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# Bio-Derived Synthetic Fuel Production – Tetra Ethyl Lead Elimination

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# Bio-derived synthetic fuel production – Tetra Ethyl lead elimination

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Aeronautical Engineering Technology student researchers involved in parallel development of new fuel and new fuel spec process

## Abstract

The aviation industry is under pressure by the EPA to phase out leaded aviation gasoline, but traditional unleaded fuels do not work in aircraft. Purdue's National Test Facility for fuels and propulsion in the Department of Aviation Technology has been working to help develop standards for, and certify, a replacement fuel. A bio-based synthetic fuel has been recently developed at The Purdue Research Park, as a drop in replacement for aviation gasoline. Unfortunately, at present the American Society of Test and Measurement (ASTM) has no specification for approving non-petroleum aviation fuels, but is in the process of creating that new specification.

## Problem

Aviation gasoline is traditionally produced in accordance with ASTM spec D-910. However, because new synthetic fuels are not truly "gasoline" as defined by D-910, there is no basis for determining the acceptability of the new fuels. Specifications and tests for petrochemical "gasoline", are based on assumptions and experiences of fuels derived from crude oil. **There is no reason to expect synthetic chemicals, tested the same way, to produce results that have the same meaning as crude derived fuel.** ASTM is in the process of creating a new guidance for determining the acceptability of non-gasoline fuels for piston engine aircraft.

## Hypothesis

A materials test can be developed using material specifications that is based, in part, on an understanding of jet fuel. Testing of the materials can be done in order to validate the proposed new ASTM specification, and concurrently to gather data for the submission of a materials report for the new fuels developer.

## Methodology

This research concurrently creates and validates the proposed materials list and testing process for the new ASTM specification, and determines the effects of bio-derived fuel on aircraft materials. The tasks are to develop the materials lists, develop sampling methods appropriate to the individual materials, determine what tests make sense, and then test the materials using these methods. These tests include such things as: tensile test, durometer, density, and dimensional change.

The materials list is compiled based on industry input:

- Cessna Aircraft
- Cirrus Aircraft
- Lycoming Engines
- Continental Engine
- ASTM Representatives
- FAA Representatives



The samples are prepared in accordance with ASTM test methods :

- D638 IV Dog-Bone
- MNL5-4 Aviation Fuel Quality Control Procedures
- D4057-06 Standard Practice for Manual Sampling of Petroleum

Samples are tested in accordance with ASTM test methods:

- D93-10a Flash Point
- D412-06a Vulcanized Rubber and Thermoplastic Elastomers Tension
- D471-10 Rubber Property- Effects of Liquid
- D1002 Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading
- D2240-05 Rubber Property – Durometer Hardness
- D2370-98 Tensile Properties of Organic Coatings D3359-09 Measuring Adhesion by Tape Test

## Materials Identified in research include

Buna-N Vinyl	Neoprene
Polyester	Viton
Cork	Nitrile
Cork & Neoprene	Rubber Hose
Silicone	Polysulfide
Nylon	3M structural adhesive

## Parameters to be tested and evaluated

Temperature	Volume
Density	Tensile Strength

## Conclusions

The materials list for "gasoline" powered aircraft is different than for "jet fuel" powered aircraft. So far the technology for doing the tests appears to be compatible. The results of these tests and recommended test methods, are currently proprietary, but are to be submitted at the ASTM meeting this June for the development of a new specification to govern bio-derived fuel.



# Fuel Specification Development



**Revised Spec  
(Drop-in Fuel)**



**New Spec  
(Non-Drop-in Fuel)**

**Unchanged  
Operating  
Limitation**

**New Operating Limitation**

# FAA Certification



**Engine Operating  
Limitations**



**Aircraft Operating Limitations**



**Aircraft Flight Manual**