ICLASS 2009, 11th International Annual Conference on Liquid Atomization and Spray Systems, Vail, Colorado USA, July 2009

Computed and Measured Fuel Vapor Distribution in a Full-Cone Spray at High Chamber Pressure and Temperature

John Abraham[*,1,2] and Lyle M. Pickett[2]
[1]Maurice J. Zucrow Laboratories, School of Mechanical Engineering, Purdue University, West Lafayette, IN-47907-2014, USA

[2]Combustion Research Facility, Sandia National Laboratories, P.O. Box 969, Livermore, CA 94550, USA

Abstract

There is limited quantitative experimental data on fuel vapor concentrations in high-pressure vaporizing full-cone sprays injected into a high-pressure high-temperature environment typical of diesel engines. As a result, the accuracy of multidimensional models, which are routinely employed to compute such sprays, has not been quantitatively assessed. In this work, quantitative fuel vapor concentrations obtained from multidimensional computations of a fuel spray with three models are compared with measured concentrations in the spray. The three models employed are a Lagrangian-drop Eulerian-fluid (LDEF) spray model, a gas jet model, and a virtual-liquid source (VLS) model. Comparison of the vapor fraction along the axial centerline during the transient development of the spray shows that the computed values of vapor fraction are generally lower than the measured values, and the leading edge of the computed profiles shows shallower gradients of vapor fraction than in the measured spray. In the case of radial distribution, the peak values of measured and computed vapor fractions agree within 20 % when the profiles are quasi-steady. The three models show similar agreement close to the orifice, but the LDEF model shows the better agreement further downstream at quasi-steady state. During transient development, there is greater disagreement between the computed and measured profiles. As expected, the computed width of the vapor phase of the spray is generally larger than the measured one, though the half-widths show agreement within 10 %. In general, the gas jet and VLS vapor fraction values are within 5% of each other at the centerline during transient development, but differ more at the edge of the spray.

Key words: diesel sprays; gas jets; spray models; multidimensional models

[*]John Abraham, jabraham@purdue.edu, work done while on sabbatical leave at Sandia National Laboratories