R & D facts

U.S. Department of Energy
National Energy Technology Laboratory

ULTRACLEAN FUELS
SCIENCE AND TECHNOLOGY

05/2000

Ultraclean Fuels Science and Technology

Description

The Ultraclean Fuels Science and Technology focus area within the National Energy Technology Laboratory (NETL) aims to develop the science for pollution-free, highly efficient, and affordable transportation systems. The next generation of transportation vehicles will use fuels, engines, and after-treatment systems that take advantage of advances in catalysts, membrane technology, nano-scale chemistry, materials science, sensors and detectors, and high-speed computing.

The work of the Ultraclean Fuels Science and Technology focus area will include research into hydrogen separation membrane technology, nano-scale storage of hydrogen, conversion of natural gas to liquid fuels free of sulfur and nitrogen, next-generation catalysts, analytical techniques to measure and characterize extremely low levels of sulfur, and environmentally acceptable oxygenated fuels. The work is grouped into the following areas:

- Computational Chemistry
- Novel Approaches to Sulfur Removal
- Advanced Analytical Methods
- Improvements in Separation Science
- Novel Synthetic Routes

These activities will strengthen the technical foundation available to ensure the success of this nation's future energy plants by leveraging research by the U.S. Department of Energy's Office of Science, Office of Energy Efficiency and Renewable Energy (EREN), the National Science Foundation, and the Department of Defense. NETL will also partner with universities, other national laboratories, and the private sector, as well as participating in the U.S. Department of Energy's Ultraclean Fuels Initiative.

The Need for Advances in Fuel Science

About 68% of advanced technology sales in the transportation sector are a result of federal and state mandates for fuel economy standards, emissions programs, or energy policy regulations. As these mandates become more stringent, new technologies will be required. Presently, vehicle tailpipe emissions of unburned hydrocarbons and NO_x are dependent on the performance of catalytic systems. It is well known that the performance of a vehicle's catalytic converter is degraded by very small amounts of sulfides present in the exhaust gases. It is anticipated that sulfur requirements in the gasoline and diesel fuels will approach near zero levels. These reduced sulfur levels will require an integrated technology development effort that encompasses fuels, engines and after-treatment systems. The Ultraclean Fuels Science and Technology focus area is intended to address these areas.

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Ultraclean Fuels Science and Technology

Benefits

The outcomes of this research, when coupled with other NETL programs will:

- The development of environmentally friendly and affordable fuels
- Ensure the availability of affordable ultraclean fuels capable of fueling tomorrow's engines
- Produce ultra-clean fuels from a diverse range of resources, including coal, natural gas, petroleum, bio-mass, and other sources
- Reduce health risks and concomitant economic issues associated with the use of fuels
- Develop technologies that mitigate greenhouse gas emissions associated with fuel use

Goal

The goal of the Ultraclean Fuels Science and Technology focus area is to develop the enabling science for producing ultraclean and affordable fuels for high-efficiency transportation systems. Research approaches will take advantage of innovations in materials science, sensors and detectors, and computational chemistry. The fields of fuel science and nanotechnology will be merged to produce new concepts for the development of ultraclean fuels.

Specific objectives include:

- Supporting the development of fuels compatible with current infrastructure in the near term
- Supporting the development of fuels for the future fleet of vehicles in the long term
- Serving as the technical focus for fuels within integrated fuels/engines/emissions control program
- Providing the enabling science for the production of ultraclean and affordable gasoline, diesel, hydrogen, alcohols, and additives from a suite of feedstocks, including oil, gas, coal, and biomass

Milestones

- In 2001, develop advanced process concepts that will reduce the cost of blending sulfur-free Fischer-Tropsch liquids into conventional diesel fuels. Develop process simulation models to predict the hydrogen yields associated with the integration of hydrogen separation membranes into high temperature hydrogen production reactions such as water gas shift and steam reforming.
- In 2002, research and develop advanced analytical techniques that allow the determination and speciation of sulfur compounds at extremely low sulfur levels. Facilitate the introduction of carbon nanotubes in fuel applications as hydrogen storage media and supports for sulfur elimination catalysts.
- In 2003, develop a method to produce environmentally friendly octane boosters based on advanced process chemistry and surface science.
- In 2004, integrate ultraclean fuels into reformers for fuel and develop oxygenat-ed fuels that are benign to the environment and compatible with existing infrastructure.
- In 2005, complete testing of advanced separation membranes for syngas/hydrogen production in on-board reforming.

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