Near-term technologies can meet future emissions targets

OAAT ACCOMPLISHMENTS

NO_x and PM Emissions Control Devices in a CIDI Vehicle

Challenge

Although lean-burn compression-ignition, direct injection (CIDI) engines offer the promise of very significant fuel efficiency gains, they face the challenge of reducing nitrogen oxides (NO_x) and particulate matter (PM) emissions to meet future emissions reduction targets. Control technologies to reduce these engine emissions must be able to handle sulfur in fuel without degrading their performance.

The Mercedes A170 on the chassis dynamometer with prototype exhaust emission controls.

Technology Description

The NO_x, PM, hydrocarbon (HC), and carbon monoxide (CO) emissions from a 1.7L 1999 Mercedes A170 CIDI vehicle (not available in the U.S.) were tested on two transient chassis dynamometer methods: the Federal Test Procedure (FTP) and the aggressive driving US06 test cycle. Emissions were measured without any emission control devices and with each of the following emission control devices attached one at a time: a manufacturer-provided oxidation catalyst, a NO_x adsorber, and a catalyzed diesel particulate filter (CDPF). The NO_x adsorber catalyst was regenerated with bottled gas simulating exhaust conditions occurring during late-cycle in-cylinder injection of fuel. The vehicle was operated on fuels with sulfur levels varying from 30 to 150 parts per million (ppm).

Accomplishments

The manufacturer-provided oxidation catalyst reduced CO and HC emissions to meet EPA's Tier 2 standards, but had no effect on NO_x emissions. These catalysts reduced PM emissions by 30-40%, but not enough to meet EPA's Tier 2 standards.

The CDPF reduced CO and HC emissions to approximately the same levels as the manufacturer-provided oxidation catalyst, but also had no effect on NO_x emissions. However, the CDPF reduced PM emissions by 95%, enough to meet EPA's Tier 2 standards. Fuel sulfur inhibited PM emission control effectiveness only at sulfur levels of 150 ppm and above, but still, PM emissions remained below EPA's Tier 2 standards.

The NO_x adsorber maintained CO and HC emissions at levels meeting EPA's Tier 2 standards, but had no effect on PM emissions. The absorber reduced NO_x emissions by about 90%, enough to meet EPA's Tier 2 standards. A short exposure (equivalent to 3,000 miles at 30 ppm sulfur fuel) to higher sulfur fuel degraded NO_x emission reduction effectiveness to 66-80%.

Benefit

Near-term NO_x and PM emissions control technologies have the potential to meet future emission targets – EPA's Tier 2 standards – when installed on a highly energy-efficient engine.

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Future Activities

The NO_x adsorber and CDPF will be used in combination to demonstrate simultaneous control of the four regulated pollutants – CO, HC, NO_x, and PM. When these devices are used together as an emissions control system, the effects of exhaust temperature, exhaust chemistry, and NO_x regeneration strategy will be explored.

Partner in Success

- Oak Ridge National Laboratory