Technical Highlights for July 2012

New Collaboration Underway to Investigate Ionic Liquids for Enhancing Engine Efficiency

A new Cooperative Research and Development Agreement (CRADA), No. NFE-12-03876, between the Oak Ridge National Laboratory (ORNL) and Shell Global Solutions was signed on July 23, 2012, to help execute the joint Vehicle Technologies Program (VTP) Funding Opportunity Announcement (FOA) #0000239 award, "Ionic Liquids as Multi-Functional Lubricant Additives to Enhance Engine Efficiency." The purpose of this collaborative research and development (R&D) effort is to develop and demonstrate oil-soluble ionic liquids as engine oil additives to substantially improve the mechanical efficiency of internal combustion engines. Potential advantages and disadvantages of this new category of additives will be explored with a combination of systematic lab experiments, modeling, engine dynamometer tests, and field tests. The kick-off meeting has been scheduled on August 6–7, 2012, and the Shell investigators, Brian L. Papke, Cheng Chen, and Hong Gao will come to ORNL for the meeting.

Summer Students Enjoy Wide Range of Research Experiences in Fuels, Engines, and Emissions Research Center (FEERC)

FEERC hosted 10 undergraduate students participating in summer Science Undergraduate Laboratory Internships (SULI), Higher Education Research Experiences (HERE), and Volkswagen (VW) Scholar research programs coordinated by Oak Ridge Associated Universities (ORAU). The students came from universities across the nation and from hometowns as far away as Colombia, South America. The students have participated in a wide range of research experiences while working with their ORNL mentors. Research projects include: optimizing power management control in hybrid vehicle powertrains, measuring the surface temperatures of particulate deposits in exhaust gas recirculation coolers, studying novel catalysts for the processing of biomass into renewable fuel, and developing a near-infrared fiber optic sensor for remote temperature measurement. The students' summer research experience will conclude with an ORNL-wide poster presentation session and a mini symposium in FEERC to share their technical results with the ORNL community during the first weeks of August.

ORNL Study Shows that Many Fuel Storage and Delivery System Materials Exhibit Similar Compatibility for Isobutanol- and Ethanol-Gasoline Fuel Blends

A preliminary analysis was performed by Mike Kass, Steve Pawel and Chris Janke which compared the compatibility of selected elastomers and metals to gasoline-based test fuels composed of 10 and 15% ethanol and 16 and 24% isobutanol. Isobutanol concentrations of 16 and 24% were evaluated in order to match the oxygen content of 10 and 15% ethanol, respectively. Analysis of the volume swelling and change in hardness indicated that elastomers exhibited less swelling and hardness change when exposed to isobutanol compared to ethanol. Interestingly, when the specimens were dried and these properties remeasured, the fluorocarbon specimens retained a slightly higher residual mass of isobutanol than ethanol. Analysis of the metal specimens showed negligible mass loss for exposure to both ethanol and isobutanol.

ORNL Releases Report Detailing Compatibility Performance of Fuel Storage and Dispensing Materials Exposed to Ethanol-blended Gasoline

The ORNL/TM-2012/88 report entitled *Compatibility Study for Plastic, Elastomeric, and Metallic Fueling Infrastructure Materials Exposed to Aggressive Formulations of Ethanol-Blended Gasoline*, published July 16, 2012. Authors are Mike Kass, Tim Theiss, Chris Janke, and Steve Pawel. This report details the compatibility performance of individual infrastructure materials (elastomers, plastics, and metals) to test fuels containing between 10 and 85% aggressive ethanol. Included in this report is a model (based on Hansen solubility theory) that predicts both the location of maximum swell and extent of solubility of

ethanol-blended gasoline to infrastructure polymers. This report had been awaiting release by the Department of Energy (DOE), which was finally approved this month. The report results will be used by industry and regulators to assess fueling infrastructure materials response to gasoline containing higher levels of ethanol.

ORNL Publishes Report for the USEPA Which Analyzes the Leak Potential of Fuel Storage Systems When Moving From E10 to E15

ORNL published report ORNL/TM-2012/182 for the United States Environmental Protection Agency (USEPA) Office of Underground Storage Tanks entitled, *Analysis of Underground Storage Tanks System Materials to Increased Leak Potential Associated with E15 Fuel*. This report describes the predicted impact of existing infrastructure materials to gasoline containing 15 percent ethanol. The EPA will post this study on their webpage for biofuels, along with other documents regarding compatibility. The study concludes that moving from E10 to E15 should not significantly increase the potential for leaking for those materials and systems highlighted in the report. The authors are Mike Kass, Tim Theiss, Chris Janke, and Steve Pawel.

Lean Gasoline Engine Mapped with Drivven

As part of ORNL's emission control research, a European BMW 120i lean gasoline engine was mapped in conjunction with subcontractor Drivven. The engine map includes a complete characterization of the fuel injection and spark timing that enables the lean engine to operate with ~10% better fuel economy than typical stoichiometric engines. Drivven is developing a controller for the engine that will enable ORNL full operational control of the engine. ORNL's research on the engine will focus on reducing emissions to United States (U.S.) emission regulation levels (the vehicle currently only meets the less stringent European emission regulations) so that this fuel-saving technology can be introduced into the U.S. market.

ORNL- FEERC hosts Center for Applied Energy Research Scientist in Study Investigating In-Situ Aging Characteristics

As part of an ongoing collaboration between ORNL and the Center for Applied Energy Research, which is associated with the University of Kentucky, YaYing Ji was hosted by Todd J. Toops. Research during this focused on developing and formalizing a technique that enable the measurement of platinum particle size using of infrared spectroscopic techniques. Improved in-situ measurements of this key catalytic feature will quickly enable measurements as a function of age rather than relying on image processing from high-resolution electron microscopy (slow and hard to distinguish platinum (Pt) from dense ceria particles), x-ray diffraction (can only be applied to large particles), or gas-phase chemisorption measurements (over predicts due to carbon monoxide (CO) spillover).

U.S. Army Visits ORNL to Discuss Engine Testing

ORNL hosted a visit by program managers and technical representatives from Science and Engineering Services, Inc. (SES) and the U.S. Army Aviation and Missile Research, Development and Engineering Center (AMRDEC) on July 10. The meeting was organized by Mike Kass and other ORNL attendees included Norberto Domingo, Brian Kaul, Robert Wagner, and Ron Graves. The U.S. Army has added ORNL to its engine evaluation team and the visit was to meet with ORNL staff to discuss the U.S. Army's High Reliable Propulsion System Test Program. SES and AMRDEC staff discussed test protocol needs and evaluated ORNL facilities at the National Transportation Research Center (NTRC) site as possible locations for upcoming unmanned aerial vehicle (UAV) engine testing. A list of action items was drafted and ORNL was asked to prepare a proposal for this activity.

Invited Talks and Presentations

FEERC Research Shows Greenhouse Gas Reduction Potential of Small Scale Combined Heat and Power
FEERC researcher Scott Curran presented a paper at the 6th International Conference on Energy Sustainability entitled "Greenhouse Gas Reduction Potential with Combined Heat and Power with Distributed Generation Prime Movers" in San Diego, California, July 23rd. The paper examined a number of commercially available distributed energy prime movers including small turbines, fuel cells, reciprocating engines and micro-turbines, and estimated the greenhouse gas reduction potential with the prime movers with and without combined heat and power application as compared to regional power production in the U.S. The study found that combined heat and power offered considerable reductions in greenhouse gases compared to traditional, separate heating systems and the use of grid power. Mr. Curran also served as a session organizer for the conference for the combined heat and power track.

ORNL Emissions Control Research Presented at 15th International Congress on Catalysis 2012
Five abstracts discussing ORNL emissions control research were presented at the 15th International Congress on Catalysis in Munich, Germany. This quadrennial conference brings together catalysis researchers from industry and academia in a unique forum to discuss the most recent progress in catalysis R&D and to meet catalysis experts. ORNL research topics included improved catalytic durability and sulfur tolerance through support modifications, ceria effects on lean nitrogen oxide (NO_X) trap (LNT) chemistry and durability, on-board ammonia (NH_3) formation during lean ethanol-selective catalytic reduction (SCR) of NO_X, nitrous oxide (N_2O) formation with LNTs as a function of reductant in exhaust, and techniques for measuring distributed temperature and species in emissions control systems.
Todd J. Toops attended from ORNL and researchers from the University of Michigan, Queen's University of Belfast, and Institute of Chemical Technology-Prague helped present the collaborative research.

Awards

FEERC Corporate Fellow Serves as External Reviewer to University of Michigan Army Research Center
Stuart Daw participated as an external reviewer for the University of Michigan (UM) Army Research Center (ARC) in their annual review meeting held on May 20th–22nd. The ARC is funded by the U.S. Army Tank Automotive Research, Development and Engineering Center (TARDEC) to do basic R&D related to Army vehicle systems technology. Besides UM, other participating universities include Wayne State, Clemson, Virginia Tech, Iowa State, and Oakland University. The other reviewers included Harold Schock (Michigan State), Dan Negrut (University of Wisconsin), Tom Doligalski (Army Research Office), Karl Hedrick (University of California, Berkeley), Lino Guzella (Eidgenössische Technische Hochschule, Zürich), Abinandan Jain (NASA Jet Propulsion Laboratory), and Raju Namburu (Army Research Lab). Dr. Daw was selected to compile the overall review board report to the ARC Coordinating Committee.

Scott Sluder Recognized with 2012 SAE International Excellence in Oral Presentation Award
Scott Sluder was named a recipient of the 2012 SAE International Excellence in Oral Presentation Award for his paper presentation on "NMOG Emissions Characterizations and Estimation for Vehicles Using Ethanol-Blended Fuels" at the 2012 SAE International Congress. The paper was also accepted in the SAE International Journal of Fuels and Lubricants. Selection for this award is based on feedback from the audience during the conference and is intended to recognize and maintain a high standard for presentations at SAE's technical meetings. Mr. Sluder has received the award twice.