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Nonpremixed Combustion in an Accelerating Transonic Flow Undergoing Transition FELIX CHENG, FENG LIU, WILLIAM SIRIGNANO, University of California, Irvine — The flow through a turbine passage is modelled by a mixing layer with fuel and oxidizer streams flowing through a channel with imposed streamwise pressure gradients due to varying cross- sectional area. Due to the strong favorable pressure gradients, the flow accelerates from low subsonic to low supersonic speed and at the same time undergoes transition from laminar flow to turbulence. In this study, we focus on the transitional stage of this unsteady, accelerating, reacting, and compressible mixing layer. The full Navier-Stokes equations coupled with multiple reacting species equations and chemical reactions are solved numerically. No turbulence model is employed since the transitional flow is fully deterministic. Inlet perturbations determined from linear stability analysis are introduced at the inlet to excite the mixing layer. The production of both positive and negative vorticity due to the exothermic chemical reactions is identified, and the interactions between regions of unlike vorticity are characterized. The instability produces a strain field that results in the tearing of the flame. The effects of the streamwise pressure gradient and the amplitude of the inlet disturbances on the flame structures are investigated. Grid- and domain- independencies are performed to ensure the accuracy of the numerical solutions.

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