DECSE

The Diesel Emission Control – Sulfur Effects (DECSE) Program Summary, No. 1, June 1999

What's New:

- Contracts signed with testing laboratories
- Emissions control systems selected and delivered
- Test fuels have been delivered to testing laboratories
- Tests are now under way.

Program Manager's Report

Welcome to the first issue of the DECSE Program Summary. The Diesel Emission Control – Sulfur Effects program (DECSE) is a joint effort of the U.S. Department of Energy (DOE), its national laboratories, manufacturers of diesel engines, and manufacturers of emissions control systems.

DOE's Office of Heavy Vehicle Technologies and private sector companies established DECSE to improve knowledge about the effects of sulfur in diesel fuel on emissions control systems. The data being collected by DECSE will address a critical lack of sound technical, publicly available information.

DECSE's objective is to conduct tests to determine the effects of various levels of sulfur in fuel on the emissions control systems that could be used to lower the levels of nitrogen oxides (NO_x) and particulate matter (PM) from diesel vehicles in the years 2002 to 2004.

This is the first phase of a larger cooperative research program involving DOE, two of its national laboratories, and manufacturers of diesel engines and exhaust emissions control systems.

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Who is DECSE?

DECSE includes representatives from DOE's Office of Heavy Vehicle Technologies within the Office of Transportation Technologies (OTT), the National Renewable Energy Laboratory (NREL), Oak Ridge National Laboratory (ORNL), and members of the Engine Manufacturers Association (EMA) and the Manufacturers of Emission Controls Association (MECA).

What is DECSE doing?

DECSE has begun to conduct tests on exhaust control systems that could lower emissions from diesel engines. Four principal emissions control technologies are being tested: diesel particle filters, NO_x adsorbers, lean NO_x catalysts, and diesel oxidation catalysts. The emissions control devices selected are generally commercially available technologies that are representative of the marketplace, and state-of-the-art developing technologies.

For each technology, tests will be conducted using diesel fuel with varying levels of sulfur: less than 10 parts per million (ppm), 30 ppm, 150 ppm, and 350 ppm. During each test, the diesel engine operates for 250 hours (or more) to detect any decline in performance. The tests will yield data that can be used to develop and implement the technologies that enable diesel engines to meet proposed stricter emissions standards. To expedite the development of the new technologies, data from the program are being made available to the public.

Who are the testing laboratories and what happens with the test data?

The testing laboratories are West Virginia University (oxidation and lean-NO_x catalysts), FEV Engine Technology (NO_x adsorber), and Engineering Testing Services (diesel particle filters). Data are being collected on engine and control technology characteristics. These data are sent by the testing laboratories directly to DECSE's data analysis committee for placement in the DECSE database. The data will be analyzed by the data analysis committee in conjunction with DECSE's technical committees. These will determine when the data are ready for release to outside organizations and the public.

What are the technical committees?

In addition to DECSE's committees for testing, data/reporting, and experimental design, there are technical committees for:

- Fuels and lubricants
- Lean NO_x catalyst
- Particle trap/filter
- NO_x adsorbers
- Oxidation catalysts.

Oversight of DECSE is provided by a joint industry/government steering committee.

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DECSE is conducting tests to determine the effects of sulfur on various emissions exhaust systems. DECSE's test results are expected to be available in late 1999.

In this first issue of DECSE's periodic program summary, we introduce you to the DECSE program and our plans for 1999. We also provide you with sources and contacts for additional information. In future issues, we'll include information about the tests we are conducting this summer and fall.

Please do not hesitate to let us know about others who may wish to be added to our mailing list. We welcome your interest in DECSE's effort to improve the environment by enabling the diesel industry to meet proposed more stringent emissions standards.

George Sverdrup
DECSE Program Manager
National Renewable Energy Laboratory

(See contact information below, right.)

Upcoming Events

- The next DECSE working group meeting will be held on June 19.
- More details in the next periodic program summary.

6/17/99

About the Emissions Standards

DECSE is part of DOE's Office of Transportation Technology's efforts to prepare for stricter emissions standards for diesel engines to be effective in 2002 to 2004.

The new emissions standards for heavy-duty vehicles could mean that by 2002 an 80 percent reduction in emissions, compared to current levels, must be made by diesel engines. On May 1, the U.S. Environmental Protection Agency (EPA) posted on its web site (http://www.epa.gov) the preliminary draft of the proposed changes in the emissions regulations. The draft proposes that lower emissions standards be phased in so that by 2007 to 2009, light trucks, minivans and sport utility vehicles would be required to meet the same standards as cars. The draft also proposes that lower sulfur fuel emissions requirements be phased in between 2004 and 2006 – to 30 ppm. Levels as high as 350 ppm, on average, are found in diesel fuels in the U.S.

In October 1998, diesel industry leaders agreed to accelerate changes in diesel engines to meet EPA's requirement that vehicle emissions standards be met two years earlier than originally set – by October 2002 instead of 2004. California has already tightened its standards. That state now requires light-duty diesel vehicles to meet the same pollution standards as gasoline vehicles.

DECSE Schedule for 1999

DECSE has completed the process of designing the test program, procuring the hardware and fuel, and contracting with test laboratories. It is now in the process of conducting tests on the four types of emissions control technologies: particle trap/filter, NO_x adsorber, lean NO_x catalyst, and diesel oxidation catalyst.

Interim reports on the tests will be prepared in late summer, and a final report is expected by the end of 1999.

Engines

In the DECSE tests, these regular production engines are tested as sources of exhaust:

- Navistar T444E
- Cummins ISM370
- Caterpillar 3126
- DDC/DaimlerChrysler/1.9-liter HSDI.

Criteria used to select the engines included: diesel engines (i.e., light-, medium- or heavy-duty); providing the range of exhaust temperatures and emissions levels typical of roadway duty cycles; generally of 1998 or 1999 calibration, electronic controls, turbocharged, with or without exhaust gas recirculation. (Note: The DDC/DaimlerChrysler engine was the only available engine developed to run on the rich/lean cycle needed for the NO_x adsorber.)

DECSE Contacts:

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A fact sheet about DECSE is now available on the Web at http://www.ott.doe.gov/programs.shtml#decse

Lean-NOx Catalysts

Sample Study Questions

What is the effect of fuel sulfur level on:

1. NO_x reduction efficiency
2. Rate of deactivation of catalyst
3. Ability of catalyst to recover
4. Production of sulfate

Emissions Control Devices

1. Device #1 - state-of-the-art, base metal catalyst (higher temperature)
2. Device #2 - state-of-the-art, precious metal catalyst (lower temperature)

Engines

1. For device #1, a Cummins ISM370 heavy-duty engine with relatively high exhaust temperature over the OICA (Organization of Motor Vehicle Manufacturers) test cycle
2. For device #2, a Navistar T-444 E, 7.3-liter engine with relatively low exhaust temperature over a simulated Federal Test Procedure (FTP) chassis cycle

Test Conditions

- HC reductant injection system to inject fuel and limit fuel economy penalty to four percent
- Device #1 tested on stabilized OICA 13-mode cycle
- Device #2 tested on Navistar 9-mode cycle

Diesel Oxidation Catalysts

Sample Study Questions

1. What is the impact of fuel sulfur level on generation of particulate matter (PM) by oxidation catalysts?
2. What is the effect of fuel sulfur level on catalyst activity during short-term aging, and how does this differ from the effects of thermal stressing?
3. How well do oxidation catalysts recover when operating on near-zero sulfur level fuel after being exposed to higher fuel sulfur levels?

Emissions Control Devices

1. Device #1 - commercial, in-use technology, low precious metal loading
2. Device #2 - technology formulated for maximum reductions in PM, carbon monoxide (CO) and hydrocarbon (HC) emissions, assuming very low fuel sulfur levels.

Engines

1. For device #1, a Cummins ISM370 heavy-duty engine with relatively high exhaust temperature over the OICA test cycle
2. For device #2, a Navistar T-444 E, 7.3-liter engine with relatively low exhaust temperature over a simulated FTP (light-duty) cycle

Test Conditions

- Device #1 tested on FTP, heavy-duty cycle (hot start) and stabilized OICA cycle
- Device #2 tested on Navistar 9-mode and an engine cycle simulating light-duty FTP chassis cycle

NO_x Adsorbers

Sample Study Questions

1. What effect does fuel sulfur level have on fresh NO_x adsorber performance?
2. How is the rate of deterioration of NO_x adsorbence performance affected by fuel sulfur level?

Emissions Control Device

- State-of-the-art device
- Catalyst designed to require less than 4 percent fuel economy penalty for regeneration
- Maximum NO_x reduction of greater than 80 percent
- NO_x reduction of at least 30 percent at temperatures of 150°C and 500°C on the base fuel

Engine

DaimlerChrysler, Detroit Diesel Corp. (DDC) 1.9-liter, with turbocharger, intercooler, electronic control, common rail fuel injection, EGR (for constant load during lean/rich cycling)

NO_x Adsorbers (continued)

Test Conditions

- Fresh device for each of three fuels (less than 10, 30, and 150 parts per million)
- Devices aged 250 hours for each fuel sulfur level with NO_x removal efficiency determined every 50 hours
- Aging sequence is a cycle of 9 temperatures (150 to 450 to 150°C) for 20 minutes at each temperature at rated engine speed with rich/lean times set for 4 percent fuel consumption penalty at each point

Diesel Particle Filters

Study Questions

1. How does fuel sulfur level affect the required filter regeneration temperature?
2. What is the effect of fuel sulfur level on mass emissions of sulfate?

Emissions Control Devices

- Both continuously regenerating diesel particle filters (CR-DPF) and catalyzed diesel particle filters (CDPF)
- Commercial technologies to be used – those that maximize the number of applications, i.e., technologies that regenerate at lowest possible temperature

Engine

Caterpillar 3126, used in applications resulting in low exhaust temperature (e.g., less than 300°C)

Test Conditions & Test Cycles

- Steady-state measurement of pressure drop and determination of balance point temperature
- Stabilized 13-mode measurement with emissions analysis, including engine-out SO_2
- PM measurements at peak torque and road-load conditions

DECSE Schedule for 1999

Task	Start	Finish
Program design	9/98	1/99
Test engines selected, delivered	12/98	4/99
Emissions control systems selected, delivered	9/98	4/99
Test fuels, lubricants delivered	1/99	5/99
Contract with testing laboratories	12/98	2/99
Conduct tests		
▪ Particle trap/filter	4/99	8/99
▪ NO_x adsorber	5/99	7/99
▪ Lean NO_x catalyst	5/99	11/99
▪ Diesel oxidation catalyst	5/99	11/99
Interim test report available		8/99
Final test reports available		***Winter 99***

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DECSE Resources

	Government	Industry	Total
Direct Funding	$1,500,000	$310,000	$1,810,000
In-Kind Contributions	$400,000	$1,200,000	$1,600,000
Total	**$1,900,000**	**$1,510,000**	**$3,410,000**