Fuels, Engines, and Emissions

Characterizing Diesel Engine NO_x Adsorber Regeneration Strategies

Background

As part of the Department of Energy's strategy to reduce imported petroleum and enhance energy security, the FreedomCAR and Vehicle Technology Program researches enabling technologies for more efficient diesel engines that will meet stringent emissions regulations for oxides of nitrogen (NO_x). An active R&D focus for diesel engine NO_x control is on the use of NO_x adsorber catalysts.

To better understand NO_x adsorber regeneration and desulfation, different control strategies for introducing the fuel-rich environments are being developed and characterized at ORNL using advanced instrumentation and measurement methods.

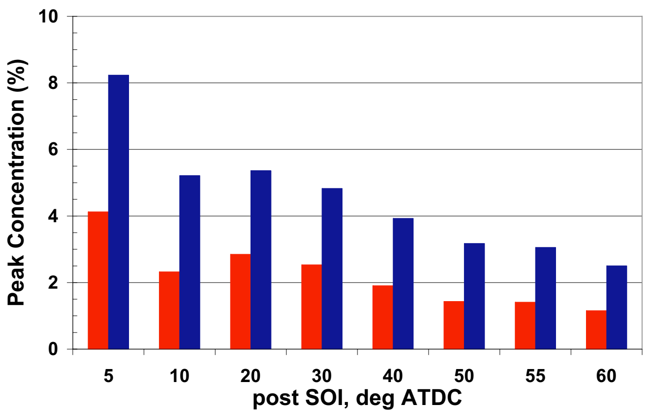
The Technology

An NO_x adsorber catalyst will absorb NO_x during normal lean operation, typical of diesel engines. The catalyst must periodically be regenerated by momentary fuel rich operation. During rich operation, the reducing atmosphere causes the release and reduction of the oxides of nitrogen. Reductants involved in these reactions include carbon monoxide (CO), hydrogen (H_2), and hydrocarbons.

Using a modern 1.7-liter Mercedes common-rail, turbocharged, diesel engine with full electronic control of fuel injection, throttle, exhaust gas recirculation, and wastegate, ORNL has developed several strategies for adsorber regeneration. These strategies are being thoroughly characterized for the H_2, CO, and hydrocarbon species formed, the fuel economy penalty, and overall NO_x reduction performance, including unique in situ measurements of some species (within catalyst channels).

The SpaciMS (Spatially resolved capillary inlet mass spectrometer) has been used to quantify the in-cylinder hydrogen formation from these adsorber regeneration strategies. The figure shows the hydrogen and CO formation for a post-timing sweep in which a fixed amount of excess fuel was injected in-cylinder at various crank angles. These results are the first confirmation of in-cylinder hydrogen generation from a diesel engine.

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



Engine-out hydrogen (red bars) and CO (blue bars) levels measured for advanced regeneration strategies.

Commercialization

Before NO_x adsorber technology is commercially viable for diesels in the United States, an improved understanding of the regeneration, desulfation, and degradation mechanisms is required.

Benefits

- Over 90% NO_x reduction is readily achievable with NO_x adsorber catalysts.
- An understanding of the relationship between various regeneration strategies, species formed, and NO_x adsorber performance can help realize best fuel efficiency.
- More detailed information available to the modeling community can accelerate adsorber development through an improved link between engine and bench-scale evaluations.
- This research will improve understanding of degradation mechanisms.

Where Can I Find More Information?

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