

An experimental and numerical study on characteristics of laminar premixed
H₂/CO/CH₄/air flames

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Abstract

The effects of variations in the fuel composition on the characteristics of H₂/CO/CH₄/air flames of gasified biomass are investigated experimentally and numerically. Experimental measurements and numerical simulations of the flame front position and temperature are performed in the premixed stoichiometric H₂/CO/CH₄/air opposed-jet flames with various H₂ and CO contents in the fuel. The adiabatic flame temperatures and laminar burning velocities are calculated using the EQUIL and PREMIX codes of Chemkin collection 3.5, respectively. Whereas the flame structures of the laminar premixed stoichiometric H₂/CO/CH₄/air opposed-jet flames are simulated using the OPPDIF package with the GRI-Mech 3.0 chemical kinetic mechanisms and detailed transport properties. The measured flame front position and temperature of the stoichiometric H₂/CO/CH₄/air opposed-jet flames are closely predicted by the numerical calculations. Detailed analysis of the calculated chemical kinetic structures reveals that the reaction rate of reactions (R38), (R46), and (R84) increase with increasing H₂ content in the fuel mixture. It is also found that the increase in the laminar flame speed with H₂ addition is most likely due to an increase in active radicals during combustion (chemical effect), rather than from changes in the adiabatic flame temperature (thermal effect). Chemical kinetic structure and sensitivity analyses indicate that for the stoichiometric H₂/CO/CH₄/air flames with fixed H₂ concentration in the fuel mixture, the reactions (R99) and (R46) play a dominant role in affecting the laminar burning velocity as the CO content in the fuel is increased.

Keyword : Gasified biomass; Premixed opposed-jet flames; Laminar burning velocity; Chemical kinetic structure