Fuels, Engines, and Emissions

Fuel-Borne Reductant for Diesel Exhaust NO_x Reduction

Background

One of the few technology options for diesel emission control is selective catalytic reduction (SCR) with hydrocarbons or urea to reduce nitrogen oxides (NO_x). With SCR, a reductant is introduced into the oxygen-rich exhaust; the exhaust gases then pass over a catalyst, and NO_x is selectively reduced to N_2. To date, only urea SCR systems have proved to control NO_x effectively, but use of urea requires a filling and storage system for the reductant that is entirely separate from the fuel system. Use of urea SCR would also require deployment of a separate delivery infrastructure, presumably at fuel filling stations. For the fuel-borne reductant concept, the reductant is part of the fuel. No separate fill system and infrastructure would be required.

Proof-of-Principle Using Ethanol

ORNL has performed proof-of-principle experiments examining the use of ethanol as a diesel fuel-borne reductant. Ethanol is a known candidate reductant for an SCR system using a silver-based catalyst.

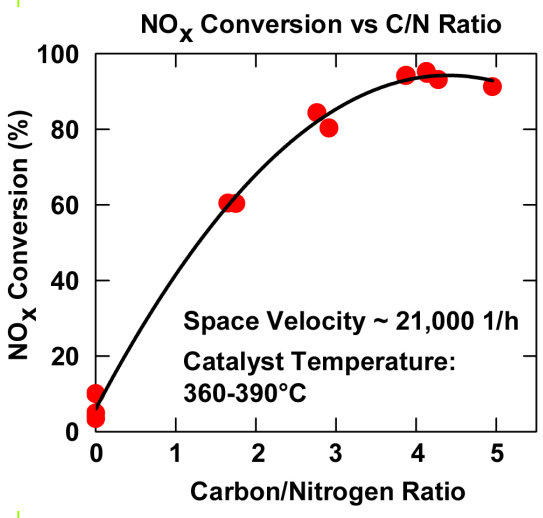
Ethanol and diesel fuel can form a relatively stable micro-emulsion containing 10 to 15% ethanol and a small amount of blending agent. This fuel is often referred to as E-diesel.

"Mild" distillation tests were performed, demonstrating that the ethanol can be evaporated from the fuel and condensed for later introduction into the exhaust as the SCR reductant.

Ethanol-Silver Catalyst System Performance

ORNL and Caterpillar, Inc., partnered to further investigate ethanol SCR performance. Experiments were completed by ORNL staff at the National Transportation Research Center (NTRC). NO_x emissions from a heavy-duty diesel engine were reduced by injecting ethanol into the exhaust upstream of a (Caterpillar-supplied) silver-alumina SCR catalyst. NO_x emission reductions of 90, 80, and 70% were achieved for space velocities of 21,000/hour, 57,000/hour, and 90,000/hour, respectively.

Less dependence on foreign oil, and eventual transition to an emissions-free, petroleum-free vehicle



High NO_x removal was obtained at reasonable ethanol consumption levels.

This is much higher conversion than was obtained previously with hydrocarbon SCR. The exhaust was carefully examined for regulated emissions and non-regulated toxic emissions using FTIR, GC-MS and other methods.

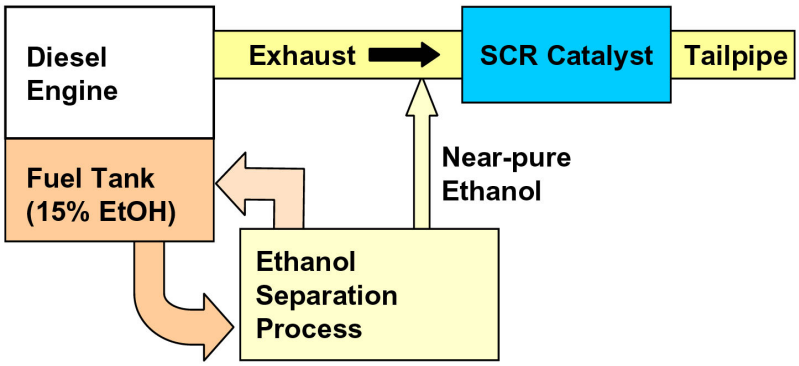
Benefits

- No separate infrastructure would be required for a fuel-borne reductant system.
- Ethanol is domestically produced and nonpetroleum- based.
- New information is available to industry, to better understand and utilize this technology.

Where Can I Find More Information?

Dr. Ronald L. Graves
Oak Ridge National Laboratory
865-946-1226
gravesrl@ornl.gov
http://www.feerc.ornl.gov

DOE Technology Manager
Steve Goguen
Department of Energy
202-586-8044
Stephen.Goguen@ee.doe.gov



Schematic diagram of fuel-borne ethanol SCR system.

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

U.S. Department of Energy
Energy Efficiency and Renewable Energy

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