Project 031(B) Methods for the Fast Quantification of Oxygenated Compounds in Alternative Jet Fuels

Washington State University

Project Lead Investigator

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University Participants

Washington State University

- P.I.(s): Manuel Garcia-Perez
- FAA Award Number: 13-C-AJFE-WaSU-008
- Period of Performance Reported: September 1st, 2016 to August 31st, 2017.
- Task(s):
    1. Literature review
    2. Improving the method for quantification of independent oxygenated compounds in AJFs
    3. Development of methods for the fast quantification of oxygenated compounds in jet fuels

Project Funding Level

Washington State University: Amount of funding from the FAA ($ 50,963), Matching funds ($51,130), Source: State Funds to support one graduate student (from Dr. Wolcott's state funded program) and Dr. Garcia-Perez's salary.

Investigation Team

Yinglei Han (PhD student): Improving the methods for quantification of independent oxygenated compounds in AJFs

Mainali Kalidas (MSc student): Literature review and development of methods for the fast quantification of oxygenated compounds in jet fuels

Manuel Garcia-Perez (Associate Professor): Principal Investigator, project management and reporting

Project Overview

This project has confirmed that the chemical compositions of the alternative jet fuels under the ASTM consideration (SK and SAK from Virent, Kior, Gevo, Amyris, and ARA; HEFA from UOP; FT from Sasol and Syntroleum) range from fuels comprised of single molecules to fuels with thousands of molecules with a wide range of molecular weights and functionalities. These fuels have contents of trace oxygenated molecules similar to commercial jet fuels, but the types of oxygen groups are fuel dependent. UV Fluorescence methods for the fast identification and quantification of oxygenated compounds for quality control in distribution and blending points were studied.

Task #1: Literature Review

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Objective(s)

To conduct a literature review on the methods for the quantification of oxygenated compounds in alternative jet fuels.

Research Approach

We concluded a literature review on methods for the quantification of oxygenated compounds in alternative jet fuels. The main goal of this task was to review the methods available for the quantification of total functional groups (acids, carbonyl, phenols) and the methods for the quantification of independent compounds in alternative jet fuels. We also reviewed methods that can be potentially used for the quantification of targeted oxygenated compounds in organic matrices.

Milestone(s)

We concluded the literature review early this year and this literature review will be part of the MSc thesis that Mainali Kalidas will defend in the spring 2018.

Major Accomplishments

The literature review on the methods for the quantification of oxygenated compounds was completed.

Publications

None

Outreach Efforts

None

Awards

None

Student Involvement

A MSc student (Mainali Kalidas) conducted this literature review and is expected to graduate in spring 2018.

Plans for Next Period

None

Task #2: Improving the Method for Quantification of Independent Oxygenated Compounds in AJFs

Washington State University

Objective(s)

Validation of Balster's method (Balster et al 2006) for the quantification of oxygenated compounds in AJFs.

Research Approach

We quantified the content of individual oxygenated compounds by the method described by Balster et al. (2006). The polar molecules were concentrated through Solid phase Extraction (SPE) using a 6 mL Agilent SampliQ silica SPE cartridge. 10 mL sample of jet fuel was analyzed per run. A volume of 12 mL hexane was used to rinse the cartridge and after that 11 mL of methanol eluted to polar species. The samples collected from SPE were then analyzed by GC/MS. Both internal and external standards were used for the analysis. Both methods were validated with new standards.

Milestone(s)
We conducted several tests, varying jet fuel/methanol ratios, with jet fuels doped with several phenols. Our results confirmed the reliability of the experimental method tested. Almost 100 % of the phenol doped was in fact detected.

Major Accomplishments
This task was completed early this year.

Publications
Pires APP, Han Y, Kramlich J, Garcia-Perez M: Chemical Composition and Fuel Properties of Alternative Jet Fuels. Submitted to *Bioresources*, **2018**

Outreach Efforts
None

Awards
None

Student Involvement
Two graduate students (Yinglei Han and Kalidas Mainali) worked in this task. Yinglei Han is still working in his PhD program and is expected to graduate next year. Kalidas Mainali will complete his MSc program in the Spring 2018.

Plans for Next Period
None

Task #3: Development of Methods for the Fast Quantification of Oxygenated Compounds in Jet Fuels
Washington State University

Objective(s)
Develop a method for the fast quantification of oxygenated functional groups in alternative jet fuels

Research Approach
The third task consists of studies to develop methods for the fast quantification of oxygenated functional groups in alternative jet fuels (E411 2012, Christiensen et al. 2011). The goal is to develop fast detection kits that can be used in field conditions. We focused on the development of kits for the analysis of total phenols by UV-Fluorescence spectroscopic that can be easily miniaturized (Kauffman 1998, Qian et al 2008, Galuszka et al 2013, Novakova and Vickova 2009, Saito et al 2002, Tobiszewski et al 2009).

Milestone(s)
This task was completed in September 2017.

Major Accomplishments
A new method for the fast determination of oxygenated functional groups based on UV florescence was developed and tested. This method is helpful because it allows the fast quantification of mono and oligo-phenols in jet fuels.

Publications
A research paper with the results of this study will be submitted in the summer 2018.

Outreach Efforts
None

Awards
None

Student Involvement
This task was conducted by our MSc student Mainali Kalidas and our PhD student Yinglei Han. Kalidas will graduate in the spring 2018. Yinglei is planning to defend his PhD dissertation in 2019.

Plans for Next Period
None

References

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