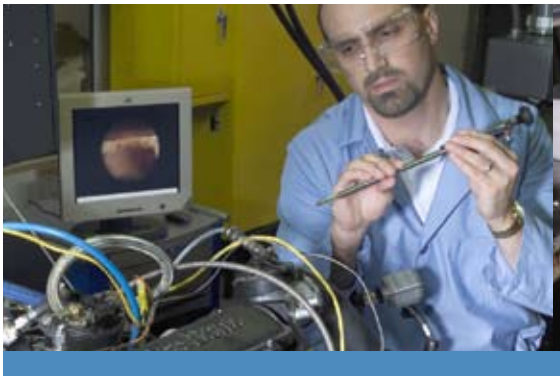
Reducing Diesel Engine Emissions



Compared to traditional gasoline engines, diesel engines require less maintenance, generate energy more efficiently, and produce less carbon dioxide emissions. But when uncontrolled, diesel engines churn out harmful emissions like particulate matter (PM) and nitrogen oxides (NO_x). Researchers at Argonne National Laboratory are currently working to develop new advanced emission control technologies that will result in cleaner, more efficient diesel engines.

What is Argonne doing?

Diesel DeNO$_x$ Catalyst

Opportunity: NO_x emissions are well-known contributors to smog, acid rain, and global warming; yet they are among the most difficult pollutants to eliminate from diesel exhaust. Many of the current technologies that reduce NO_x cause increases in undesirable particulate emissions.

Solution: Argonne researchers developed the Diesel DeNO$_x$ catalyst to help diesel truck manufacturers eliminate NO_x emissions, without an increase in particulate emissions. The catalyst is applied as a coating to a monolithic ceramic brick which is installed in a vehicle's emissions system. The new technology helps reduce NO_x emissions by up to 95 percent.

Outcome: The Diesel DeNO$_x$ Catalyst has been licensed to Integrated Fuel Technologies, Inc. (IFT) in Kirkland, Washington. IFT is also collaborating with Argonne under a two-year research agreement to test the technology's longevity in real-world use. IFT plans to demonstrate the Diesel DeNO$_x$ Catalyst in real-world applications to determine if it can meet a broad array of transportation applications.

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Low-Temperature Combustion

Opportunity: With stringent U.S. Environmental Protection Agency (EPA) regulations in place for diesel engines, vehicle manufacturers are interested in solutions that reduce both emissions and the need for aftertreatment devices. Low-temperature combustion (LTC) is a method that can help achieve these goals, but most current approaches to LTC have problems with ignition predictability and very low power densities.

Solution: The idea behind LTC is to avoid creating harmful diesel emissions by reducing the combustion temperature from 3,000 degrees Kelvin to less than 2,000 degrees Kelvin. To optimize LTC, detailed combustion information is needed. Argonne researchers are using endoscopes, advanced cameras and fiber-optic tools to obtain information on fuel spray characteristics and combustion reactions and temperatures. The ultimate goal is to define conditions that will enable high engine efficiency and reduced emissions.

Outcome: Low combustion temperatures can result in very low outputs of NO_x and PM, which allow for much smaller and less expensive aftertreatment devices. LTC systems could also potentially increase fuel efficiency by as much as 25 to 50 percent. Argonne is working with General Motors, BP, the University of Illinois at Chicago, and the U.S. Air Force to develop this technology into a usable system for automobiles.

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Advanced Diesel Particulate Filtration Systems

Opportunity: U.S. EPA regulations require that diesel vehicles on the highway have filtration systems to reduce tailpipe soot emissions. Diesel particulate filtration (DPF) systems are currently the most efficient at directly controlling soot emissions, also known as PM. However, research has been limited to macroscopic observations, due to difficulties in accessing the micro-scaled structures of DPF membranes. Challenges in monitoring particulate filtration and high-temperature thermal processes have also hampered research efforts.

Solution: Argonne researchers are exploring new technology and research results on diesel PM filtration and regeneration processes. Current work is focused on examining PM filtration and oxidation processes at a microscopic level. Extensive experiments are being conducted under various engine operating conditions and regeneration schemes.

Outcome: Argonne researchers aim to develop a technology transfer of advanced PM emission control for industry. They are working on this with Corning, Inc. and Caterpillar, Inc. through a Cooperative Research and Development Agreement (CRADA).

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