MEASUREMENT OF ABSOLUTE HYDROXYL RADICAL CONCENTRATION IN LEAN FUEL-AIR MIXTURES EXCITED BY NANOSECOND PULSED DISCHARGE[a].

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The focus in plasma assisted combustion research has been on the evaluation of conventional plasma/combustion mechanisms in predicting oxidation and ignition processes initiated and/or sustained by non-equilibrium, nanosecond discharges. Accurate quantitative data such as temperature and species concentration are needed for assessing and improving numerical modeling. As an important intermediate species, the concentration of hydroxyl radical (OH) is very sensitive to the combustion environment (e.g., temperature, equivalence ratio), and therefore is of great interest to kinetic study.
In this work, Laser-Induced Fluorescence (LIF) was used for time-resolved temperature and OH number density measurements in lean H_2-, CH_4-, C_2H_4-, and C_3H_8- air mixtures in a plasma flow reactor inside a tube furnace. The premixed fuel-air flow in the reactor, initially at T_0=500 K and P=100 torr, was excited by a burst of repetitive nanosecond electric pulses in a dielectric-barrier plane-to-plane geometry ($\sim$28 kV peak voltage and $\sim$5 nsec pulse width, estimated 1.25 mJ/pulse coupled energy). Laser was timed to probe after the discharge burst was over to avoid strong plasma emission interference. Relative fluorescence signal was put on an absolute scale by calibrating against Rayleigh scattering signal in the same flow reactor. Experimental results were compared to predictions from a 0-D plasma/combustion chemistry model employing several well-established combustion mechanisms. 2-D temperature and OH concentration distributions in the discharge volume were obtained by planar LIF and was used to quantitatively evaluate plasma uniformity in the reactor. These results were used to determine the validity of the 0-D model.

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