



Alternate-Fueled Combustor-Sector Emissions

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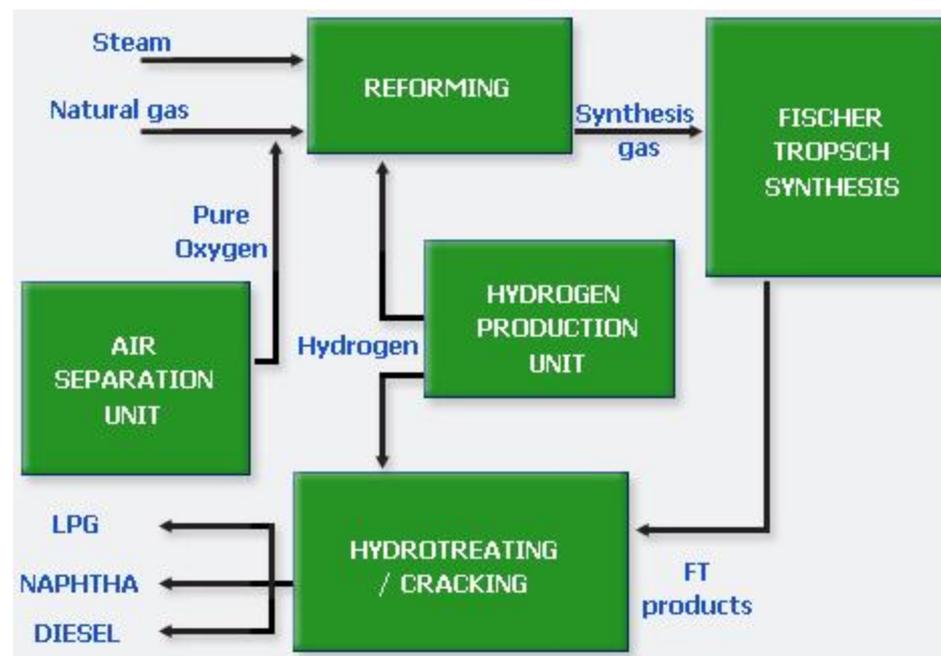
Outline

- **Objective**
- **Experiment**
 - Testing parameters
 - Data collected
- **Results**
 - NO_x emissions
 - CO emissions
 - Combustor Efficiency
 - Particulate Emissions
- **Conclusions**

Objective

Compare combustor performance and emissions data for alternate fuel-flexible combustor-sector systems

FT fuel in 0%, 50%, and 100% blends with JP-8 (Jet fuel)

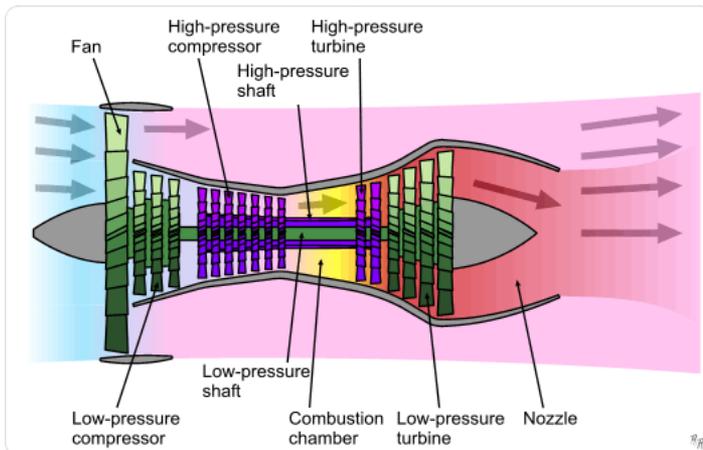


A truly effective alternate fuel would emit at or under the level of traditional fuels and not compromise performance ability

“Combustor A” Testing Parameters

Testing variables:

- *Inlet pressure (P) and temperature (T):*
 - 75 psia (0.52MPa) and 500°F (533K)
 - 125 psia (.086MPa) and 625°F (603K)
 - 175 psia (1.21MPa) and 725°F (658K)
 - 225 psia (1.55MPa) and 790°F (694 K)
- *Combustor pressure drops (ΔP):* 3%, 4%, and 5%
- *Fuel blends:* 100% JP-8, 50:50 JP-8:FT, and 100% FT
- *Fuel-to-air (F/A) ratios:* 0.010, 0.015, 0.020, 0.025

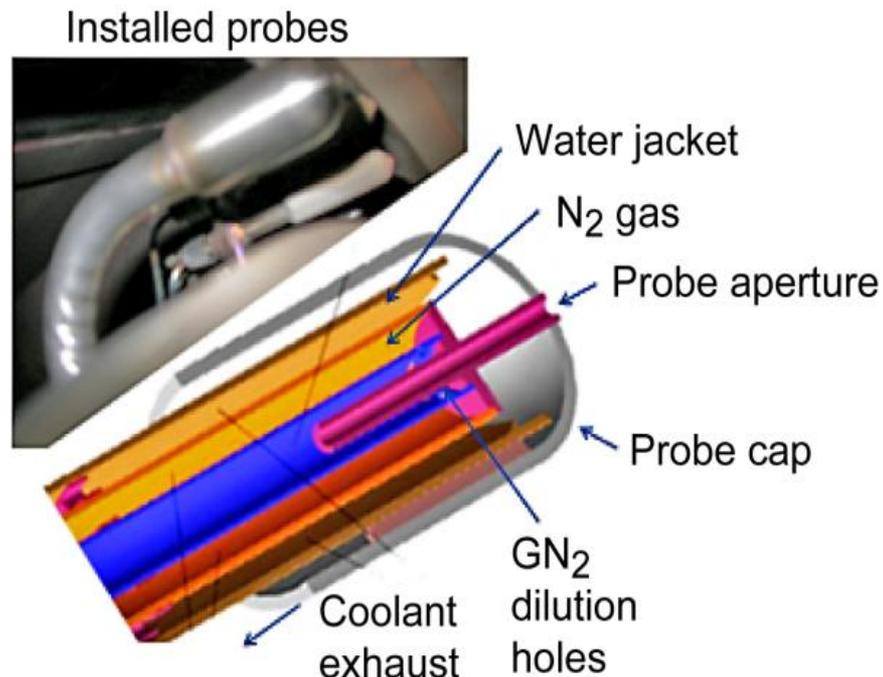


The sampling probe was placed at the nozzle exit plane.

Data Collected

- Gaseous Emissions Data:

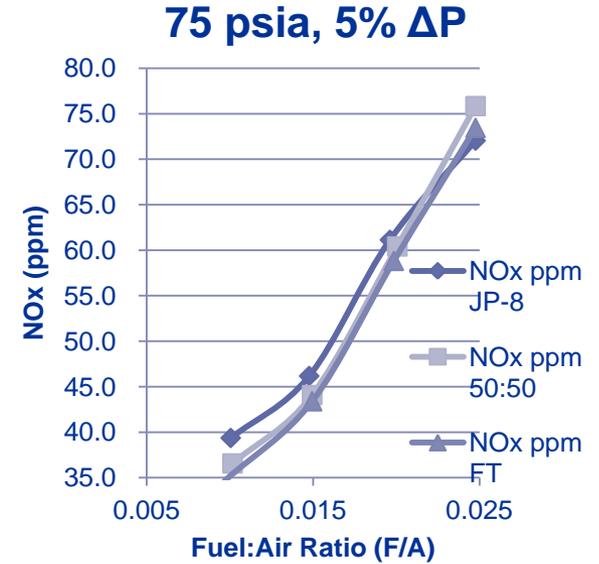
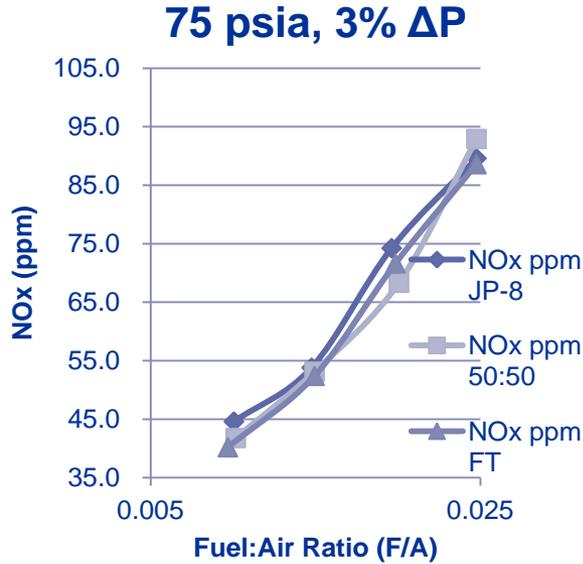
- **NO** (ppm)
- **NO₂**(ppm)
- **NO_x**(ppm)
- **CO**(ppm)
- **CO₂**(%)
- **O₂**(%)
- **THC**(ppm)



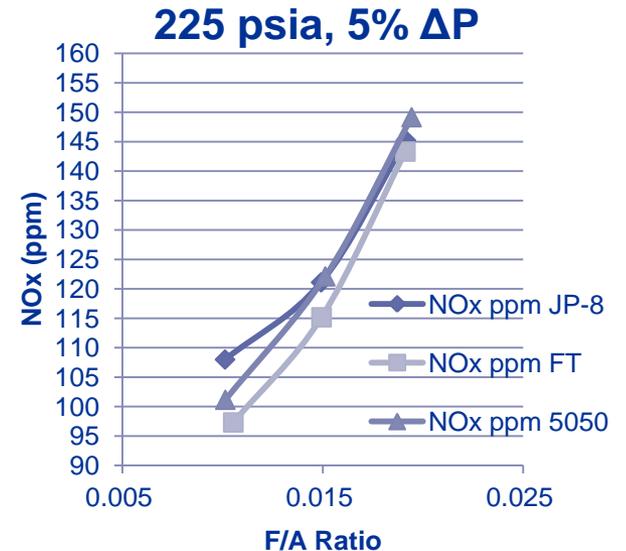
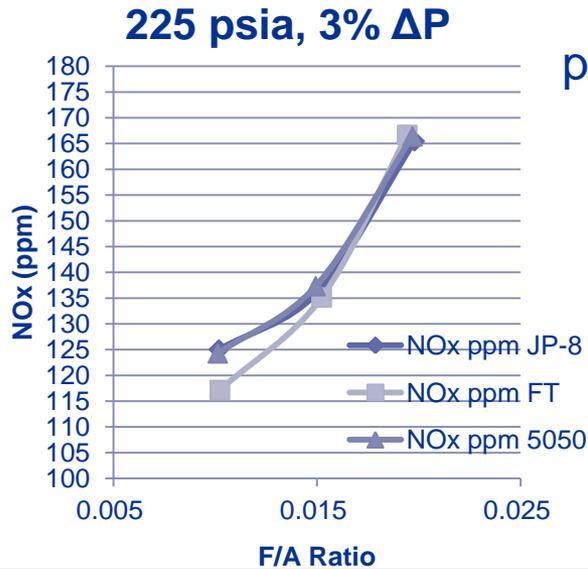
- Photo diode output voltage (V)
- Incomplete smoke number and particulate emissions data



NOx emissions



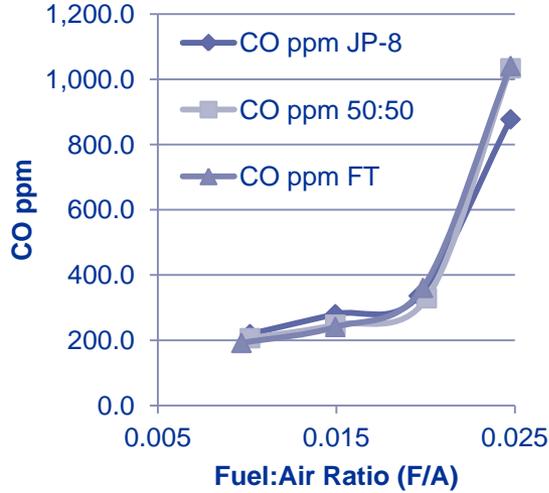
NOx emission (ppm)
variations w/
pressure, F/A and fuel
composition



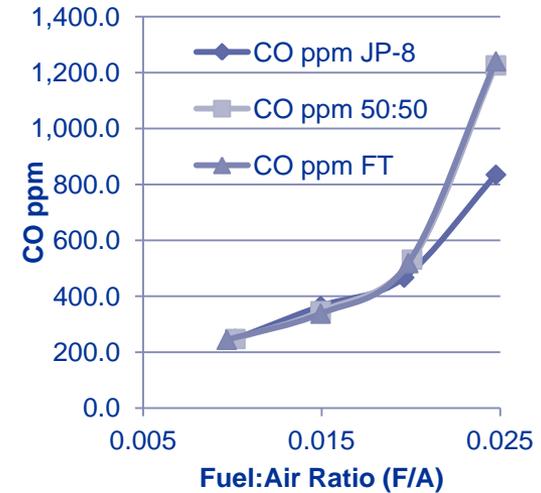


CO emissions

75 psia, 3% ΔP

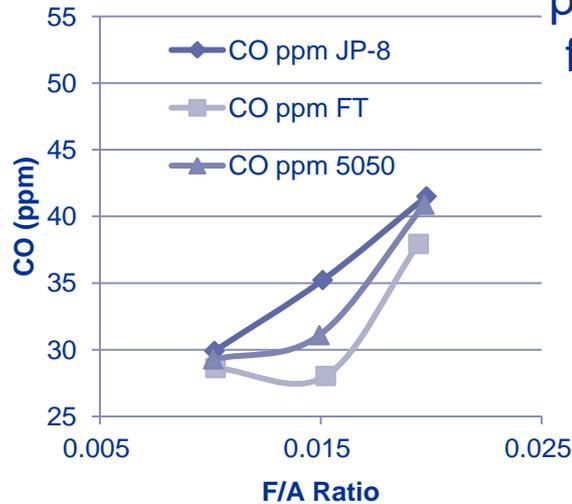


75 psia, 5% ΔP

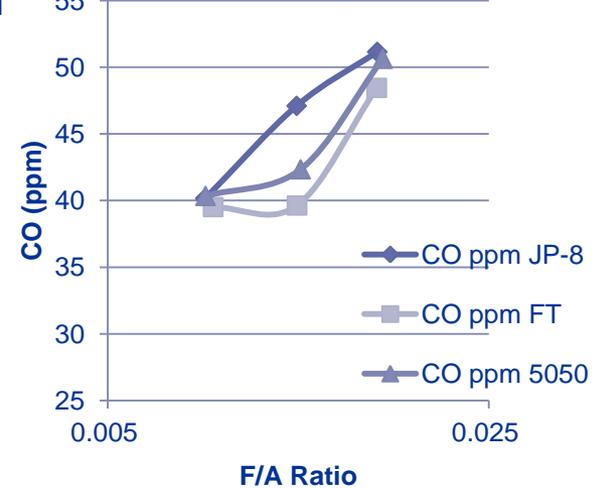


CO emission (ppm) variations w/ pressure, F/A and fuel composition

225 psia, 3% ΔP

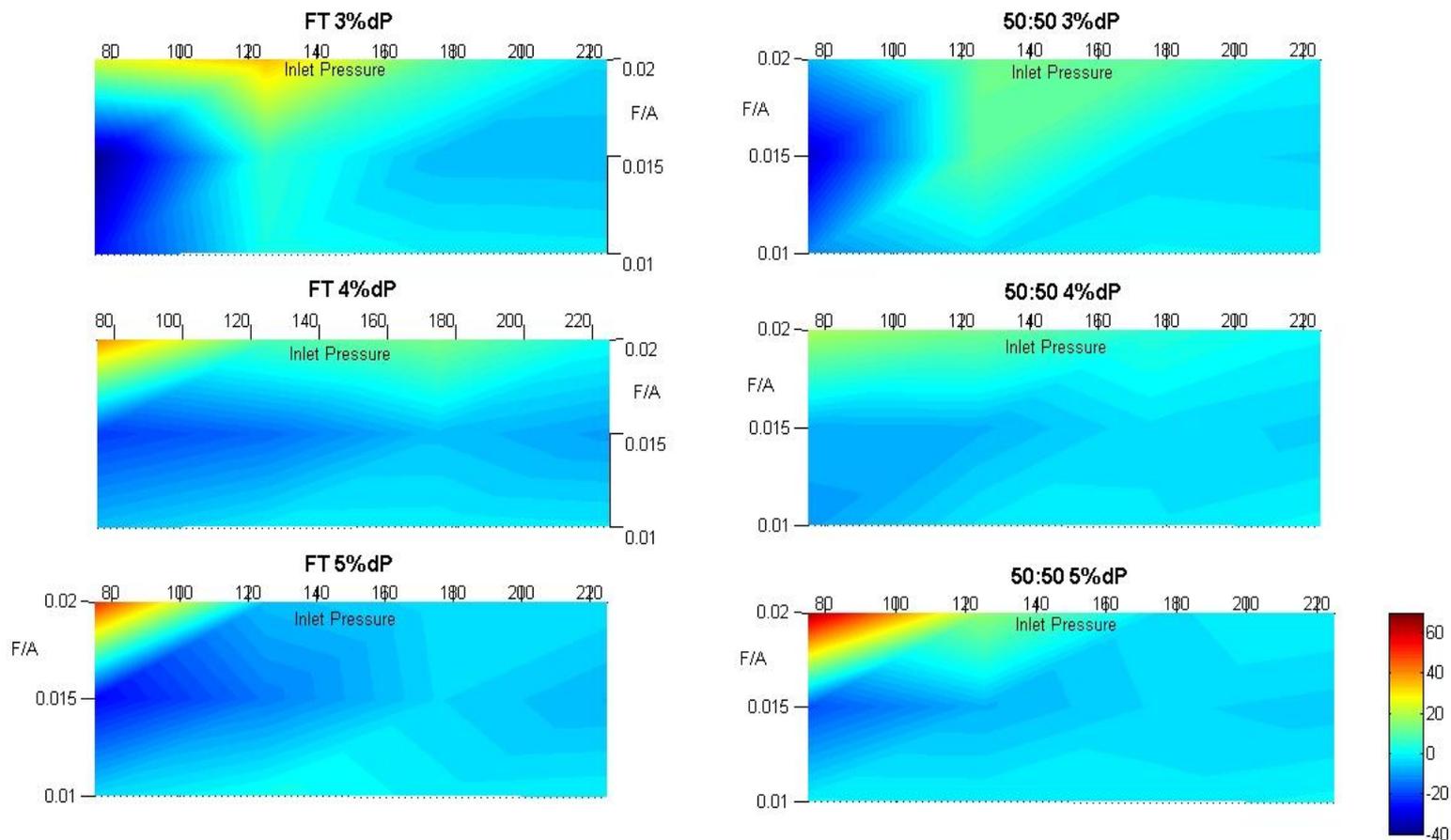


225 psia, 5% ΔP



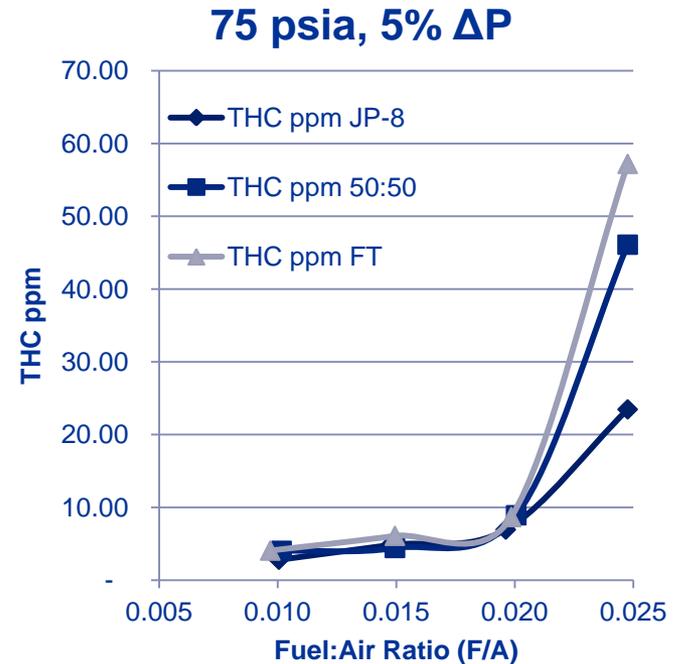
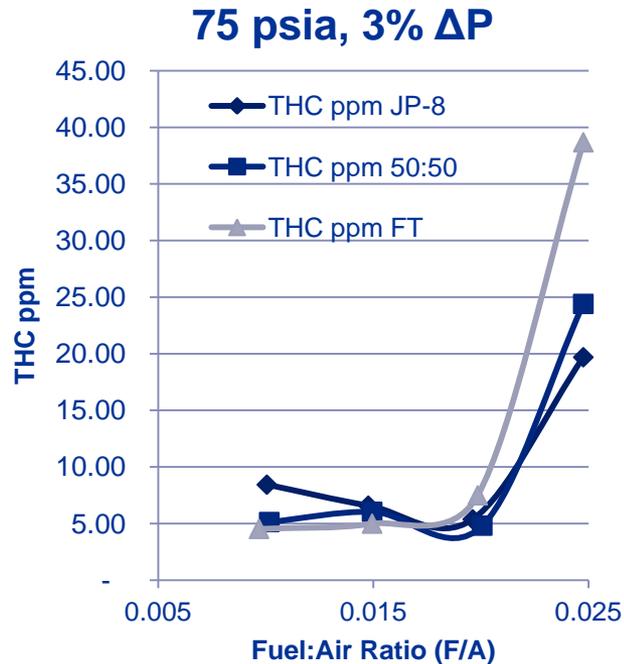


CO emission differences





THC (total hydrocarbon) emissions



THC emissions
(ppm) w/ F/A and
fuel composition



Combustor Efficiency

@75psia	3%		4%		5%	
F/A	0.010-0.020	0.025	0.010-0.020	0.025	0.010-0.020	0.025
Average	99.64	99.25	99.56	99.05	99.47	98.99
JP-8	99.61	99.32	99.56	99.10	99.46	99.20
50:50	99.65	99.24	99.56	99.09	99.46	98.90
FT	99.66	99.20	99.58	98.96	99.48	98.87
Std. Dev.	0.024	0.058	0.011	0.080	0.013	0.181

Combustor efficiency data summary at 75 psia (0.52MPa). The efficiency does drop off at 0.025, and the differences between the fuels are more pronounced.

Photo Diode Output (V)

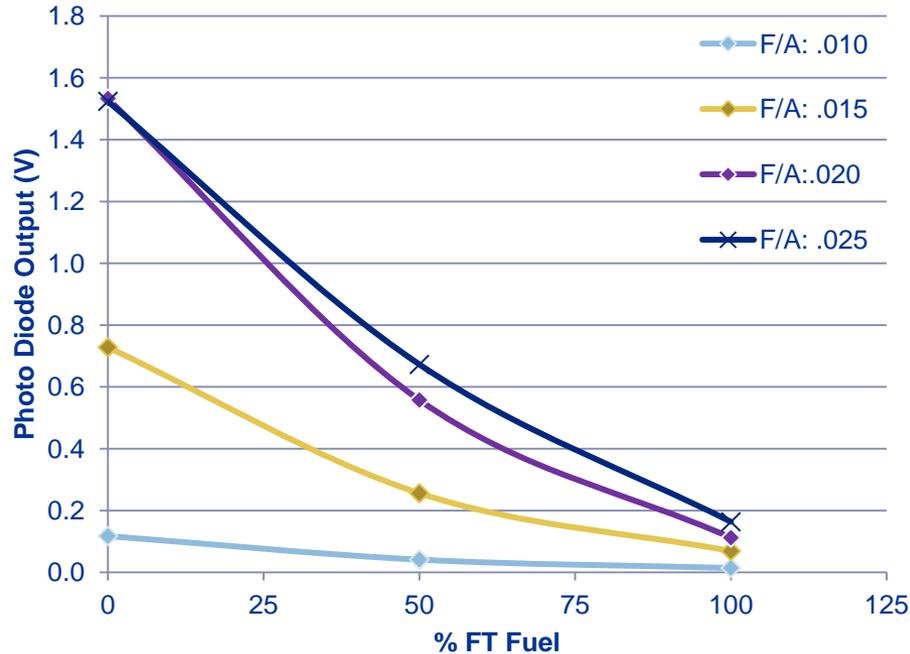


Photo diode output (V) variations with fuel blends and F/A

0% FT

50% FT: 50% JP-8

100% FT

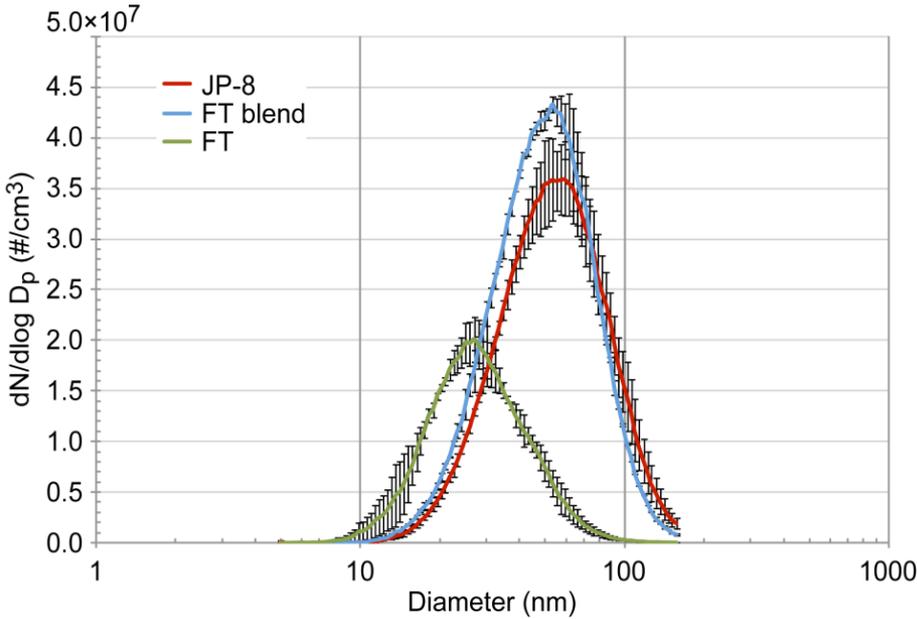
F/A = 0.020



Digital camera photographs showing flame changes with changes in fuel blend at **F/A = 0.020**

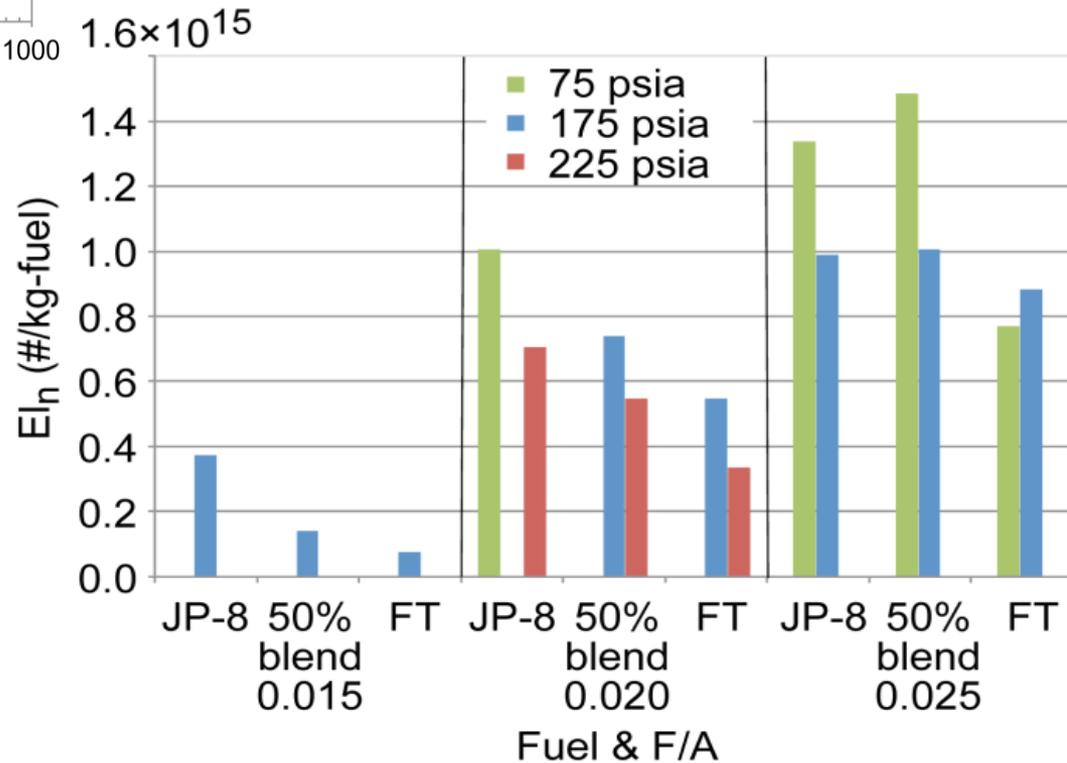


Particulate Emissions



Particle size distribution (ppm) at 0.52MPa and F/A=0.025

Particulate emissions (ppm) variations with test pressure and F/A (incomplete)





Emissions Implications

- European Union has recently moved to implement a carbon emissions tax on airlines flying in and out of its airspace
- necessary for countries to move towards alternate fuels
- SPK fuels could be a promising near-term alternative for jet fuels



Conclusions

- **Gaseous emissions:** varied more based on F/A ratio than the fuel blend used
 - FT fuel did have generally lower NO_x and CO emissions by a small amount
 - NO_x Emissions count increased with absolute pressure, while CO emissions decreased
- **Combustor Efficiency:** insignificant difference between fuels at low F/A ratios
 - Efficiency drops at $F/A = 0.025$, and differences between fuels become more pronounced
- **Particulate Emissions:** 50:50 blend does not correlate to 50% reduction in emissions
 - Number and size of particulates less in FT blends than in JP-8
- **Future directions:** Further compile particulate emissions data and continue to test various alternative fuels



Acknowledgements

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