The Global Consumption Speeds of Premixed Large-Hydrocarbon Fuel/Air Turbulent Bunsen Flames

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Abstract

Large hydrocarbon fuels are used for ground and air transportation and will be for the foreseeable future. Despite their extensive use, combustion of large hydrocarbon fuels in a turbulent environment is poorly understood and difficult to predict. A key combustion property for such reaction is the turbulent global consumption speed, which is the velocity at which fuel and air are consumed through a turbulent flame front. Such information can be quite useful as a model input parameter and for validation. This thesis seeks to identify key physics governing the turbulent global consumption speed. Turbulent global consumption speeds are measured using a fully premixed turbulent Bunsen burner capable of independently controlling turbulence intensity, unburned temperature, and equivalence ratio. A clear sensitivity to fuel chemistry is observed and seems to be linked to aromatic and alkane content; higher flame speeds and increased stability have been measured for fuels with shorter average hydrocarbon chain lengths and high aromatic content. In addition, the turbulent global consumption speed is highly sensitive turbulence intensity of the flow; the turbulent flame speed increases an average of 30% for all fuels between the minimum and maximum turbulence intensity cases. Results are attributed to a strong sensitivity of the global consumption speed to flame stretch and a strong coupling of turbulence and fuel chemistry effects.

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