TECHNICAL HIGHLIGHTS FOR DECEMBER 2013

Final Report from the Advanced Collaborative Emissions Study (ACES) Phase 2 Posted by the Coordinating Research Council (CRC)

The final report, "Phase 2 of the Advanced Collaborative Emissions Study," includes critical data provided by the Oak Ridge National Laboratory (ORNL) - Fuels, Engines, and Emissions Research Center (FEERC) on the emissions of urea and urea-related compounds from the three 2010-compliant heavy-duty diesel engines. The methods to analyze these compounds were developed at FEERC under the former Health Impacts program of the Department of Energy (DOE) Vehicle Technologies Office led by James Eberhardt. Because of the dramatic reductions in harmful emissions brought about by the 2007 and 2010 heavy-duty diesel engine regulations, ACES was initiated to both identify any chemical species remaining in the exhaust and determine the toxicological effects of exhaust emissions form modern diesel engines. The ACES program was unprecedented in its scope; more than 750 separate chemical species were analyzed and the toxicological exposures lasted as long as 18 months. In the Phase 2 activity, ORNL-FEERC provided unique analysis of the ACES exhaust samples for by-products of the urea-selective catalytic reduction (SCR) catalytic process used to control NOx emissions. Because the heavy-duty engine manufacturers are using urea-SCR in their U.S. applications, it is critical to identify and avoid any potential unwanted consequences of this NOx control technology.

Fuel System Elastomers Evaluated with Exposure to No. 2 Heating Oil to Assess Bio-Oil Compatibility

ORNL initiated a study to assess the compatibility of fueling infrastructure materials (common to home heating oil systems) to fuels containing bio-oil. The materials under investigation include elastomers and plastics. Elastomer materials included fluoroelastomers, acrylonitrile rubbers, styrene butadiene rubber, polyurethane, neoprene, and silicone rubber. The baseline fuel was No. 2 home heating oil and a four-week exposure run for the elastomer specimens has been completed. Visual observation indicates modest swelling occurred in several elastomer types. The specimens will be measured for volume, mass, and hardness change and these results will be available at the end of the following month.

Paper Published in *Tribology International*, pp. 88–97, 71, 2014.

A paper by J. Qu, H. Luo, M. Chi, C. Ma, P. J. Blau, S. Dai, and M. B. Viola entitled, "Comparison of an Oil-Miscible Ionic Liquid and ZDDP as a Lubricant Anti-Wear Additive," reports the anti-scuffing/anti-wear behavior and mechanism of an oil-miscible ionic liquid (IL), trihexyltetradecylphosphonium bis(2-ethylhexyl) phosphate, in a base oil at 1.0 wt% concentration under both room and elevated temperatures. Results are benchmarked against those for a conventional zinc dithiophosphate (ZDDP). Reciprocating sliding, boundary lubrication tests were conducted using a piston ring segment against a cylinder liner piece cut from actual automotive engine components. Although the IL and ZDDP worked equally well to prevent scuffing and reduce wear in the room-temperature tests, the IL significantly outperformed ZDDP in the 100°C tests. The top surfaces and cross sections of the worn surfaces were characterized to reveal the morphology, thickness, nanostructure, and chemical composition of the IL-induced tribo-films.

Research Highlighted in *Green Car Congress*

ORNL's ionic liquid lubrication research was highlighted in an article entitled, "Oak Ridge-GM Prototype Low-Viscosity Ionic Liquid-Additized Engine Oil Delivers 2% Fuel Economy Improvement over 5W-30," in *Green Car Congress*, available at http://www.greencarcongress.com/2013/12/20131230-qu.html.

Spark Plug Test Chamber Established to Evaluate Methods to Improve Flame Kernel Stabilization
A 0.5 liter combustion chamber was modified to enable the elucidation of flame kernel propagation kinetics under conditions representing high dilution. This chamber is equipped with pressure and temperature measurement and the face plate was adapted to insert a spark plug and includes a series of port-mounted capillaries to feed minute levels of oxygen (and other gases) to the spark plug gap. The addition of oxygen and oxygen-methane mixtures in the gap region is expected to lower the dielectric constant at the spark plug gap to improve spark breakdown. The addition of oxygen also provides a high concentration of highly reactive ions, which should further stabilize flame propagation.

INVITED TALKS AND PRESENTATIONS

FEERC organizes and presents at 2013 Society of Automotive Engineers (SAE) Symposium in Shanghai, China
Robert Wagner of FEERC presented at the SAE 2013 Vehicle Electronics and Powertrain Technologies Forum in Shanghai, China. This forum consisted of three symposiums on electronic systems for vehicle propulsion, electric powertrain technologies, and high efficiency combustion systems. Robert presented in the High Efficiency Combustion Symposium and also served as the organizer and session chairman. The keynote for the combustion focused symposium was presented by Dr. Gary Smyth, Executive Director of North American Science Labs for General Motors (GM) Global Research and Development. The SAE Forum was part of a larger Automechanika international trade fair for automotive parts, equipment, and service suppliers. The fair had more than 80,000 visitors and more than 4,600 exhibitors from 38 countries.

FEERC Staff Attend the United States Driving Research and Innovation for Vehicle Efficiency (USDRIVE) All Tech Team Meeting
Robert Wagner of FEERC and several other ORNL staff attended the USDRIVE All Tech Team Meeting in Troy, Michigan. USDRIVE fosters government-industry partnership focused on advanced automotive and infrastructure technology research and development. More information is available at http://www1.eere.energy.gov/vehiclesandfuels/about/partnerships/usdrive.html.

AWARDS

FEERC Staff Member Selected to Receive 2014 SAE International Leadership Citation
Robert Wagner of FEERC has been chosen to receive the 2014 International Leadership Citation in recognition of his "outstanding accomplishments which have led to the success of SAE's global initiatives." The citation was created in 1988 to provide public recognition to an individual well known internationally for continuous professional involvement and participation in SAE meetings, conferences, congresses, and unique assistance and support in helping SAE achieve its goals and objectives. The citation will be presented to Robert at the 2014 SAE World Congress.