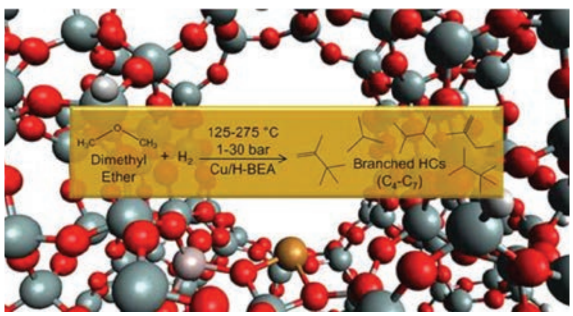
New Catalyst Reduces Wasted Carbon in Biofuel Process, Lowers Cost

Highlights in Research & Development

NREL researchers have shown that incorporating copper-modified catalysts into the dimethyl ether-to-fuels pathway increases carbon efficiency and decreases overall production costs.

The biomass-to-liquid-fuel approach remains one of the most promising renewable fuel processes in terms of its immediate impact and compatibility with existing infrastructure. Methanol and dimethyl ether (DME) can be produced from biomass, and recent investigations have shown that certain catalysts can convert these to high-octane gasoline. However, this is a hydrogen-deficient process that produces a large amount of wasted carbon byproducts that result in catalyst deactivation, thus increasing overall costs. The bottom line: because carbon-rich biomass is one of the primary expenses of the high-octane gasoline pathway, if the process is wasting carbon, it's wasting money.



Recent research shows that the addition of a newly formulated copper catalyst allows more hydrogen to be incorporated into the biomass-to-liquid-fuel process, thus increasing production rates and decreasing unwanted byproducts. Image by Carrie Farberow and Joshua Schaidle, NREL.

Recently, scientists at the National Renewable Energy Laboratory (NREL) developed a catalyst formulation and structure that is capable of incorporating more hydrogen into the high-octane gasoline product, thus increasing the overall rate of reaction, decreasing wasted aromatic byproducts, and increasing carbon efficiency. The catalysts are comprised of a beta zeolite modified with copper, gallium, and other non-noble metals.

The metals provide sites for hydrogen addition and minimize side-reactions that produce unwanted byproducts—all with the goal of decreasing overall process costs. In addition, the NREL researchers have developed a secondary process that takes a portion of the gasoline-range product and efficiently converts it into a distillate-range fuel, 80% of which can be used as a jet fuel blendstock.

This improved DME-to-high-octane gasoline process operates under relatively mild conditions, thus offering the benefit of reduced capital and operating costs for the reactor compared to previously developed technologies.

Technical Contact: Dan Ruddy, Dan.Ruddy@nrel.gov

References: Behl, Mayank, Joshua A. Schaidle, Earl Christensen, and Jesse E. Hensley. "Synthetic Middle-Distillate-Range Hydrocarbons via Catalytic Dimerization of Branched C_6–C_8 Olefins Derived from Renewable Dimethyl Ether." *Energy & Fuels* 29, no.9 (2015): 6078–6087. doi: 10.1021/acs.energyfuels.5b01175.

Schaidle, Joshua A., Daniel A. Ruddy, Susan E. Habas, Ming Pan, Guanghui Zhang, Jeffrey T. Miller, and Jesse E. Hensley. "Conversion of Dimethyl Ether to 2,2,3-Trimethylbutane over a Cu/BEA Catalyst: Role of Cu Sites in Hydrogen Incorporation." *ACS Catalysis* 5, no. 3 (2015): 1794–1803. doi: 10.1021/cs501876w.

Key Research Results

Achievement

Researchers at NREL recently developed a catalyst formulation that incorporates more hydrogen into the DME-to-high-octane gasoline process, resulting in a higher yield to gasoline-range products. Further, the researchers developed a secondary process that efficiently couples a portion of the gasoline-range product to yield jet/diesel fuels.

Key Result

The modified catalyst doubles the conversion rate of DME, which can be produced from biomass, to the high-octane gasoline product and significantly decreases the formation of wasted byproducts. For the distillate-range product, 80% of the mixture is in line with ASTM standards for use as a jet fuel blendstock.

Potential Impact

The increased productivity of high-octane gasoline and the development of a value-added distillate blendstock process further improve the economic viability toward commercially implementing this renewable fuels process.

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

15013 Denver West Parkway
Golden, CO 80401
303-275-3000 | www.nrel.gov

NREL/FS-5100-65850 | February 2016

NREL prints on paper that contains recycled content.