Laser Raman measurements of temperature and species concentration in swirling lifted hydrogen jet diffusion flames

鄭藏勝,S. R. March,R. W. Pitz,J. A. Wehrmeyer,J.-Y. Chen
Mechanical Engineering
Engineering
tscheng@chu.edu.tw

Abstract

Simultaneous spatially and temporally resolved point measurements of temperature, mixture fraction, major species (H2, H2O, O2, N2), and minor species (OH) concentrations are performed in unswirled (Sg = 0), low swirl (Sg = 0.12), and high swirl (Sg = 0.5) lifted turbulent hydrogen jet diffusion flames into still air. Ultraviolet (UV) Raman scattering and laser-induced predissociative fluorescence (LIPF) techniques are combined to make the multi-parameter measurements using a single KrF excimer laser. Experimental results are compared to the fast chemistry (equilibrium) limit, to the mixing without reaction limit, and to simulations of steady stretched laminar opposed-flow flames. It is found that in the lifted region where the swirling effects are strong, the measured chemical compositions are inconsistent with those calculated from stretched laminar diffusion flames or stretched partially premixed flames. Sub-equilibrium values of temperature, sub-flamelet values of H2O, and super-flamelet values of OH are found in an intermittent annular turbulent brush of the swirled flame but not in the unswirled flame. Farther downstream of the nozzle exit (x/D 50), swirl has little effect on the finite-rate chemistry.

Keyword：Swirling lifted hydrogen flame; Raman scattering; Laser-induced predissociative fluorescence; Opposed flow laminar flame calculations