EFFECTS OF GAS AND SOOT RADIATION ON SOOT FORMATION IN A COFLOW LAMINAR ETHYLENE DIFFUSION FLAME

Fengshan Liu, Hongsheng Guo, Gregory J. Smallwood, and Ömer L. Gülder

Combustion Research Group
Institute for Chemical Process and Environmental Technology
National Research Council Canada, Building M-9, Montreal Road, Ottawa, K1A 0R6

ABSTRACT. A computational study of soot formation in an undilute axisymmetric laminar ethylene-air coflow jet diffusion flame at atmospheric pressure was conducted using a detailed gas-phase reaction mechanism and complex thermal and transport properties. A simple two-equation soot model was employed to predict soot formation, growth, and oxidation with interactions between the soot chemistry and the gas-hase chemistry taken into account. Both the optically thin model and the discrete-ordinates method coupled with a statistical narrow-band correlated-k based wide band model for radiative properties of CO, CO_2, H_2O, and soot were employed in the calculation of radiation heat transfer to evaluate the adequacy of using the optically thin model. Several calculations were performed with and without radiative transfer of radiating gases and/or soot to investigate their respective effects on the computed soot field and flame structure. Radiative heat transfer by both radiating gases and soot were found to be important in this relatively heavily sooting flame studied. Results of the optically thin radiation model are in good agreement with those obtained using the wide band model except for the flame temperature near the flame tip.