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NEAR-LIMIT FLAME SPREAD IN LOW-SPEED OPPOSED AND CONCURRENT FLOWS OVER THICK FUELS

Abstract

Flame spread over solid fuels in low velocity flows is of fundamental interest and practical importance for spacecraft fire safety. Traditionally, the flame spread is categorized as opposed-flow or concurrent-flow mode according to the direction of flame spread relative to the direction of oxidizer flow. Although this classification is very useful in understanding the different mechanisms for flame spread, few studies have compared the two modes for thermally thick fuels. In the present study, a narrow channel apparatus is employed to investigate the phenomenon of flame spread over a thick PMMA sheet in low-speed forced opposing and concurrent flows. Extinction limits using flow velocity and oxygen concentration as coordinates are presented, and a comparison between opposing and concurrent spreading flames is made. At a given oxygen concentration, the limiting flow velocity is lower for concurrent flame, showing that the flammability limit can be wider for the concurrent mode in low-speed flows. Flame spread rates are determined as a function of the velocity and oxygen concentration of the gas flow. The comparison of measured data with theoritical preditions shows the significant effects of radiation loss on flame spread in low velocity flows. Based on the experimental observations, mechanisms for flame spread and extinction in the opposed and concurrent modes are discussed.