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Radiation and Turbulence-Chemistry-Soot-Radiation Interactions in a High-Pressure Turbulent Spray Flame S. FERREYRO, C. PAUL, A. SIRCAR, A. IMREN, D. C. HAWORTH, The Pennsylvania State University, S. ROY, M. F. MODEST, University of California, Merced — Simulations are performed of a transient high-pressure turbulent n-dodecane spray flame under engine-relevant conditions. An unsteady RANS formulation is used, with detailed chemistry, a two-equation soot model, various radiation heat transfer models, and a particle-based transported composition probability density function (PDF) method to account for composition and temperature. The PDF model results are compared with those from a locally well-stirred reactor (WSR) model to quantify the effects of turbulence-chemistry-soot-radiation interactions. Computed liquid and vapor penetration versus time, ignition delay, and flame lift-off are in good agreement with experiment, and relatively small differences are seen between the WSR and PDF models for these global quantities. Computed soot levels and spatial distributions from the WSR and PDF models show large differences, with PDF results being in better agreement with experimental measurements. A photon Monte Carlo method with line-by-line spectral resolution is used to compute the spectral intensity distribution of the radiation reachingthe wall. This provides new insight into the relative importance of molecular gas radiation versus soot radiation, and the importance of unresolved turbulent fluctuations on radiative heat transfer.

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