

A Cleaner-Burning Diesel

The development of novel technologies is helping to reduce harmful emissions from the otherwise efficient diesel engine.

Low emission strategies that diesel engine manufacturers can use to improve air quality and meet stringent regulations are being investigated at Southwest Research Institute (SwRI). The \$6 million Clean Diesel III consortium — comprising 19 engine manufacturers, component suppliers, and petroleum companies from eight countries — builds on eight years of successful clean diesel consortia at SwRI.

“Our goals are ambitious — to reduce emissions by more than 90 percent over the next four years,” says Program Manager Daniel W. Dickey, a director in SwRI’s Engine and Vehicle Research Division. Specifically, the consortium anticipates reducing emissions to 0.2 grams per horsepower-hour for oxides of nitrogen (NOx) and to 0.01 g/hp-hr for particulate matter (PM).

The diesel engine is the most efficient internal combustion engine. Its reputation for durability is excellent, but it produces NOx and PM emissions that can be harmful to the environment. A three-way catalyst, such as used on gasoline engines, isn’t available to reduce those emissions on diesels.

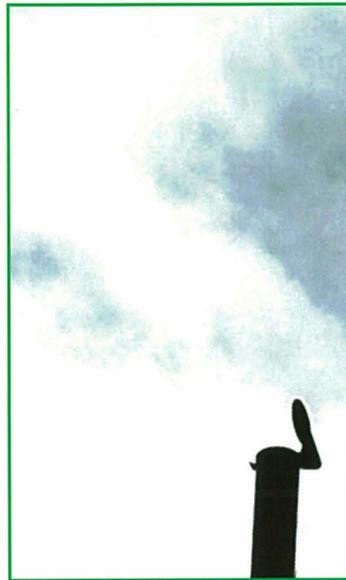
“NOx emissions have already been reduced by a factor of five,” says Dickey. “Despite this, an increase in the number of diesel vehicles on the road has caused emissions to actually rise over the last 10 years.”

The members of Clean Diesel III select the areas of investigation and, as such, are pursuing five technologies that show promise for reducing diesel engine emissions. One of the most successful has been “water + exhaust gas recirculation (EGR).” In traditional EGR, a portion of the exhaust is routed back to the intake manifold, helping to reduce the combustion flame temperature, which in turn lowers NOx emissions. SwRI recently developed and patented an EGR valve that was developed during the Clean Diesel program.

NOx emissions are easily reduced with EGR technology; however, PM emissions increase during the process. Because the particulate matter emitted by diesels is a suspected carcinogen, it is of serious concern to industry as well as the U.S. Environmental



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The SwRI-developed “water + EGR” system effectively reduces oxides of nitrogen (NOx) emissions from diesel exhaust. These images show the particulate emissions from an emissions stack on a heavy-duty diesel truck before (left) and after the addition of the water + EGR system.

Protection Agency. Several researchers are looking at the use of exotic fuels, such as dimethyl ether, to help reduce the occurrence of PM in diesel engines. SwRI’s approach uses water, a much more readily available liquid.

The addition of water to the diesel combustion process serves two functions. It acts as a diluent to reduce peak flame temperature, thus reducing NOx. The water also tends to boil before the fuel, breaking up the fuel particles and reducing particulates. A unique metering system developed by SwRI and consortium member Delphi Diesel Systems mixes the water with diesel before injecting it into the engine.

SwRI tested the water + EGR system on an engine under laboratory conditions. Results showed that it greatly reduced NOx and effectively counteracted the production of particulates.

Other technologies being researched by the consortium include a novel direct-injection homogeneous charge compression ignition system, model-based engine controls, variable valve actuation systems, and medium-duty gasoline engines. The consortium will address additional projects following completion of these tasks.

Clean Diesel III is a follow-on program to SwRI’s highly successful Clean Heavy-Duty Diesel Engine (CHDDE) I and II programs, which began in 1991 and 1995, respectively. The cost to participate in Clean Diesel III is \$95,000 per year for engine manufacturers and \$55,000 per year for component suppliers and petroleum companies. ❖

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The Clean Diesel Team

Petroleum companies, component suppliers, and engine manufacturers make up the Clean Diesel III consortium, which is focused on developing new technologies to reduce diesel engine emissions.

U.S. participants include Caterpillar, Inc.; Delphi Diesel Systems; EMITEC, Inc.; Jacobs Vehicle Equipment Co.; Mack Trucks, Inc./Renault Vehicules Industriels; Cummins Engine Co.; Detroit Diesel Corp.; Honeywell Turbocharging Systems; John Deere PEC; Eaton Corp.; Pure Energy Co., and Texaco.

Overseas participants include Isuzu Motors Advanced Engineering Center Ltd., Japan; IVECO Motorenforschung AG, Switzerland; PSA Peugeot Citroen, France; Volvo Truck Corp., Sweden; DAF Trucks, N.V., Netherlands; Hyundai Motors Ltd., Korea; and Komatsu, Ltd., Japan.

Several other organizations are in the process of joining.