FUEL INJECTION AND MIXING

Plain Jet in Crossflow

OVERVIEW

As environmental emissions considerations become more important in the development or upgrade of systems, the generation and control of the fuel spray plays an increasingly significant role. One reason for this is that the emissions of pollutants in exhaust streams is a function of the spray quality irrespective of the actual combustion system used.

This research is aimed at gaining a better understanding of the characteristics of sprays generated by injecting liquid fuel jets into a cross flow of air as might be found in the premixing duct of a gas turbine fuel injector.

OBJECTIVES

Collect data on for the jet produced by a “recessed” liquid jet injector using high speed videography for a distillate fuel under elevated pressure and temperature conditions.

Establish a correlation describing the penetration and behavior of the jet and examine the sensitivity of the results to the analysis protocols and assumptions made regarding velocities

Compare the current results to existing correlations based on flush wall jet configurations

RESULTS

Ambient temperatures and pressures between 350 and 475 K and 3.7 to 6.4 atm were considered for a range of liquid flow rates. High speed, short exposure digital shadowgraphy was utilized to document the behavior. Instantaneous images were extracted, averaged, and analyzed to provide data on penetration vs. downstream distance.

The test section is a straight 2-D duct. A liquid jet is formed by passing fuel through an orifice located in one wall of the test section. The wall jet is a plain orifice, having an L/D of 5. The orifice is located at the entrance to a short tube, which shields the jet as it passes through the test section wall.

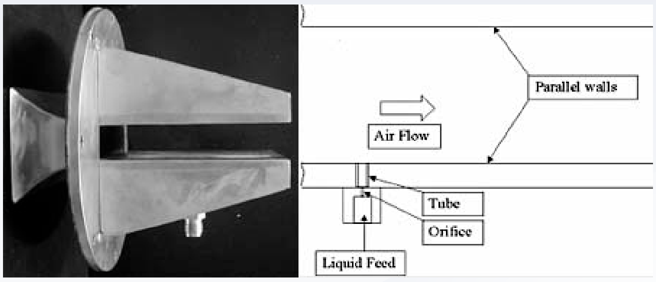

Figure 1. Averaged Image & Instantaneous Image

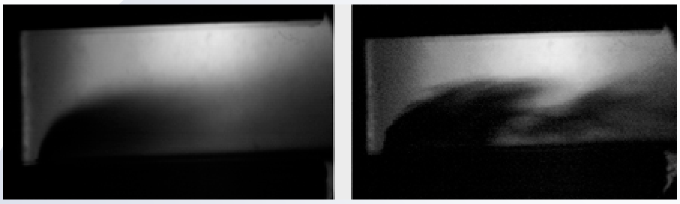

Figure 2. Test Hardware & Hardware Schematic

CONCLUSIONS:

Low momentum flux cases (q < 30) were isolated and a regression analysis carried out. The best correlation coefficients were obtained with the following formulation:

$$\frac{y_t}{d} = 0.92\,\bar{q}^{\,0.50}\left(\frac{x}{d}\right)^{0.33}$$

- At higher momentum flux ratios, two of the more recently developed penetration correlations appear to provide a better description.
- Inclusion of dimensionless parameters such as the Weber number and viscosity ratio improves the range of momentum flux ratios that can be predicted.

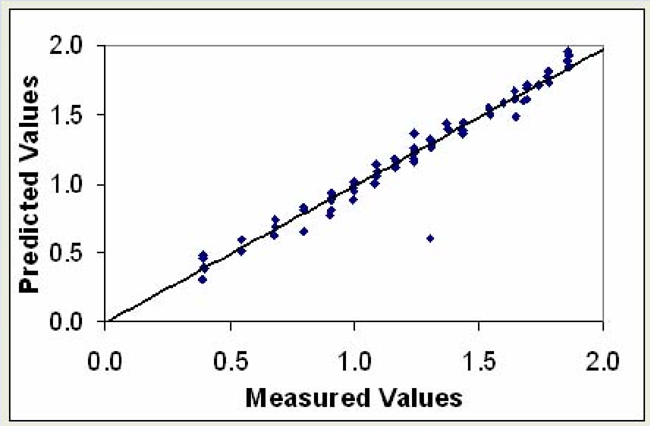

Figure 3. Data Comparison for New Low Momentum Correlation (q<30)

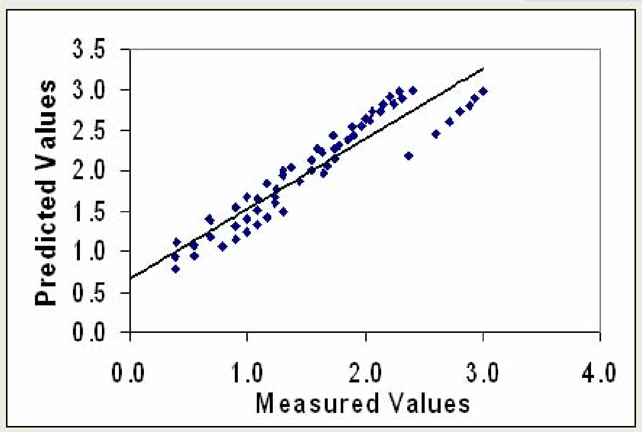

Figure 4. Data comparison Including Webber Number and Viscosity (q<75)

RECENT PUBLICATIONS/PAPERS

SOME OBSERVATIONS OF LIQUID JETS IN CROSSFLOW (2005). Proceedings, 18th ILASS-Americas Conference, Irvine, CA (B.J. Masuda, R.L. Hack, V.G. McDonell, G. Oskam, and D. Cramb).

PERSONNEL

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