Project 88

A Method for Rapidly Assessing Jet Fuel Compatibility with non-Metallic Materials

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Cost Share Partner(s): Global Bioenergies, Boeing, GE Aviation, NRC Canada, Lanzatech, Neste, Shell, and IHI.

Objective:

The objective of this project is to develop a method for rapidly assessing the compatibility of candidate sustainable aviation fuels (SAFs) with non-metallic materials (seals, sealants, hoses, diaphragms, coatings, adhesives, etc.).

Project Benefits:

The proposed program will help lower the cost and speed the development and certification of candidate SAFs by providing a relatively simple means of evaluating their material compatibility using very small volumes of fuel and small amounts of materials.

Research Approach:

This project will build on nearly 20 years of prior work with the material compatibility of alternative aviation fuels. Key elements of the proposed effort will include developing a clear understanding of the link between fuel composition and material compatibility and defining specific requirements for a drop-in SAF. This program will combine elements of fuel chemistry, material science, and materials engineering to provide computational and physical tools to assist in the development and certification of drop-in SAFs using small volumes of fuel (<250 mL) and materials (milligrams).

Major Accomplishments (to date):

Complete technical proposal submitted & accepted

Future Work / Schedule:

Award is pending

Initial period of performance (7 tasks) is 12 months

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Background

This project will be conducted UDRI's Small Sample Material Compatibility Laboratory (SSMC Lab)

The SSMC Lab was established in 2003 to support the DoD Flexible JP-8 Program

The lineage of the SSMC Lab dates to the 1960s when it was the Engineering Design and Development Group

The overall approach of the Lab has always been to distill engineering problems down to first principals, establish a sound understanding of these principals, and then build back up to the level of engineering performance using the best practices of material science and material engineering

- 1980s – Examined Jet Turbine Fuels Derived from Shale Oil
- 1990s – Examined Biodiesel and FT Diesel and their Effects on CI Engines
- 2003 to 2006 – The Flexible JP-8 Program
- 2006 – B-52 Flight Test w/ 50% JP-8/FT Fuel Blend
- 2006 to Present – Developed the Tier II Material Compatibility Test Protocol
- 2011 to 2012 – Alternative JP-5 and F-76 Diesel Fuels (ONR, Navair)
- 2013 – The Boeing Company CLEEN I Material Compatibility (incl. Cycloparaffins)
- 2012 to 2014 – The Influence of Fuels and Fuel Switching on O-ring Seals (DLA)
- 2015 to Present – Material Compatibility Support for AFRL Materials Directorate
- 2021 to Present – The Boeing Company CLEEN III Fuels/Fuel Switching on O-ring Service Life
- 2022 – A Method for Rapidly Assessing SAF Compatibility with non-Metallic Materials

Project Overview

A Method for Rapidly Assessing SAF Compatibility with non-Metallic Materials

The objective of this project is to develop a method for rapidly assessing the compatibility of candidate sustainable aviation fuels (SAFs) with non-metallic fuel system materials

This effort will build on prior work on the development of fully synthetic, fully interchangeable jet turbine fuels

Task 1 - Material Selection & Acquisition

10-20 fielded Jet A Reference Fuels, Selected SAFs, D4054 Short List (approximately 30 non-metallic)

Task 2 - Fuel Composition

GCxGC Class Fraction Analysis; n,i-Paraffins, Cycloparaffins, Alkyl Benzenes, Alkyl Naphthalenes

Task 3 - Volume Swell

Optical Dilatometry

Task 4 - Analysis of Absorbed Fuel

Overall and Class Fraction Polymer/Fuel Partition Coefficients (solubility)

Task 5 - Statistical Analysis

Swelling Coefficients, Class Fraction Correlations (R^2 values), 90% Prediction Intervals

Task 6 – Multiple Regression Modeling

Class Fraction Contributions to Volume Swell; Interpretive & Predictive Modeling

Task 7 – Reporting

Reporting, Briefing, and Publishing Test Results

Next Steps

This project is a new start and notification of the award is expected in early October

Once the contract is in place work is expected to ramp up fairly quickly with progress on several of the tasks that will run in parallel with each other

Task 1 - Material Selection & Acquisition

Begin the process of obtaining 10-20 fuel samples as quickly as possible (1 liter each)
Review, prioritize, and acquire samples from the D4054 short list of non-metallic materials

Task 2 - Fuel Composition

As fuels arrive submit them for class fraction analysis using GC x GC

Task 3 - Volume Swell

As soon as fuel and material samples become available the volume swell work will begin

Task 4 - Analysis of Absorbed Fuel

As volume swell exposures are completed the samples will evaluated for the analysis of the absorbed fuel

Task 5 - Statistical Analysis

Concurrent with Task 4 the statistical analysis of the volume swell data will be conducted

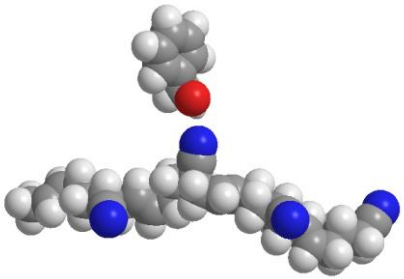
Task 6 – Multiple Regression Modeling

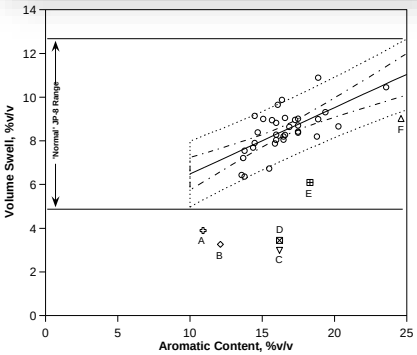
As Tasks 3-5 become routine work will begin on the multiple regression volume swell models

Task 7 – Reporting

Reporting will be stood-up as required by the Project Monitor

Questions?




Volume Swell, %v/v
Aromatic Content, %v/v
'Normal' JP-8 Range
A
B
C
D
E
F
0
2
4
6
8
10
12
14
0
5
10
15
20
25