Effects of CO addition on the characteristics of laminar premixed CH4/air opposed-jet flames

吳志勇,趙怡欽,鄭藏勝,陳志鵬,何俊慶
Mechanical Engineering
Engineering
tscheng@chu.edu.tw

Abstract

The effect of CO addition on the characteristics of premixed CH4/air opposed-jet flames are investigated experimentally and numerically. Experimental measurements and numerical simulations of the flame front position, temperature, and velocity are performed in the stoichiometric CH4/CO/air opposed-jet flames with various CO contents in the fuel. Thermocouple is used for the determination of flame temperature, velocity measurement is made using particle image velocimetry (PIV), and the flame front position is measured by direct photograph as well as laser-induced predissociative fluorescence (LIPF) of OH imaging techniques. The laminar burning velocity is calculated using the PREMIX code of Chemkin collection 3.5. While the flame structures of the premixed stoichiometric CH4/CO/air opposed-jet flames are simulated using the OPPDIF package with GRI-Mech 3.0 chemical kinetic mechanisms and detailed transport properties. The measured flame front position, temperature, and velocity of the stoichiometric CH4/CO/air flames are closely predicted by the numerical calculations. Detailed analysis of the calculated chemical kinetic structures reveals that as the CO content in the fuel is increased from 0% to 80%, the rate of CO oxidation (R99) increases significantly and contributes to a significant amount of heat-release, and the chemistry shifts toward the kinetics of the additive CO. The laminar burning velocity reaches to a maximum value (57.5 cm/s) at the condition of 80% of CO in the fuel. Comparison of the computed laminar burning velocity, flame temperature, and reaction rate of reaction (R99) reveals that the effect of CO addition on the laminar burning velocity of the stoichiometric CH4/CO/air flames is due to chemical kinetic effect. Moreover, the laminar burning velocity can be correlated well to the flame front position in premixed CH4/CO/air opposed-jet flames.

Keyword：Blended fuel; Premixed opposed-jet flames; PIV; LIPF-OH imaging; Numerical simulation