MEASUREMENT OF SOOT CONCENTRATION IN A COUNTERFLOW DIFFUSION FLAME USING OPTICAL DIAGNOSTIC UP TO 10 ATM

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Work-In-Progress Abstract

Soot emissions from practical combustion devices pose a significant risk to the environment and human health. Soot formation involves complex processes and a better understanding of how soot is formed and oxidized is necessary to control overall emissions. In this study, a nitrogen diluted ethylene air counterflow diffusion flame is investigated experimentally at pressures up to 10 atm. A fuel mole fraction of 0.3 is maintained from 2 to 7 atm whereas it is 0.2 from 8 to 10 atm because the flame becomes optically thicker at high pressures. To study the effects of pressure on soot concentration, a global strain rate of 30 s^{-1} is maintained constant at all pressures by adjusting the inlet mass flux. All the flames investigated are soot formation flames and are stabilized on the oxidizer side of the stagnation plane. 2D diffused line of sight attenuation (LOSA) is used to measure, quantitatively, the soot volume fraction profiles along the axis of the flame. To alleviate uncertainties due to the line-of-sight feature of LOSA, laser induced incandescence (LII) is also used to measure the soot volume. An infrared laser sheet at the wavelength of 1064 nm is used to heat the soot. This wavelength is chosen to avoid absorption and fluorescence from PAH molecules. The LII signal is collected at 435 nm and the signal is calibrated using a He-Ne laser. The soot volume fraction is seen to increase with pressure when the strain rate is kept constant. Laser induced fluorescence is also used to investigate the formation of polycyclic aromatic hydrocarbons (PAH). Different detection wavelengths are selected to examine PAH featuring a different number of benzene rings. The PAH are excited at 282.9 nm and the fluorescence signal is collected at 350, 400, 450 and 510 nm. It is observed that the position of the peak fluorescence intensity shifts towards the flame as the detection wavelength is increased, which shows the sequence of formation of different PAH rings.