Acoustic response of strained methane-oxygen diffusion flames

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Abstract

A general formulation is given for the analysis of planar counterflow hydrocarbon-oxygen diffusion flames subject to variable pressure and variable strain rate. A salient feature of the derivation is the introduction of a heat-conduction-weighted transverse coordinate that results in a compact transport operator in the conservation equations. The formulation is used for the analysis of the acoustic pressure response for a one-step chemistry model. Coupling functions allowing for general non-unity Lewis numbers of the fuel are introduced for the description of the fast-reaction limit. The results are used together with the Rayleigh criterion to identify frequency ranges of amplification and attenuation with specific attention focused on methane-oxygen systems. The flame response to both direct modifications of outer chemical-equilibrium transport regions and to variations of the reaction rate in the inner reactive-diffusive zone is examined, with criteria given for when each effect dominates.