CONSEIL INTERNATIONAL
DES MACHINES A COMBUSTION

INTERNATIONAL COUNCIL
ON COMBUSTION ENGINES

Awarded Best Presented Paper at the Joint International ASME/CIMAC Congress
Kyoto, Japan, June 7-11, 2004

COMPARISON OF X-RAY BASED FUEL SPRAY MEASUREMENTS WITH COMPUTER SIMULATION USING THE CAB MODEL

PAPER NO.: 264

S. A. Ciatti, C. F. Powell, Center for Transportation Research, Argonne National Laboratory (USA)

S. K. Cheong, J. Liu, Advanced Photon Source, Argonne National Laboratory (USA)

F. X. Tanner, Dept. of Mathematical Sciences, Michigan Technological University (USA)

SUMMARY

The purpose of this research is to reconcile the differences discovered in data comparisons between x-ray and optical experiments. Numerical simulation data is also presented to support the conclusions derived from the experiments.

Diesel spray cone angles and spray mass distributions were measured using absorption techniques with a monochromatic synchrotron X-ray beam. The measurements provided the location of spray mass as a function of time and axial distance downstream of the spray nozzle. The test conditions were 500 bar injection pressure into a 1 bar and 5 bar ambient environment of nitrogen gas. Spray widths and integrated mass calculations were performed using the x-ray absorption data. Inconsistencies with published optical spray data were found and an explanation for these inconsistencies was determined.

The study showed that the fundamental differences in spray width definition between optical and x-ray experiments account for the lack of agreement in the results. The x-ray definition of Gaussian Full Width Half Maximum (FWHM) accounts for the discrepancy betweeen optical and x-ray measured spray widths. Optical based correlations, which rely upon the reflective droplet properties for definition, show a dependence of spray width upon density ratio ($\rho_{ambien\ gas}/\rho_{fuel}$). X-ray measurements showed that spray width as defined by Gaussian FWHM was independent of the density ratio. Computer simulations support these results.

When the two definitions of spray width were applied in computer simulations using the CAB model, the simulation results agreed with both the x-ray measurements and the optical correlation.

CONCLUSIONS

Based upon the results of this experiment and the comparisons with optical spray data and simulation results, two primary conclusions were reached in this study. Computer simulations support both conclusions.

1. The x-ray definition of Gaussian FWHM is fundamentally different than the definition of spray width for optical methods. This leads to the disagreement in aboslute numbers between the x-ray measurements and the optical values.

2. Using the FWHM definition, spray width is not influenced by ambient density.