Ignition Working Group Update

Motivation and Objectives

Ignition, a combustor stability limit, is a key criteria for alternative jet fuel certification.

The Ignition WG aims to predict possible deleterious ignitability behavior of alternative jet fuels via identifying the limiting physical process and properties. This identification is done through experimentation of various NJFCP fuels in various rigs at appropriate conditions.

Identifying these properties and developing test methods can guide fuel development and help streamline the certification process.

Experimental Methods

Fuels

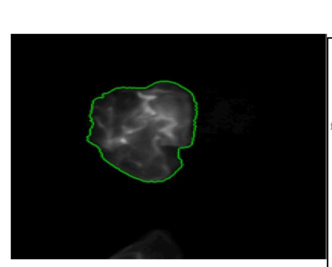
Category A: Three Conventional (Petroleum) Fuels

- "Best" case (A-1)
- "Average" (A-2)
- "Worst" case (A-3)

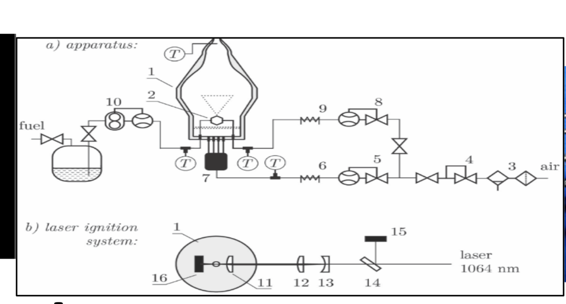
Category C: Nine "Test Fluids" With Unusual Properties

- C-1: low cetane, narrow boiling (downselected)
- C-2: bimodal boiling, aromatic front end
- C-3: high viscosity
- C-4: low cetane, wide boiling
- C-5: narrow boiling, full fuel (downselected)
- C-6 and C-6a: high cycloparaffins (not available)
- C-7 – blended fuel with maximum achievable cycloparaffins (~62 vol%)
- C-8 – blended fuel with maximum aromatics (25 vol%)
- C-9 – modified alternative fuel that has maximum DCN (63)

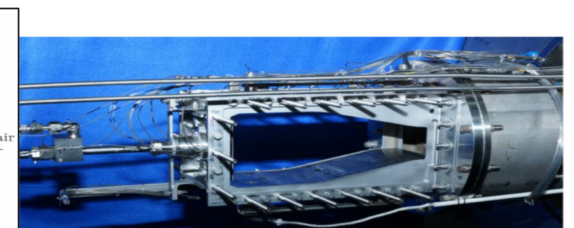
Rigs



Prevaporized Georgia Tech



Univ. of Cambridge



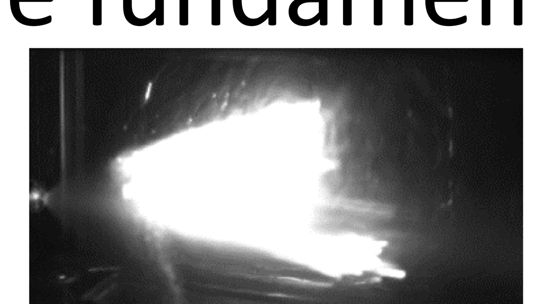
Referee Rig

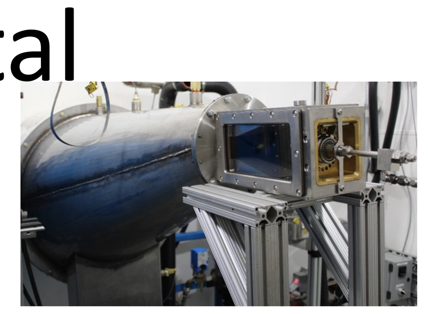
NRC Canada

More 'Product-like'

More fundamental

Spray Georgia Tech





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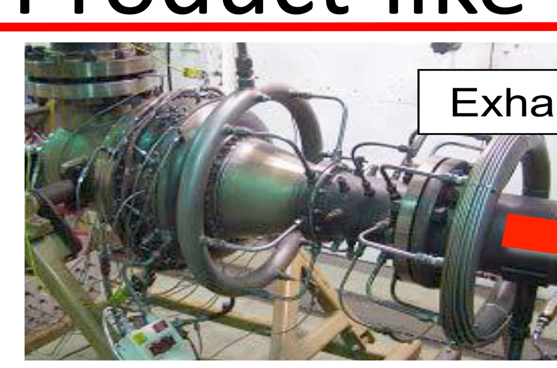
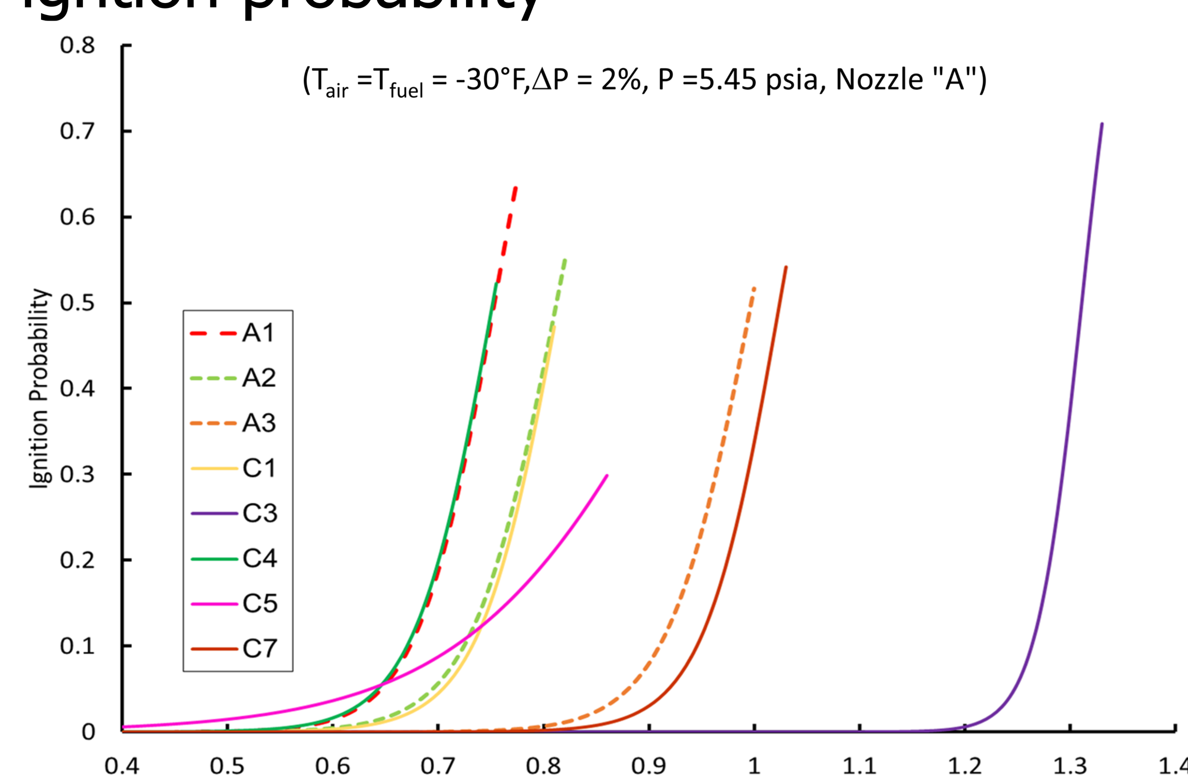


Honeywell

Summary

Since the inception of the NJFCP, OEMs requested cold fuel & air experiments. This required significant hardware and facility upgrades. New results from newly upgraded facilities:

- Ignition experiments conducted at altitude (T and P corresponding to 25,000 ft altitude)
- Differences in ignition performance is evident across fuels
- Physical properties (viscosity and surface tension) are the most important factors in predicting cold start ignition
- Viscosity and lower fraction distillation temperatures (T10, T20) important for altitude ignition
- High Temperature sensitivity shown for igntion probability



Ignition probabilities vs ϕ for high altitude conditions

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Project manager: C. Shaw, FAA

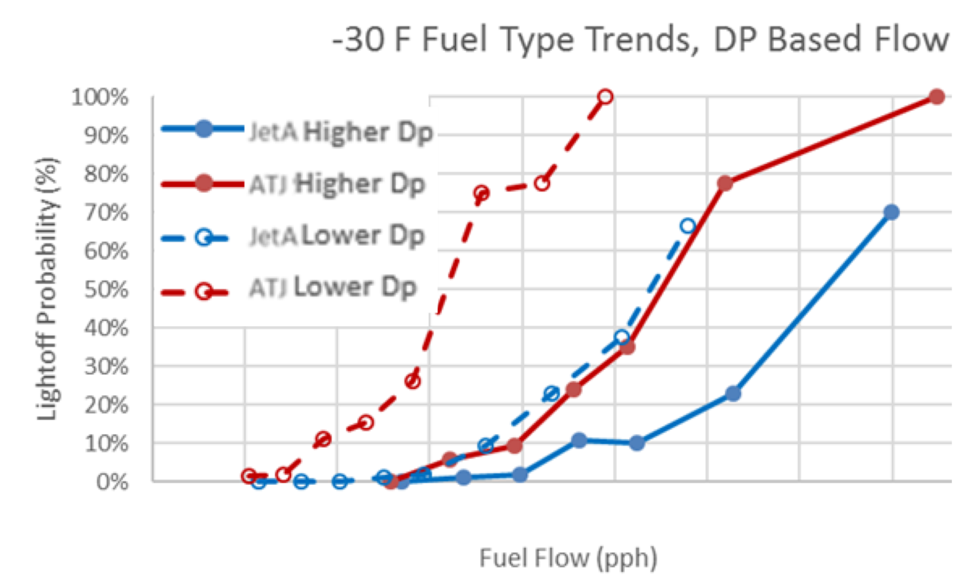
October 9, 2018

This work was funded by the US Federal Aviation Administration (FAA) Office of Environment and Energy as a part of ASCENT Projects 27, 30, and 34 under FAA Award Number: 13-C-AJFE-UD-018 and others. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the FAA or other ASCENT Sponsors.

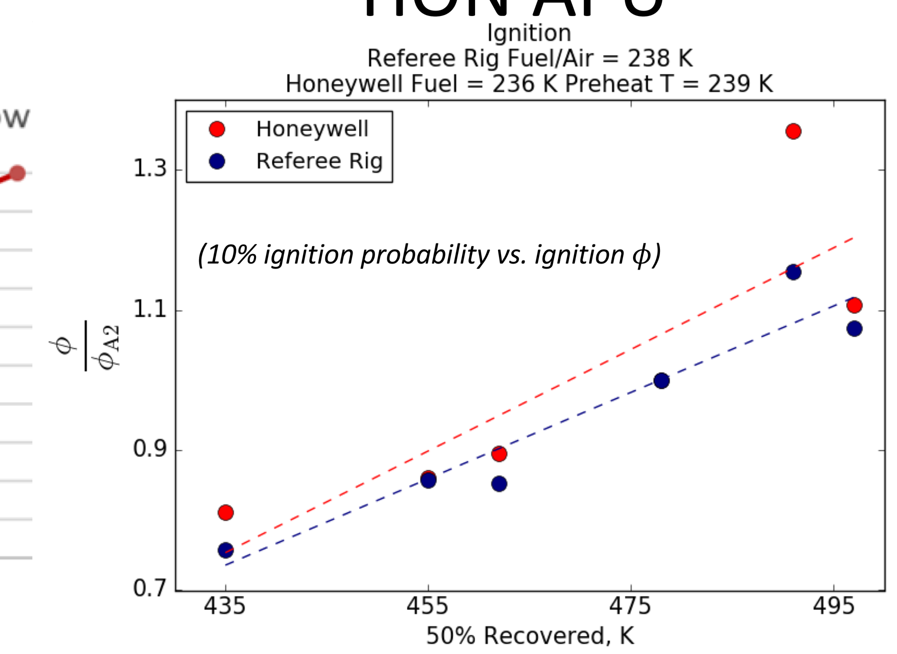
Results and Discussion

Rig comparisons:

GE TAPS



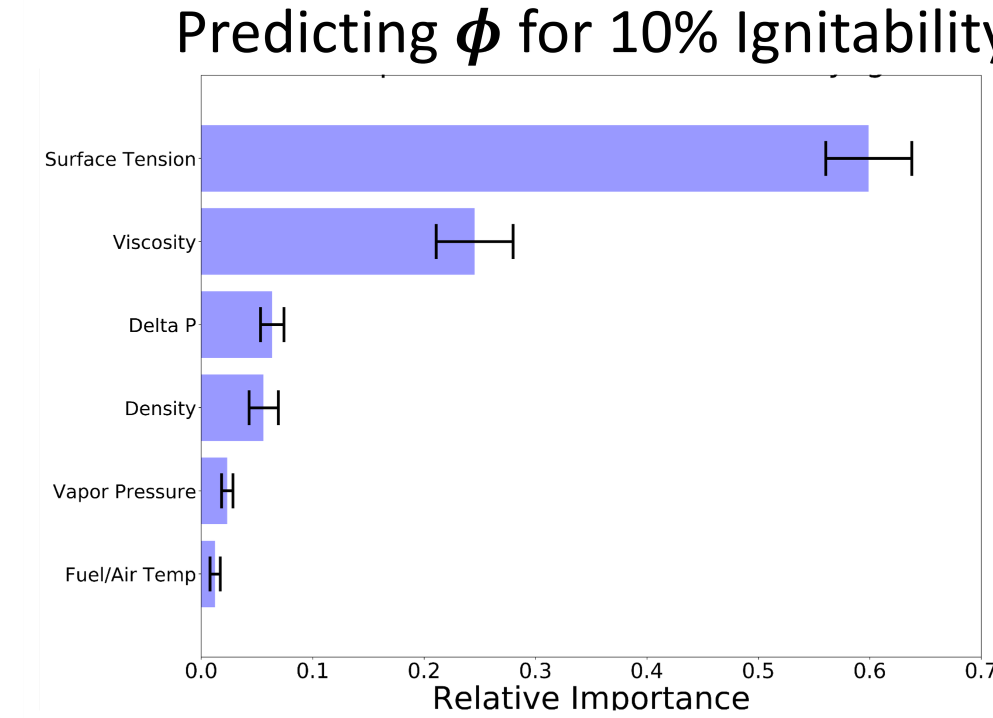
Referee Rig vs. HON APU



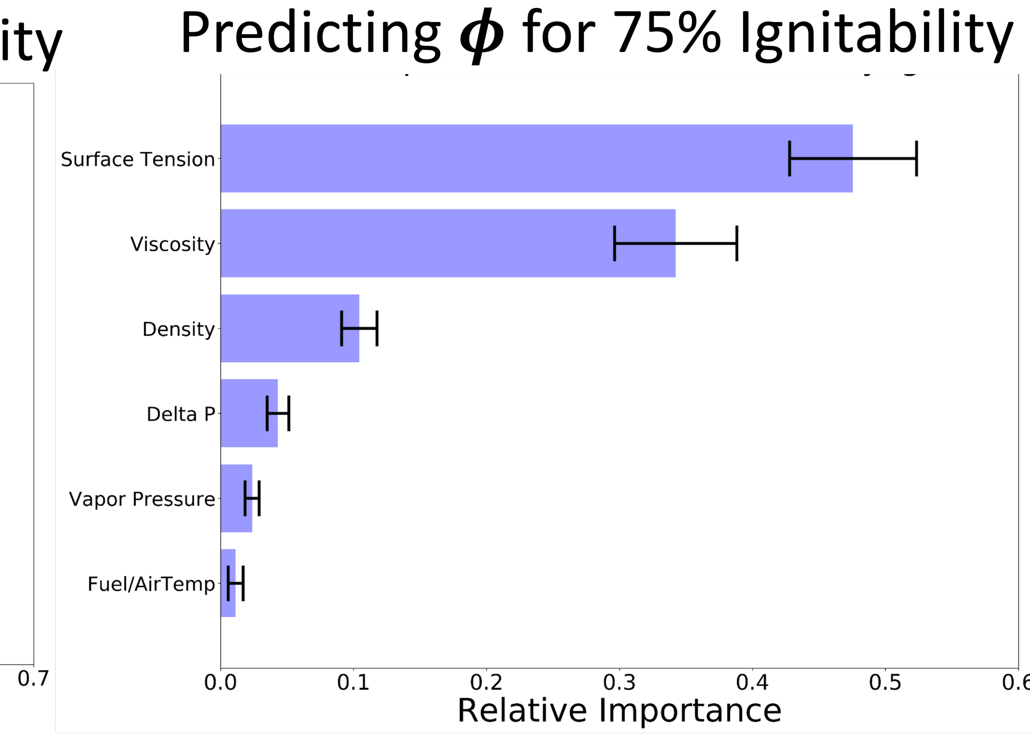
Referee Rig is consistent with multiple fuel results at HON and one fuel, C-1, at GE.

Fuel Property Characterization and Random Forest Analysis:

Predicting ϕ for 10% Ignitability



Predicting ϕ for 75% Ignitability



Physical properties (surface tension and viscosity) are the most important for predicting ignition across the atmospheric cold start ignition probability datasets for the Referee Rig

- *Viscosity currently has two spec limits, -20 and -40 °C, included in the evaluation and approval process.*
- *There is no specification for surface tension, although surface tension is correlated to density which does have spec limits.*
- *Other analysis suggest that viscosity is the dominant parameter for predicting ignition probability.*

Conclusions and Next Steps

AIAA Book Chapter writing in progress,
Investigation of various molecular groups with surface tension and viscosity
Several archival papers are in progress