Pacific Northwest National Laboratory:

INSTITUTE FOR INTERFACIAL CATALYSIS

Exhaust Emissions Research

To meet stricter air quality standards and reduce the impacts from emissions, the Pacific Northwest National Laboratory's (PNNL's) Institute for Interfacial Catalysis is addressing the scientific challenges involved in developing technologies that reduce gaseous and particulate matter emissions from gasoline- and diesel-powered engines.

To satisfy environmental and industry standards, diesel engine manufacturers are implementing one or more exhaust after-treatment technologies. To help facilitate this implementation, the Institute investigates the development of NO_x reduction catalysts and soot filtration devices for diesel engines.

ELIMINATING OXIDES OF NITROGEN EMISSIONS

The challenge to removing NO_x from diesel engine exhaust is to develop catalytic materials and processes that selectively reduce NO_x from an oxygen-rich exhaust without negatively impacting fuel economy. Moreover, the catalyst technology must have a long life, and function over wide operating ranges that include periodic high-temperature excursions.

Ongoing research by the Institute of Interfacial Catalysis includes work with Cummins Inc. to develop robust NO_x after-treatment for high-efficiency diesel engines. Research includes

- Determination of the mechanisms for higher temperature NO_x storage performance for modified and/or alternatives to current generation BaO-based storage materials
- Understanding of the nature of the interactions between precious metals and the current and next generation storage materials for both optimum NO_x storage performance and long-term stability
- Determination of the sulfur adsorption and regeneration mechanisms for modified and/or alternative storage materials.

Researchers in PNNL's Engine Emissions Laboratory investigate catalysts, particulate traps, and other methods for reducing diesel engine emissions.

Pacific Northwest NATIONAL LABORATORY

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Through invention, development, modeling, and testing of catalysts and catalytic devices, the Institute is working closely with industry leaders to remediate transportation-generated toxic pollutants and greenhouse gases.

U.S. DEPARTMENT OF ENERGY

IMPROVING COMBUSTION TO REDUCE EMISSIONS

Another industry approach to reducing NO_x emissions is to design engines that operate at lower temperatures. This new engine technology will require the use of novel catalysts to oxidize, at these lower temperatures, the byproduct carbon monoxide and hydrocarbons that would be otherwise emitted in the exhaust. Recent IIC work in this area has focused on several different catalytic routes including nano-phase catalysts, doped noble-metal catalysts, and highly acidic catalyst support materials.

With Caterpillar Inc., we are

- Formulating, characterizing, and screening catalyst formulations
- Conducting speciation studies of hydrocarbons in the exhaust
- Assessing the performance and stability of monolith-supported catalysts
- Conducting bench-scale transient studies of catalysts.

CAPTURING PARTICULATES

To efficiently meet federal regulations for diesel engine particulate emissions, we are working with manufacturers to develop soot filters and catalytic materials to regenerate these filters without increasing back pressure, which reduces fuel efficiency.

With the Dow Chemical Company, we are conducting lattice-Boltzmann simulations to aid in optimizing particulate filter materials. Extensive and accurate modeling of materials, before they are developed for empirical testing, can minimize test time, reduce implementation time, and optimize cost versus performance objectives.

▶ INNOVATIVE RESEARCH

The Institute for Interfacial Catalysis conducts cutting-edge research and works closely with industrial leaders through Cooperative Research and Development Agreement (CRADA) arrangements, to reduce transportation-caused emissions.

Our projects include:

- Combination and integration of diesel particulate filtration and urea selective catalytic reduction after-treatment led by **Ken Rappe and Jonathan Male.**
- Deactivation mechanisms of base metal zeolite urea selective catalytic reduction materials led by **Charles Peden.**
- Diesel soot filter characterization and modeling led by **Mark Stewart.**
- Fuel-efficient diesel particulate filters led by **Mark Stewart.**
- Enhanced high-temperature performance of NO_x storage/reduction (NSR) materials led by **Charles Peden.**
- Modeling of hydrocarbon and urea selective catalytic reduction NO_x after-treatment systems led by **John (Jong) Lee.**
- Experimental studies for diesel particulate filtration and selective catalytic reduction control system and onboard diagnostics development for engines using diesel and biodiesel fuels led by **Maruthi Devarakonda.** This program is a collaboration with Michigan Technological University.
- Fundamental studies of lean-NO_x traps led by **Charles Peden.**
- Degradation mechanisms of the urea selective catalytic reduction technology led by **Charles Peden.**

This research draws upon our expertise and resources in exhaust emissions science, including catalyst materials synthesis and characterization, surface chemistry, catalytic reaction mechanisms, in situ observation and computational modeling.

ABOUT PNNL

Pacific Northwest National Laboratory is a Department of Energy Office of Science national laboratory where interdisciplinary teams advance science and technology and deliver solutions to America's most intractable problems in energy, national security, and the environment. PNNL employs 4,650 staff, has a business volume of $954 million, and has been managed by Ohio-based Battelle since the lab's inception in 1965.

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