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Abstract
A numerical study was made on the time-dependent ignition and subsequent transition to steady flame spread of a thin solid fuel on the floor, which is heated by an external radiation in a quiescent normal gravity environment. The gas phase model consist of two-dimensional, time-dependent continuity, complete elliptic Navier-Stokes, energy and species equations. The combustion is described by a one-step overall chemical reaction with finite rate global kinetics. The solid phase is modeled by an unsteady energy and mass conservation equations, which coupled with the gas phase through the energy feed back term from the gas phase. The solid pyroysis is described by first-order Arrhenius expression. The external radiant flux is a Gaussian distribution with peak value of 5 W/cm2 and half width 0.5 cm applied at the origin point at s. The computational results indicate that little solid fuel be consumed before ignition occurs and the solid fuel surface reaches pyrolysis temperature when ignition occurs. Ignition is initiated at the middle of the sample to give a disk shape point flame at the instant of ignition. The point flame grows and immediately becomes an arch-shaped flame with two flame fronts at its bases. Then, the arch-shaped flame breaks into two individual flames at the top, spreading in opposite directions. The two spreading flames are in opposed mode because the directions between entrained flow and flame spread are opposite. The left flame propagates against in a greater opposite entrained flow thus the rate of flame spread of the left flame was found to be slightly slower than that of the right flame. The left flame structure also significantly deformed by this stronger entrained flow. Two vortices with opposite swirl directions were found to exist above the flames. The left vortex was stronger than the right, inducing a greater entrained flow at the front of the left flame.
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