SwRI develops low-emission natural gas truck engine

San Antonio -- July 8, 2005 -- Southwest Research Institute (SwRI), as part of the U.S. Department of Energy's (DOE) Next Generation Natural Gas Vehicle Program, has developed a low-emissions, heavy-duty natural gas engine that more than meets stringent U.S. Environmental Protection Agency (EPA) 2010 emissions standards. The next-generation engine emits greatly reduced levels of oxides of nitrogen (NOx) and particulate matter (PM), allowing production of heavy-duty trucks that restrict release of pollutants to the atmosphere.

SwRI engineers modified a standard production Mack E7 natural gas-fueled engine to reduce regulated emission levels. Test results with a "degreened," or seasoned, catalyst showed NOx emissions at 0.049 gram per brake horsepower hour (g/bhp-hr), less than one-quarter of the 2010 standard, and PM at 0.002 g/bhp-hr, one-fifth of the future standard. A degreened catalyst is one that has been operated briefly before testing to achieve a stable emissions reduction.

The DOE's Next Generation Natural Gas Vehicle Program funds developing technologies for alternative fuels. The National Renewable Energy Laboratories and the South Coast Air Quality Management District (a California air pollution control agency), through separate agreements, funded the program with Mack Trucks, Inc. to develop the next-generation, stoichiometric heavy-duty natural gas engine and to evaluate the prototype in a fleet of refuse hauler trucks. As subcontractor to Mack, SwRI was tasked to develop the engine and perform emissions evaluations.

Natural gas engines operate on a gaseous fuel and are typically spark ignited, which emits lower PM. However, the engines are normally adjusted to run with a lean air-fuel ratio, which prevents using a simple catalytic aftertreatment device to reduce NOx emissions. "The key to decreasing emissions," said James Chiu, program manager and a principal engineer in the SwRI Engine, Emissions and Vehicle Research Division, "is to allow the engine to run under stoichiometric, or chemically correct, conditions. Then a three-way catalytic converter can significantly reduce engine emissions."

In addition to the catalyst, other changes to the engine included adding a cooled exhaust gas recirculation (EGR) system and modifying an engine controller with algorithms to control the EGR and to maintain proper air-fuel ratio control with varying EGR rates. Use of the EGR improved engine efficiency, lowered temperatures, reduced engine-out NOx emissions and decreased the tendency to knock.

SwRI, which operates the world's largest independent emissions laboratory, performed emissions evaluations on the newly developed engine, including the 13-mode steady-state emission procedures and the more revealing U.S. transient emission assessment. In the transient operations, the composite Federal Test Procedure values, in g/bhp-hr, included NOx, 0.049; carbon monoxide (CO), 4.153; and PM, 0.002. The 2010 standards mandate NOx, 0.2; CO, 15.5; and PM, 0.01. The 13-mode series showed similar results.

"Our team is pleased with the program results so far. We have more than met the 2010 emissions standards without using a complicated exhaust aftertreatment device, and we have exceeded the technical objectives with relatively inexpensive and simple, proven technology, without the environmentally friendly engine incurring a large efficiency penalty," explained Chiu.

SwRI has more than 55 years of experience in engine and vehicle development. In addition to performing research on natural gas engines, Institute automotive staff members are conducting programs on diesel, gasoline and hybrid electric vehicles.

Editors: For a high-resolution, downloadable image of the engine in the laboratory, please visit: www.swri.org/press/2005/low-emissionengine.htm.

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