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Propagation Limits of High Pressure Cool Flames YIGUANG JU, Princeton University — The flame speeds and propagation limits of premixed cool flames at elevated pressures with radiative heat loss are numerically modelled using dimethyl ether mixtures. The primary focus is paid on the effects of pressure, mixture dilution, flame size, and heat loss on cool flame propagation. The results showed that cool flames exist on both fuel lean and fuel rich sides and thus dramatically extend the lean and rich flammability limits. There exist three different flame regimes, hot flame, cool flame, and double flame. A new flame flammability diagram including both cool flames and hot flames is obtained at elevated pressure. The results show that pressure significantly changes cool flame propagation. It is found that the increases of pressure affects the propagation speeds of lean and rich cool flames differently due to the negative temperature coefficient effect. On the lean side, the increase of pressure accelerates the cool flame chemistry and shifts the transition limit of cool flame to hot flame to lower equivalence ratio. At lower pressure, there is an extinction transition from hot flame to cool flame. However, there exists a critical pressure above which the cool flame to hot flame transition limit merges with the lean flammability limit of the hot flame, resulting in a direct transition from hot flame to cool flame. On the other hand, the increase of dilution reduces the heat release of hot flame and promotes cool flame formation. Moreover, it is shown that a smaller flame size and a higher heat loss also extend the cool flame transition limit and promote cool flame formation.

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