Argonne NATIONAL LABORATORY

Materials

THE DIESEL DeNO$_x$ CATALYST

A new catalyst that, when attached to the exhaust of diesel-powered engines, reduces between 95 and 100% of the nitrogen oxides emissions

APPLICATIONS

- Diesel-powered engines in vehicles
- Stationary diesel-powered engines used at industrial plants
- Heaters for chemical plants
- Power generators that use gasoline, liquid, or solid hydrocarbons, such as methane, diesel, or coal

BENEFITS

- Effective - Reduces between 95 and 100% of nitrogen oxide emissions
- Simple - Onboard catalyst attached to the engine enables passive system
- Safe - Does not require the onboard storage of additional chemicals
- Long lifetime - Offers a long lifetime of up to 200,000 miles
- Cost-effective - Uses inexpensive metals (Cu and Ce)
- Adaptable - Technology can be quickly and easily added to current equipment

STATUS

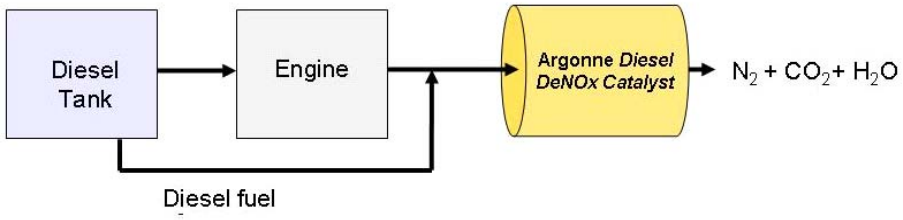
- Preliminary manufacturing is under way

Overview

One of the planet's major pollutants, nitrogen oxides (NO_x) are formed in all high-temperature fuel-air flames, and so they are a particular emissions problem for diesel engines. Although diesel-fueled engines emit very small amounts of carbon monoxide (CO) and hydrocarbons (HCs), they do, however, release relatively high amounts of NO_x and particulate matter (PM) or soot — the emissions that lead to acid rain, smog, and poor health conditions. Thus, removing NO_x from emission streams has become a global concern.

Argonne researchers have developed an innovative diesel DeNO$_x$ catalyst technology that provides industry with a totally passive, easy-to-use system for removing NO_x from exhaust streams. Vehicle drivers do not need to add any additional secondary fluids into a separate tank for injection, and there is no need for complicated engineering controls. The catalyst is expected to have a long lifetime and to require minimal space on the truck chassis. Also, the materials used in the technology are considered to be inexpensive and relatively nontoxic.

Because the catalyst can be adapted for use both with stationary diesel-powered engines used at industrial plants and for diesel engine vehicles, it provides the capability to clean up the NOx emissions of all key sectors targeted by the U.S. EPA.



Concept behind Argonne's Diesel DeNOx Catalyst

Key Innovation Contributes to Outstanding Performance

Argonne's catalyst formulation uses a copper zeolite system (Cu-ZSM-5). Very commonly used in the petroleum refining industry, zeolites are a class of natural or synthesized silicates that are of similar structure and are used in such applications as water softening, chemical adsorbents, and other catalyst applications.

Argonne's key innovation is the addition of a cerium-oxide coating over the zeolite formulation, which improves the catalyst's activity at the lower temperatures (300°F) typical of diesel exhaust and its long-term stability. The new catalyst formulation can achieve rates of 95–100% in converting NO_x to N_2 — a harmless compound that makes up about 78% of the atmosphere — by using only the heat supplied by the engine. The cerium-oxide coating also improves the catalyst's long-term stability.

LINKS TO ONLINE INFORMATION

http://www.anl.gov/techtransfer/Available_Technologies/Material_Science/index.html

CONTACT INFORMATION

Licensing:
William Ragland
Senior Account Manager
Office of Technology Transfer
Argonne National Laboratory
9700 S. Cass Ave.
Argonne, IL 60439
630-252-4832 (phone)
630-252-5230 (fax)
ragland@anl.gov

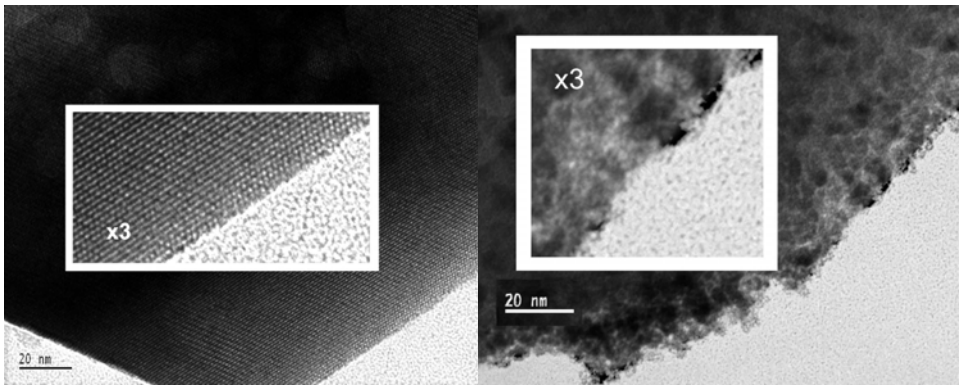
Technical:
Christopher L. Marshall
(co-inventor)
Group Leader, Heterogeneous Catalyst Section
Chemical Sciences and Engineering Division
Argonne National Laboratory
9700 S. Cass Ave.
Argonne, IL 60439
630-252-4310 (phone)
630-252-4408 (fax)
marshall@anl.gov

ABOUT ARGONNE TECHNOLOGY TRANSFER

Argonne National Laboratory is committed to developing and transferring new technologies that meet industry's goals of improving energy efficiency, reducing wastes and pollution, lowering production costs, and improving productivity. Argonne's industrial research program, comprised of leading-edge materials research, cost-saving modeling, and unique testing and analysis facilities, is providing solutions to the challenges that face U.S. manufacturing and processing industries.

Environmental and Health Benefits

With its highly active and successful conversion rate — combined with lower expected manufacturing and installation costs, ease of use, and significant market potential — Argonne's patented technology is exceptionally well-positioned and equipped to deliver significant environmental and health benefits. Using Argonne's diesel De NO_x catalyst will move the United States diesel fleet closer to achieving very low emissions, helping to lessen our overall emissions "footprint."



At left, the uncoated Cu-ZSM-5 catalyst, which is unstable under wet conditions. At right, a uniform, optimized coating of CeO_2 imparts high activity and selectivity to the catalyst, even at high levels of moisture content.

What Sets Argonne's Technology Apart

Through innovative design, Argonne's technology overcomes several dilemmas associated with existing and emerging NO_x emissions technologies.

For example, Argonne researchers made sure that the catalyst would accommodate the use of ultra-low sulfur diesel (ULSD) fuel that is now required for on-highway use (and will soon be required for most off-road use, as well). Containing only 15 parts per million (ppm) of sulfur, the ULSD fuel enables a long life for the catalyst, which normally would be "poisoned" over time by the levels of sulfur present in prior diesel fuel formulations. Argonne's technology offers a practical way of using a small amount of diesel fuel to reduce NO_x to N_2. This capability is important because using diesel fuel as the reductant (substance that reduces a chemical compound usually by donating electrons) eliminates the need for the onboard storage of additional chemicals, such as the ammonia, urea, or "swing" catalysts used by other technologies.

As another example, Argonne's catalyst exhibits increased (rather than decreased) performance in the presence of water vapor — again, in contrast to other technologies — making it ideal for use in automotive/truck exhaust systems where water is always present.

Another important feature of Argonne's catalyst system is that it can be attached — or "retrofitted" — easily to existing diesel-powered vehicles in a simple process that would take the vehicle off the road for less than one day. In other words, the catalyst can be installed not only on the assembly lines for new diesel vehicles but on existing sources of NO_x emissions as well. As a result, diesel owners can move ahead now on cleaning up the NO_x emissions generated by the 11 million diesel-powered vehicles that are currently on the road in the United States — a fleet that represents a sizable and ready market for Argonne's catalyst.