Emissions Characteristics Study of Conventional and Alternative Aviation Fuels

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Conventional Jet Fuels vs Renewable Biofuels

Purpose: Explore whether biofuels are a suitable replacement to conventional jet fuels while mitigating negative impacts of fuel combustion on environment

Areas of Interest:

- The Combustion Process and Reactions
- Comparing Fuel Properties of Various Fuels
- Emissions Output of Conventional Jet Fuels vs Renewable Biofuels

Research Process

- Read Articles on Fuel Properties, Emissions, Effects of Mixing on Performance
- Collection and Comparison of Fuel Properties

Fig. 1 Elsevier, major source of research publications

Preparation

- C491 Machine Calibration
- Collection of Fuel Samples

Fig. 2 Trip to Martin State Airport for Jet A samples

Experimentation

- Testing of Fuels and Analysis of Experiment Results

Fig. 3 Christopher Taylor gathering emissions data

Combustion Process

Ideal Reaction: $C_XH_X + O_2 \Rightarrow H_2O + CO_2$

Other Significant Reactants:

- N_2
- H_2S
- NO
- C

Other Significant Reactions:

$N_2(g) + O_2(g) \Rightarrow 2NO(g)$

$2H_2S(g) + 3O_2\ (g) \Rightarrow 2SO_2(g) + 2H_2O(l)$

$CH_4(g) + O_2(g) \Rightarrow C(s) + 2H_2O(g)$

$2C(s) + O_2(g) \Rightarrow 2CO(g)$

Comparison of Fuel Properties

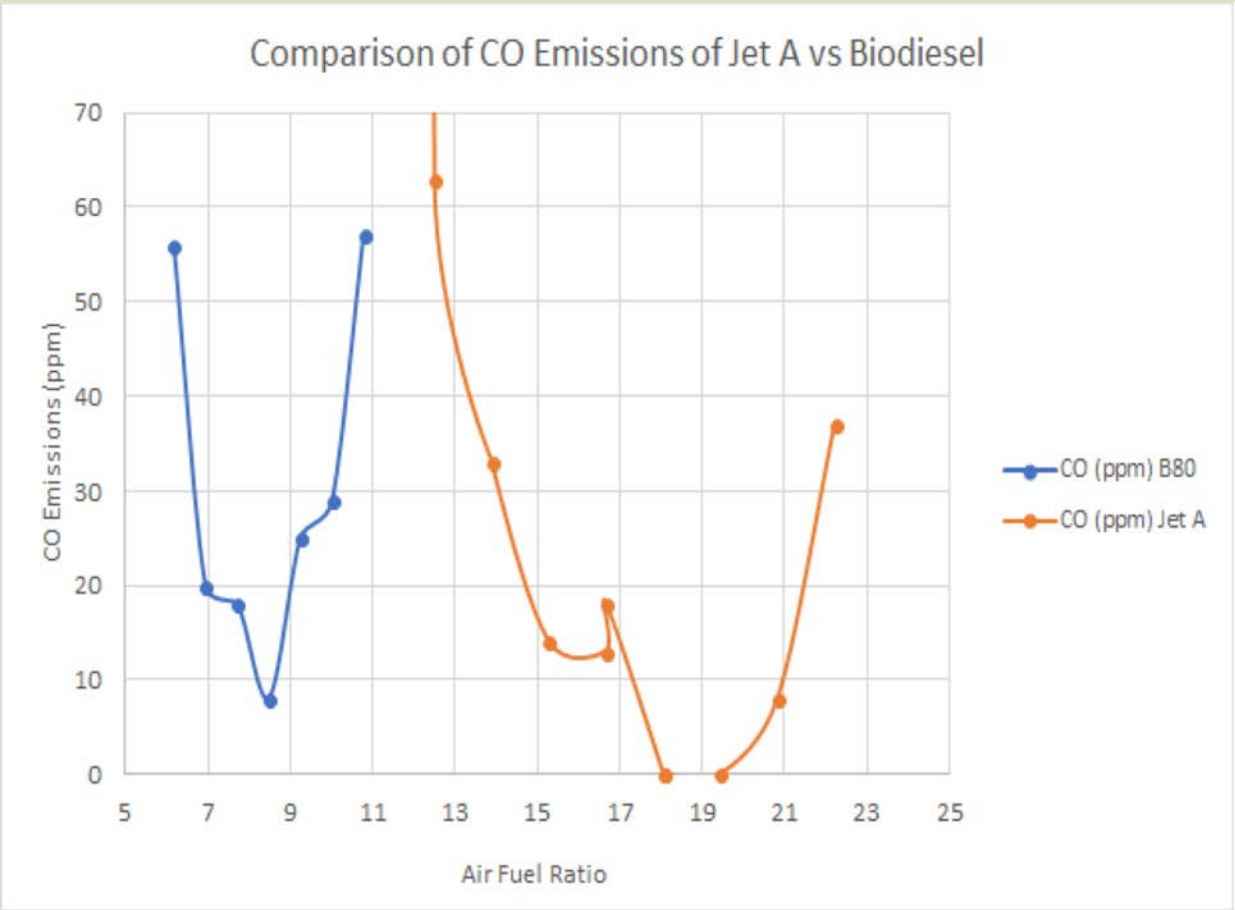
Jet A Fuel	Biofuel
Density: (@15^{o}C) 775/840 kg/m^{3}	Higher
Viscosity: (@-20^{o}C) 8.0 mm/s	Higher
Freezing Point: -40^{o}C	Lower
Flash Point: 38^{o}C	Varies
Specific Enthalpy: 42.8 MJ/kg	Varies

Experimental Setup

Fig.4 Enerac 500 Micro Emissions Analyzer

Fig.5 C491 Combustion Laboratory Unit

Comparison of Emissions: Carbon Monoxide



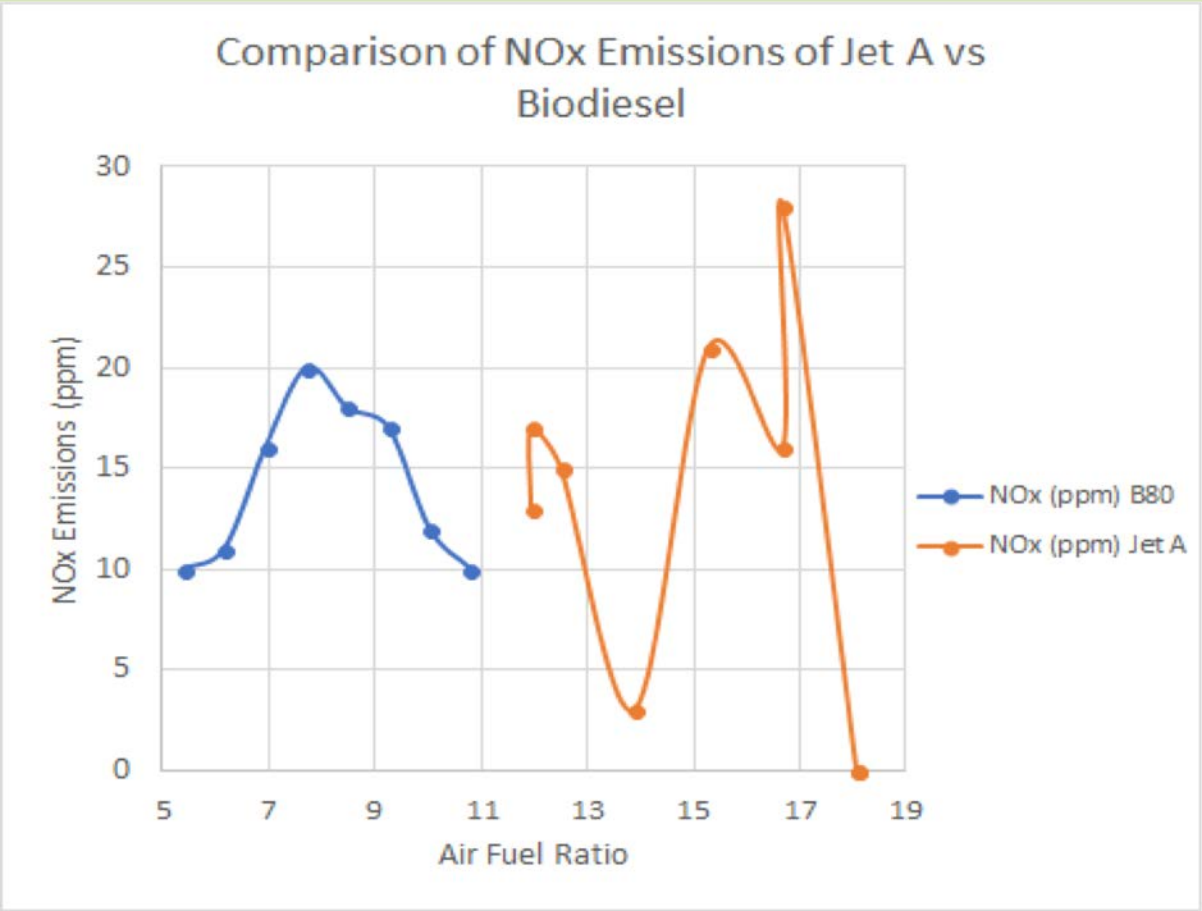
Jet A requires more oxygen

Focus is on carbon output

Biodiesel produces less carbon monoxide

Biofuels are carbon neutral
Net carbon output is zero

Comparison of Emissions: Nitric Oxide



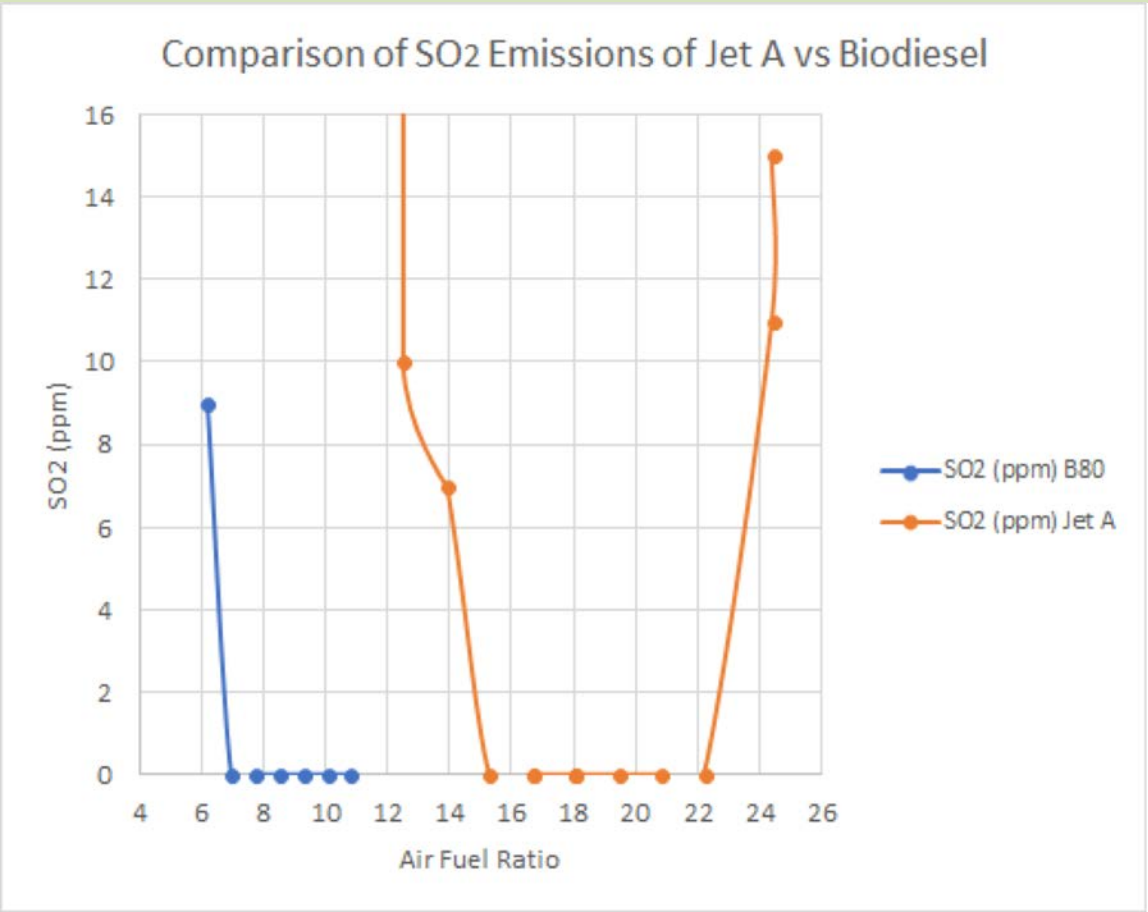
Average NO emissions are relatively similar.

Neither fuel proves better for environment in terms of NO emissions

Neither fuel produced a measurable amount of NO_2

Air is the source of nitrogen. More air more nitric oxide

Comparison of Emissions: Sulfur Dioxide

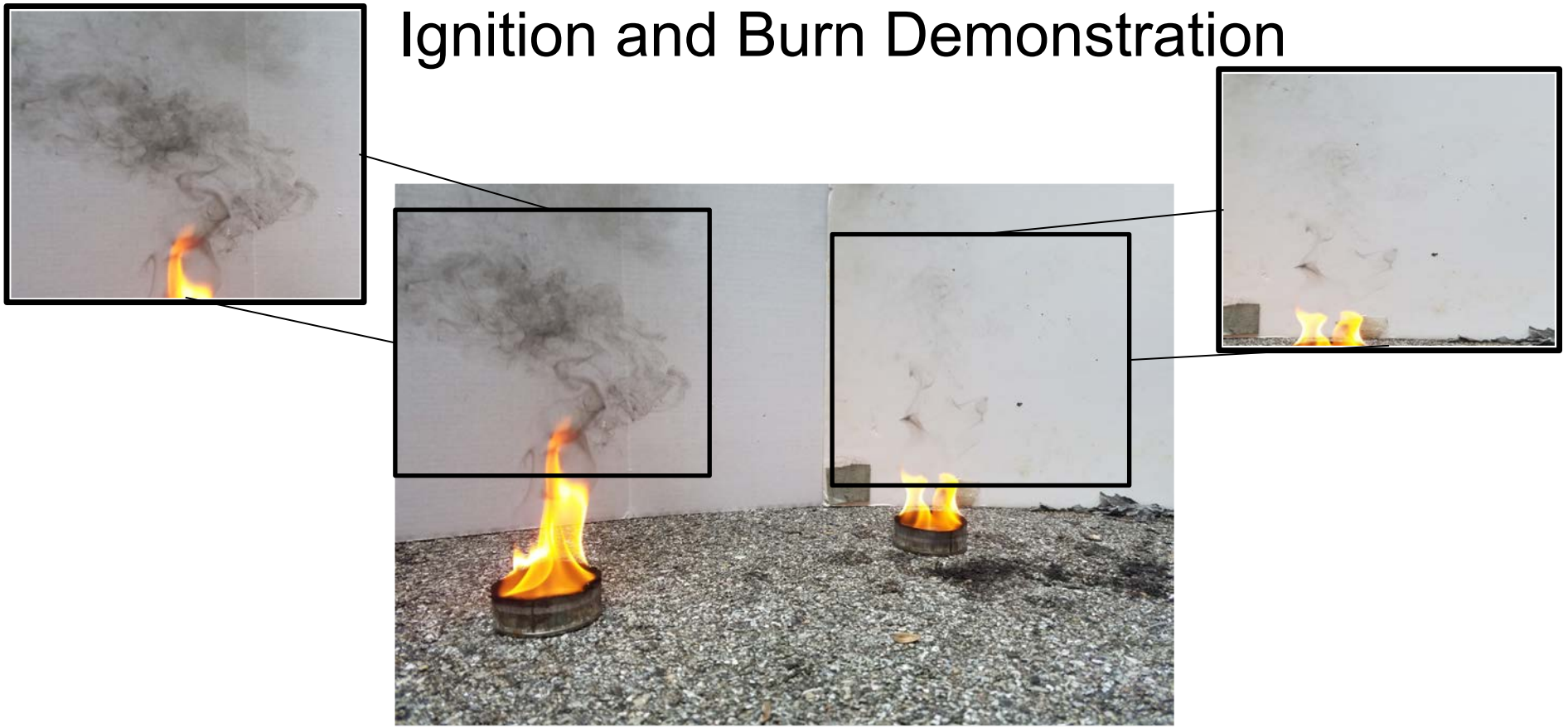


Impurities in fuel contain traces of sulfur resulting in SO2 emissions during combustion

Despite restrictions on sulfur content, Jet A still releases significant SO_2 emissions

In contrast biofuels emit less SO2 and don't incur further refinement costs

Ignition and Burn Demonstration



B80 (right container) burns visibly cleaner than Jet A (left container)

Conclusion

Biofuels successfully tested and proved to be a suitable replacement for conventional jet fuels while simultaneously producing less harmful emissions. Still, there are some tradeoffs.

Benefits:

- Lower impact on the environment
- Good lubricant for engine parts

Problems:

- Poor low temperature fuel flow properties
- Thick biofuels can clog fuel filters and put extra strain on fuel pumps

Potential Future Work:

- Research on the tradeoffs between emissions and power output
- Fuel efficiency of conventional jet fuels vs biofuels

References and Acknowledgements

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Thanks and Q&A!!!

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