EFFECTS OF SOOT ABSORPTION AND SCATTERING ON LII INTENSITIES IN LAMINAR COFLOW DIFFUSION FLAMES

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ABSTRACT. Absorption and scattering of laser-induced incandescence (LII) intensities by soot particles present between the measurement volume and the detector were numerically investigated at detection wavelengths of 400 and 780 nm in a laminar coflow ethylene/air flame. The radiative properties of aggregated soot particles were calculated using the Rayleigh-Debye-Gans polydisperse fractal aggregate theory. The radiative transfer equation in emitting, absorbing, and scattering media was solved using the discrete-ordinates method. The radiation intensity along an arbitrary direction was obtained using the infinitely small weight technique. The effects of absorption and scattering on LII intensities are significant, especially at the shorter wavelength and when the soot volume fraction distribution is doubled. Such wavelength dependent signal trapping leads to a lower particle temperature estimated from the ratio of LII intensities at the two wavelengths. The corresponding soot volume fraction derived from the absolute LII intensity technique is overestimated. The Beer-Lambert relationship can be used to describe radiation attenuation in absorbing and scattering media with good accuracy provided the effective extinction coefficient is adequately defined.

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