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Simulations of Turbulent Spray Combustion in a Constant-Volume Chamber for Diesel-Engine-Like Conditions H. ZHANG, D.C. HAWORTH, The Pennsylvania State University — In-cylinder aero-thermal-chemical processes in piston engines are rich and complex, and modern engines are already at a high level of refinement. Further increases in performance, reductions in fuel consumption and emissions, and accommodation of nontraditional fuels will require the effective use of high-spatial-and-temporal-resolution optical diagnostics and numerical simulations. In this research, computational fluid dynamics tools are being developed to explore the influences of fuel properties on autoignition, combustion, and pollutant emissions in compression-ignition engines. The modeling includes a transported probability density function method to account for turbulent fluctuations in composition and temperature, detailed soot models with a method of moments for soot aerosol dynamics, a stochastic photon Monte Carlo method for participating-medium radiation heat transfer, and line-by-line spectral properties for mixtures of molecular gases and soot. The models are applied to a constant-volume spray combustion bomb where measurements are available for a range of thermochemical conditions and for a variety of fuels. Parametric studies of the influences of key physical and numerical parameters are performed to determine sensitivities and to establish best practices to be carried forward into subsequent modeling studies of real engines.

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