

## Technical Highlights for January 2013

### **Cummins and the Oak Ridge National Laboratory (ORNL) Cooperative Research and Development Agreement (CRADA) Team Works to Validate Design Models and Improve Exhaust Gas Recirculation (EGR) Systems**

FEERC staff member Bill Partridge and Post-Doctoral Research Associates Jon Yoo and Rodrigo Sanchez-Gonzalez performed on-site work at the Cummins Technical Center (CTC) October 22–26, 2012, to make certain EGR-system assessments on a development engine. This work was performed under the Combustion section of the Cummins-ORNL\FEERC CRADA. The Cummins team members were led by Dr. Partridge's Co-PI and Cummins staff member Sam Geckler and the results enabled validation of numerical design tools used in product development; advancement of these models will hasten development of low-cost, practical, and durable high-efficiency engine systems. An improved laser-based EGR Probe was used for the first time in this campaign and enables several analytical improvements including response linearity and greater sensitivity at higher EGR levels, simultaneous high-speed pressure measurements, greater immunity to potential species interferences, and probe multiplexing; EGR Probe multiplexing will allow for simultaneous application of multiple probes at different locations for faster and more extensive system mapping. This was the third joint CRADA campaign at the CTC in the last 18 months focused on EGR Probe development and applications, and a demonstration of Cummins' strong support of this important partnership and technology, as well as the relevance of the resulting insights to practical efficiency advances.

### **Fuels, Engines, and Emissions Research Center (FEERC) Research Featured in *Green Car Congress* (GCC) Article**

Recent research of Andreas Malikopoulos was featured in *GCC*. The article refers to the optimization framework developed to facilitate better understanding of the benefits from proper selection of motor/generator and battery size on fuel economy and greenhouse gas (GHG) emissions in plug-in hybrid vehicles (PHEVs). The proposed optimization and modeling approach can aim to identify the right sizing of these components and thus reduce the PHEV cost. Addressing optimal sizing of PHEV components could lead to an extensive market penetration of PHEVs.

### **FEERC Study on Effect of Highway Speed on Fuel Economy Catches Media Attention**

FEERC researchers have been collecting fuel economy data for a wide range of vehicles at highway cruise conditions in support of the fueleconomy.gov website. Results for 74 vehicles tested at steady-state speeds from 50–80 mph show that fuel economy declines linearly with increasing speed. While it was clear that fuel economy would decrease with increasing speed, the study quantifies the fuel economy loss and the data are being used to develop models that would allow predicting highway fuel economy as a function of speed for any vehicle in the Environmental Protection Agency (EPA) database. Tested vehicles include various sizes of 2003–2012 sedans, wagons, hybrids, SUVs, pickup trucks, minivans, and a few “muscle” and sports cars from multiple manufacturers. Twenty-three of the vehicles were tested in ORNL's FEERC laboratory and data from 51 vehicles tested by Chrysler were loaned to ORNL through a non-disclosure agreement. The percent decrease in fuel economy for a 10 mph speed increase varies from below 7% to over 20%, although results show a fairly normal distribution with about 2/3rd of the vehicles having similar fuel economy decrease in the middle of the range at about 11–17%. An article summarizing the work was published in *GCC* and garnered considerable attention from other media, including The Detroit Bureau, NBC News, the Detroit Free

Press, Michigan Radio, Consumer's Digest, The Raleigh News Observer, and several others. Following the GCC article, staff were interviewed several times and responded to multiple emails about the work.

### **ORNL and Southwest Research Institute (SwRI) Staff Organize Inaugural Society of Automotive Engineers (SAE) High Octane Fuels Symposium**

Scott Sluder, Brian West, and Jim Szybist of ORNL and Patrick Merritt of SwRI recently organized a symposium to explore the potential fuel economy improvements offered by increasing the octane ratings of fuels in the United States (U.S.). This subject is emerging as a potential growth area, with the opportunity to afford significant benefits to future vehicle fuel efficiency. The symposium was held January 28–29, 2013, in conjunction with the SAE Government/Industry Meeting in Washington, D.C. Over 70 people attended the meeting representing the auto companies, energy companies, the ethanol industry, refueling station owners, government agencies, and other interested parties. A session was held to explain the often complex interactions of the gasoline regulatory environment followed by a session focusing on what the potential benefits in terms of future engine efficiency could be if a dedicated high-octane fuel was available in the marketplace. The final session focused on opportunities, challenges, and pathways towards marketplace introduction of high-octane fuels.

### **ORNL Team Awarded Three Days at Neutron Beamline to Study Fluid Flow in Fuel Injectors**

Researchers from FEERC spent three days employing ORNL's High Flux Isotope Reactor (HFIR) neutron beamline to investigate the internal fluid flow of Bosch diesel injectors. Diesel fuel rail pressures up to 1600 bar were studied with efforts focusing on the composite fluid flow when the injector nozzle is open. Additionally, the researchers used the beamline to obtain computed tomographic (CT) scans of both the diesel injectors and injectors employed in gasoline direct injection with no fluid flow. This unique beamline time was awarded through the HFIR user program which is open to researchers across the globe. Results are currently being processed and will be reported at the DOE Annual Merit Review.

### **FEERC Staff Participates in U.S.-China Clean Energy Research Center (CERC) Steering Committee Meeting**

Robert Wagner participated in the U.S.-China CERC Steering Committee meeting in Washington, D.C. Robert is the ORNL lead for the CERC Clean Vehicles activity and a member of the executive committee. The Steering Committee meeting was held on January 10, 2013, with Chinese Minister of Science and Technology Wan Gang and U.S. Secretary of Energy Steven Chu leading the meeting. Each of the three CERC's (Clean Coal, Clean Vehicles, and Building Energy & Efficiency) presented research progress in their respective areas. Feedback from Secretary Chu and Minister Wan Gang was positive and reinforced that the CERC will be a grand experiment with many measures of success, beyond papers and publications.

## **Invited Talks and Presentations**

### **FEERC Staff Presents Invited Lecture to Instrumentation Group**

ORNL\FEERC Distinguished Research Staff Dr. Bill Partridge presented an invited lecture to the local Oak Ridge section of the International Society of Automation (ISA). The lecture was titled "Diagnostics Development and Applications for Enabling Advanced Efficiency Automotive Systems," and highlighted development and applications of a wide range of diagnostics within the Cummins-ORNL CRADA for advancing Department of Energy (DOE) goals for energy efficiency and security; specifically covered were the SpaciMS, Fuel-in-Oil, EGR Probe, and optical-fiber-based species and temperature sensing. As

part of the meeting, 4 of the 19 attendees received Professional Development Credits needed to maintain their Professional Engineer, P.E., license.

## **Awards**

### **Scott Sluder Joins SAE Engineering Meetings Board as Chairman of Land & Sea Operating Group**

Scott Sluder was recommended by 2013 SAE International President Don Hillebrand and approved by the SAE Board of Directors for appointment to the SAE Engineering Meetings Board (EMB) as the Chairman of EMB's Land & Sea Operating Group. Mr. Sluder will serve as Chairman of the Land & Sea Operating Group for 2013–2014. The Land & Sea Operating Group is charged with overseeing the business of SAE's ground vehicle activities, their committees, and the General/Steering Committees of ground vehicle conferences with which SAE is affiliated. SAE International is the foremost professional society in the mobility community, with more than 128,000 individual members in 110 countries.