

A Study of the Effect of Fuel/Air Nonuniformity on Nitric Oxide Emissions

by

Valerie Lyons

Airbreathing Engines Division
NASA Lewis Research Center
Cleveland, Ohio

A study of the effect of fuel/air nonuniformity on exhaust emissions was performed in a flame tube combustor using Jet A fuel. The experiments were performed at a pressure of .3 Mpa and a reference velocity of 25 meters/second for three inlet air temperatures of 600, 700, and 800 K. The gas sample measurements were taken at locations 18 cm. and 48 cm. downstream of the perforated plate flameholder as shown in the rig schematic in figure 1. Nonuniform fuel/air profiles were produced using the fuel injector shown in figure 2 by separately fueling the inner five fuel tubes and the outer ring of twelve fuel tubes. Six fuel/air profiles were produced for nominal overall equivalence ratios of .5 and .6. An example of three of these profiles and their resultant NO_x emissions are shown in figure 3 and 4.

Figures 5 and 6 show NO_x emission indices which have been mass-weighted before determining a mean value of the particular fuel/air profile. These mean E. I. values are plotted versus a fuel/air nonuniformity parameter, s , which is the standard deviation from the mean of the local equivalence ratio profile for the particular fuel/air profile studied.

The uniform fuel/air profile cases produced uniform and relatively low NO_x profile levels. When the profiles were either center-peaked or edge-peaked, the overall mass-weighted NO_x levels increased. The maximum increase in NO_x was sixteen-fold deviation from the uniform profile values for the 600K inlet air temperature, ϕ nominal = .5 case as seen in figure 5. For the ϕ nominal = .6 case, 800 K inlet air, the NO_x showed a five-fold maximum increase from the uniform case (see figure 6). Figure 6 also shows that changing the inlet air temperature produced no change in the overall trends in the effect of nonuniformity on NO_x .

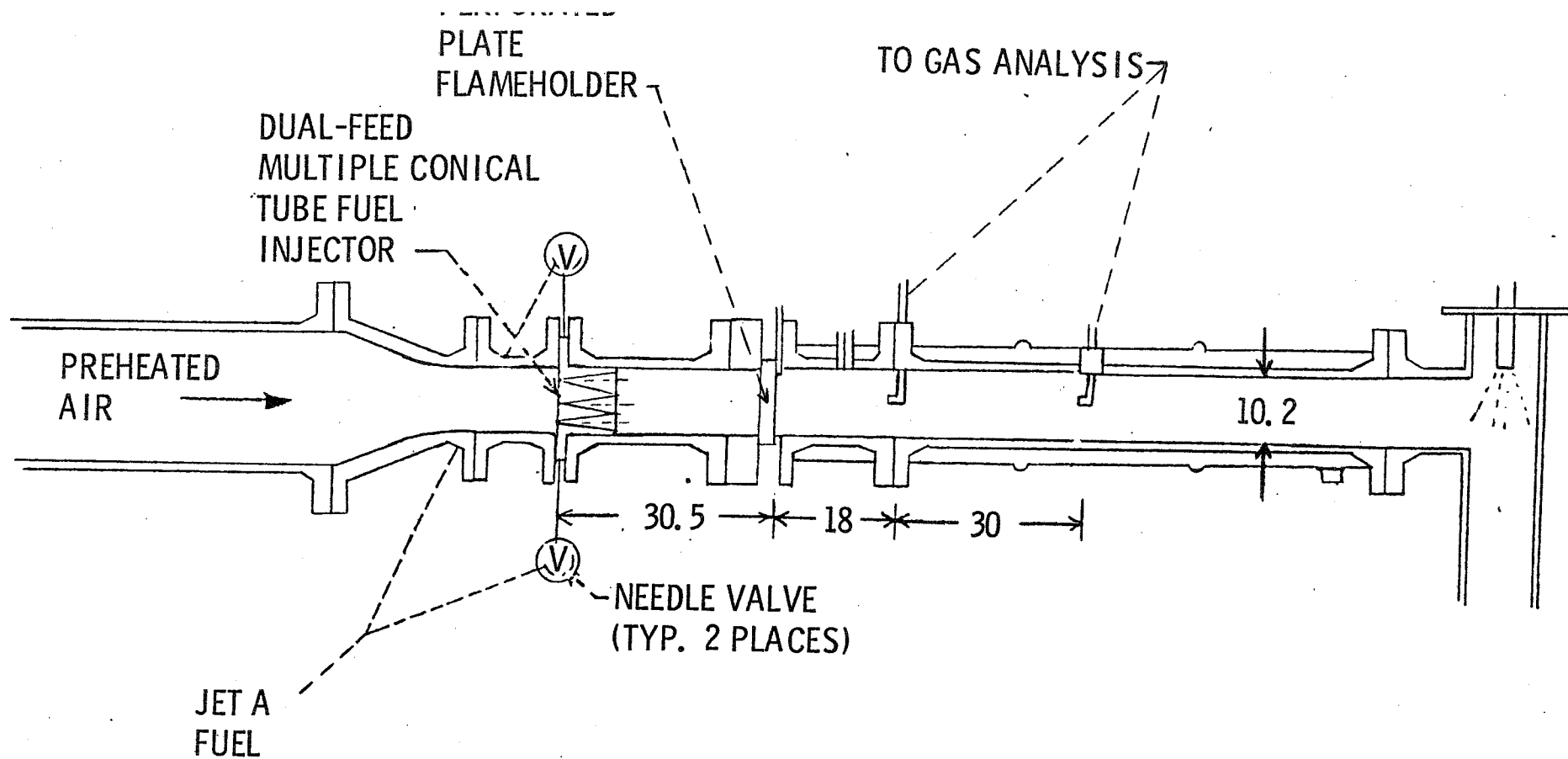


FIGURE 1 - Rig schematic (all dimensions in cm).

MULTIPLE CONICAL TUBE INJECTOR

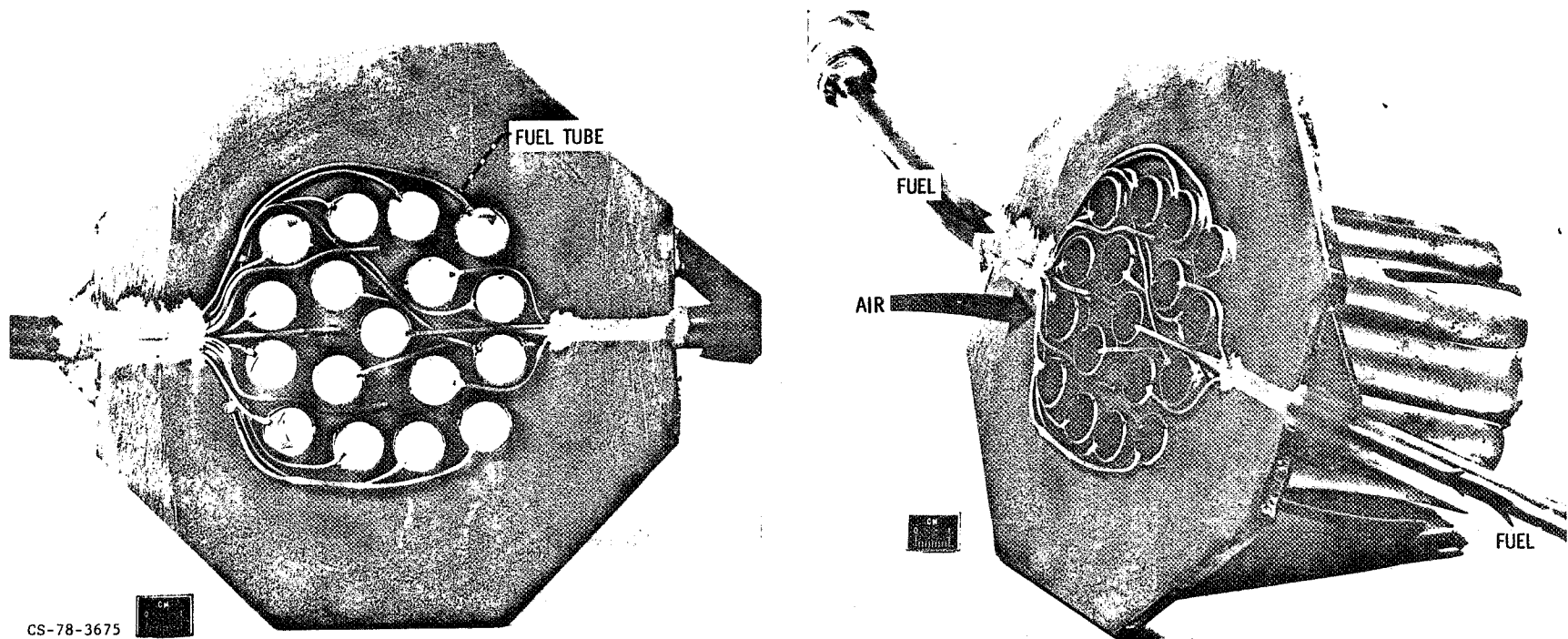


FIGURE 2

THREE FUEL/AIR PROFILES FOR A NOMINAL EQUIVALENCE RATIO
OF 0.6 AND INLET AIR TEMPERATURE OF 600°K.

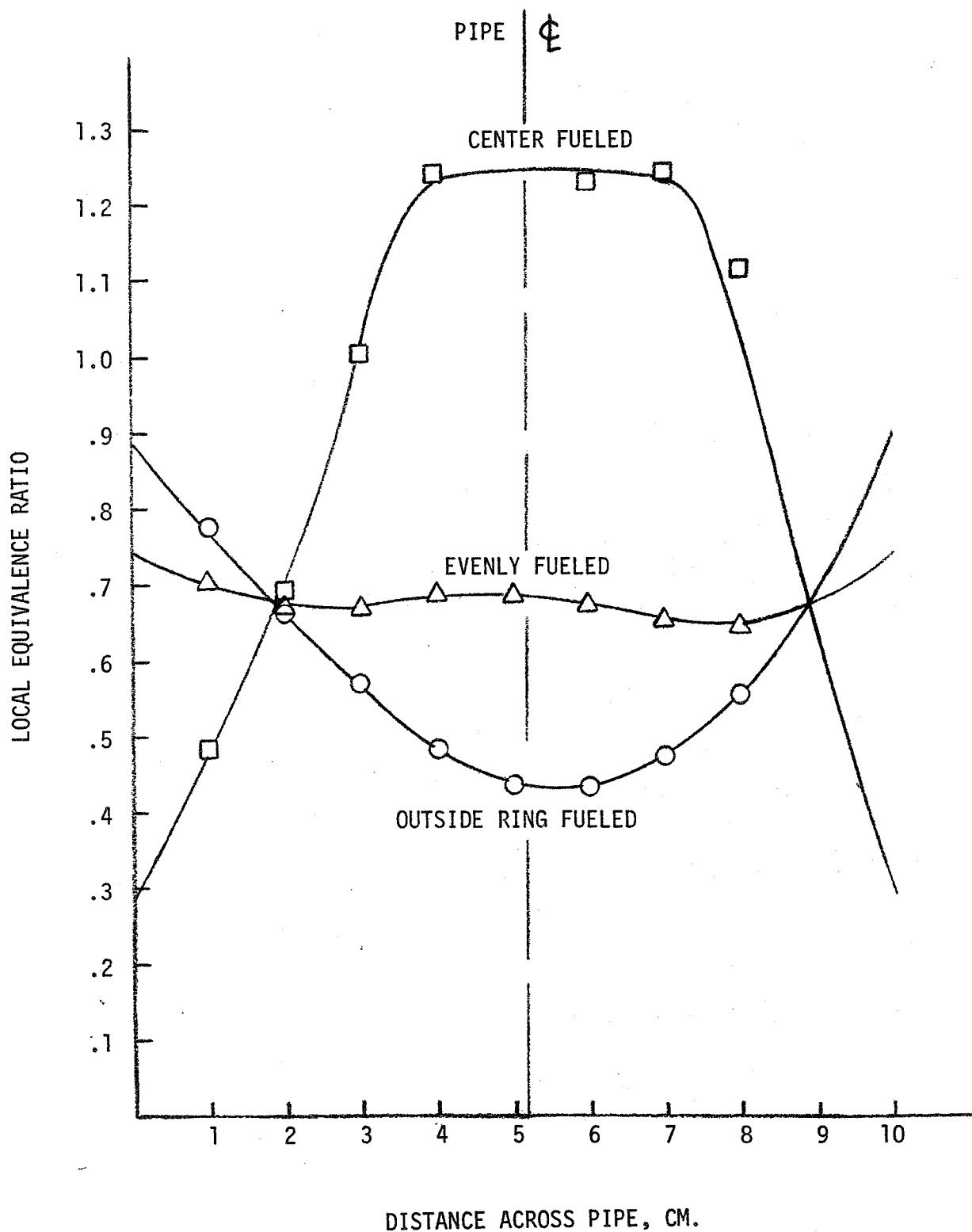


FIGURE 3