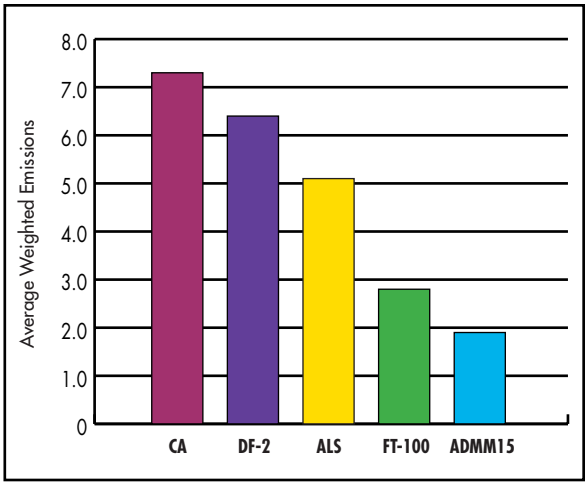
PM and toxics dramatically reduced by advanced diesel fuels

OAAT ACCOMPLISHMENTS

Characterization of Toxic Compounds from Diesel Emissions

Challenge

Particulate matter (PM) emissions from compression-ignition, direct-injection (CIDI) engines must be reduced by about 90 percent to enable these highly efficient engines to be used in light-duty vehicles. While the primary means of reducing PM is through catalyzed particulate filters, fuel modifications can also result in significant reductions in PM. However, it is important that any fuel modifications made to reduce PM not cause adverse impacts such as an increase in air toxic emissions. U.S. Department of Energy (DOE) researchers are testing advanced petroleum-based fuels in CIDI engines and evaluating their effects on PM and toxic emissions. Reducing PM and toxic emissions through fuel modifications reduces the size and cost of catalyzed PM filters, and allows more latitude in engine calibration to reduce oxides of nitrogen emissions, the other large emissions hurdle facing CIDI engines.



Benzene emissions of the test fuels (mg/kWh).

Technology Description

Tests were conducted on a DaimlerChrysler OM611 CIDI engine. This engine was operated at five different combinations of engine speeds and loads and controlled to hold location of peak pressure of combustion in the cylinders at 7° ATDC (after top dead center). In addition, two different pilot-injection control strategies were employed at two of the speed and load combinations.

Five test fuels were employed: 1) baseline EPA diesel certification fuel (DF-2), 2) California reference diesel fuel (CA), 3) low-sulfur diesel fuel (ALS), 4) Fisher-Tropsch diesel (FT-100), and 5) an oxygenate blend of 15% dimethoxymethane with 85% low-sulfur diesel fuel (ADMM15).

The four Clean Air Act mobile source air toxics (benzene, formaldehyde, acetaldehyde, and 1,3 butadiene) were measured. Eleven gaseous polycyclic aromatic hydrocarbon (PAH) compounds were measured. Seventeen PAH compounds were measured as the soluble organic fraction extract of the exhaust particulate matter.

Accomplishments

The emission of PM and mobile source air toxics can be significantly lowered through the use of advanced fuels containing oxygenate additives and reduced aromatics and sulfur.

- The emission of all four air toxics is drastically reduced through the use of the FT-100 and the ADMM15 diesel fuels when compared with the use of conventional diesel fuel. (See the figure for benzene results; the results for other air toxics are similar.)
- The use of FT-100 and ADMM15 diesel fuels greatly reduces PM when compared with levels produced by conventional diesel fuels.

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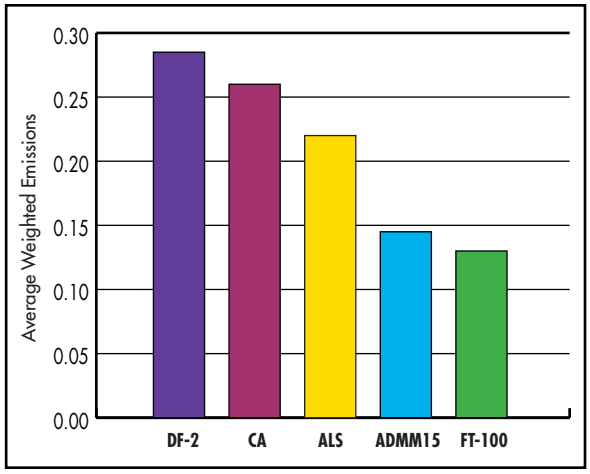
Benefits

The advanced CIDI engine is the most promising near-term powertrain option for achievement of significant fuel economy gains in cars and light trucks. If the oxides of nitrogen and PM emissions can be reduced, the high fuel economy benefits of CIDI engines can be realized. Fuel modifications that have the potential to significantly reduce PM emissions also significantly reduce toxic emissions.



PM emissions of the test fuels (g/kWh).

Future Activities

Follow-on investigations will be conducted on an engine equipped with exhaust emission-control devices.

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