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Large-activation-energy analysis of gaseous reactive flow in pipes
DANIEL MORENO-BOZA, University of California San Diego, IMMACULADA IGLESIAS, Universidad Carlos III de Madrid, ANTONIO L SANCHEZ, University of California San Diego — Frank-Kamenetskii's analysis of thermal explosions is applied, using also a single-reaction model with an Arrhenius rate having a large activation energy, to describe the evolution of an initially cold gaseous mixture flowing along a circular pipe with constant wall temperature for moderately large values of the relevant Reynolds number. The analysis shows two modes of combustion. There is a flameless slowly reacting mode for low wall temperatures or small pipe radii, when the temperature rise resulting from the heat released by the reaction is kept small by the heat-conduction losses to the wall, so as not to change significantly the order of magnitude of the reaction rate. In the other mode, the slow reaction rates occur only in an initial ignition stage, which ends abruptly when very large reaction rates cause a temperature runaway, or thermal explosion, at a well-defined ignition distance. The analysis determines the slow streamwise evolution for the flameless mode of combustion as well as the ignition distance for the explosive mode.

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