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A NUMERICAL STUDY ON EFFECTS OF ENVIRONMENTAL VARIABLES ON CONCURRENT FLOW FLAME SPREAD RATE

Abstract

A 2-D numerical model has been formulated to analyze the effects of environmental variables on flame spread behavior in an opposed flow configuration. The numerical model comprises of solid phase and gas phase model. The solid phase model consists of equations of continuity and energy in one-dimension parallel to the solid fuel surface. A solid fuel pyrolysis law is used to simulate flame spread rate. The species equations are for fuel vapor, oxygen, carbon-dioxide and water vapor. The gas phase models comprises two-dimensional governing equations for the conservation of mass, momentum, energy, species and are coupled to solid phase equations. The solid fuel considered here is an aerodynamically and thermally thin cellulose material. The solid is assumed to burn ideally i.e. it vaporizes to form fuel vapors without melting. The environmental variables used are pressure, gravity level, oxygen concentration and flow velocity. The effects of various parameters on flame spread rate and flame extinction behavior have been studied. The comparison of flame spread rate variation has been done for various gravity levels, ranging from microgravity to the normal gravity keeping other parameters constant. Observations based on numerical simulation show that the flame spread behavior is qualitatively the same from 0.1g to 1g, whereas the variations are largely fluctuating between 0g and 0.1g. The numerical data has also been obtained for flame spread rate at nearly zero free-stream velocity at both 0g and 1g. An effort has been made to establish a numerical relation between pressure and gravity for maximum flame spread rate at various velocities and oxygen concentrations.