewis numbers associated with the fuel and the oxidizer, the initial mixture fraction, and the flow conditions.

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