R & D facts

U.S. Department of Energy
Office of Fossil Energy
National Energy Technology Laboratory

Clean Fuels

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NETL

Fischer-Tropsch Fuels

Background

The Fischer-Tropsch reaction converts a mixture of hydrogen and carbon monoxide – derived from coal, methane or biomass – to liquid fuels. The Department of Energy (DOE) refers to the coal-based process as Coal-to-Liquids. The Fischer-Tropsch process was discovered by German scientists and used to make fuels during World War II. There has been continued interest of varying intensity in Fischer-Tropsch technology ever since. Both iron-based and cobalt-based catalysts have been examined. SASOL in South Africa has produced liquid fuels from coal for approximately 30 years. Many oil companies such as Shell Oil, Chevron (Texaco), and ExxonMobil have been conducting research and have built pilot plants or smaller plants. In conjunction with several private sector organizations, NETL built and operated a pilot plant in LaPorte, Texas, focusing on the development of slurry-phase reactor technology.

The Department of Defense (DOD) has an interest in F-T fuels because they will lessen dependence on foreign oil, reduce the number of different fuels required, and reduce environmental impacts because they burn cleaner than other liquid fuels. The U.S. military is the world's largest buyer of fuel, consuming 8 billion gallons per year. The DOD and DOE have partnered with Syntroleum Corporation to produce raw liquid F-T fuels from natural gas, which are further refined to create jet and diesel fuels. These highly-isomerized fuels have branched and straight chain alkanes and few alkenes, but no aromatics or oxygenates. Syntroleum's diesel fuels have been engine tested and produce very little particulates or pollutants. Their jet fuel, mixed 50:50 with conventional petroleum-derived fuel, has recently successfully been tested by the Air Force in a flight of a B-52 jet with all eight of its engines fueled by the mixture.

Primary Project Goal

NETL's Defense Fuels Team is part of a research effort studying F-T jet and diesel fuels. The majority of the work is funded by DOE's Office of Fossil Energy with partial funding by the DOD. The goal is to overcome obstacles that prevent fully synthetic F-T jet fuel from being used in legacy jet engines and diesel land vehicles. Certain physical properties, such as lubricity and the ability to swell o-rings and seals in fuel systems, are deficient in F-T fuels. Some of these properties are impacted by nitrogen-containing and oxygen-containing compounds in conventional jet fuel as well as the presence of aromatics and cyclo-paraffins.

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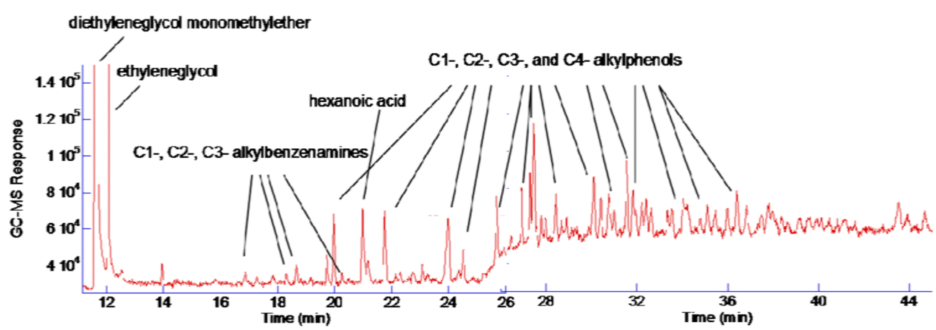
Objectives

- To overcome obstacles that prevent fully synthetic F-T jet fuel from being usable in jet engines and diesel land vehicles and to contribute to the development for a fuel specification for such use.
- To better understand the relationship between the composition and properties of reformable liquid fuels.
- To identify additives appropriate for F-T fuels that improve their compatibility with fuel system components.
- To study accelerated fuel oxidation and thermal stability of F-T fuels as they are impacted by the use of additives.
- To develop and deploy advanced analytical and experimental methods to characterize the cracking and thermal oxidation products of F-T jet fuel.

Accomplishments

- Developed chromatographic methods for identifying trace polar compounds in conventional jet fuels that may influence the properties of the fuel.
- Used switch-loading tests in combination with newly developed chromatographic methods to identify compounds active in seal swelling and that may be used as additives in F-T fuels.
- Conducted computer modeling studies in parallel to identify best classes of compounds to serve as o-ring swelling additives to F-T fuels.
- Developed a micro-reactor for accelerated fuel thermal stability testing at increased temperature and pressure.



GC-MS chromatogram of HPLC-separated polar fraction of MeOH extract of a JP-5 fuel, with identified components labeled.

References

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