Technical Highlights for March 2012

Fuels, Engines, and Emissions Research Center (FEERC) Demonstrates Potential of Biofuels to Expand High Efficiency Operation of Advanced Combustion Engines

The Oak Ridge National Laboratory (ORNL) Reactivity Controlled Compression Ignition (RCCI) combustion methodology was used on a multi-cylinder light-duty diesel engine to demonstrate the potential of biofuels to expand speed/load operating range. Improved load expansion is important to enable RCCI operation over the majority of the light-duty drive cycle as well as to fully realize the efficiency and emissions potential of RCCI over conventional diesel combustion. Improvements in maximum engine load with RCCI using E85 (85% ethanol, 15% gasoline) and B20 (20% biodiesel, 80% diesel) were as high as 30% over that of using gasoline and diesel fuel and as high as 20% with E20 and B20. The synergy between using ethanol and biodiesel blends was found to be important for fully realizing the full load expansion potential with RCCI. RCCI brake thermal efficiencies higher (43.0) than the peak efficiency point of the baseline engine (42.3) were achieved with RCCI using biofuels with an order of magnitude decrease in engine out nitrogen oxide (NO_X) compared to conventional diesel combustion operation with near zero soot emissions. The higher RCCI efficiency was demonstrated under conditions applicable to the federal drive cycle, whereas the peak efficiency of the base diesel engine is at very high load and outside conditions observed over the federal drive cycle. The project team was led by Scott Curran.

FEERC Researchers Commission New Gasoline Direct Injection (GDI) Engine

A GM 2.0L LNF GDI engine modified for flex-fuel capabilities with higher compression ratio, higher peak cylinder pressures, an advanced fuel system, and advanced camshaft timing control has been loaned to ORNL by Robert Bosch LLC along with an advanced open control system. The installation, commissioning, and shakedown of the engine and controller have now been completed along with the installation of an external exhaust gas recirculation (EGR) system and this new platform is being used to support research related to high-dilution stoichiometric GDI combustion stability and particulate studies.

ORNL FEERC Staff Performs Theoretical Solubility Exercise

A theoretical solubility exercise was performed by Mike Kass to determine the relative compatibility of fueling infrastructure polymer materials to gasoline containing either ethanol or isobutanol. The polymer materials included those elastomers and plastics which were evaluated in the fueling infrastructure compatibility effort funded by the Department of Energy (DOE) Office of Biomass and Vehicle Technologies Programs. The solubility distance is a thermodynamic-based parameter and is used to determine solubility (or compatibility) potential between a solid (polymer) and a liquid (fuel). As the solubility distance decreases, the polymer and fuel become more thermodynamically similar, which will result in increased fuel permeation and swell. The results show that for most plastic and elastomeric materials, the potential compatibility with isobutanol is approximately equivalent with gasoline containing equivalent amounts of ethanol when the concentrations for these alcohols are less than 50% by volume. At higher concentrations, the calculations indicate that ethanol is more compatible than isobutanol for the elastomer materials, whereas isobutanol shows better compatibility with plastics. With knowledge of the Hansen solubility parameters for each material and test fuel component, the level of solubility (and hence compatibility) can be predicted for any combination of test fuel chemistry (including multiple mixtures of fuel components). This exercise can be performed for any material-fuel combination to gage compatibility.

ORNL/FEERC Hosts Representatives from Butamax Advanced Biofuels and Underwriters Laboratories (UL)

ORNL hosted a visit by Butamax Advanced Biofuels and UL on February 28th to discuss an upcoming series of experiments to evaluate isobutanol compatibility to fueling infrastructure materials. ORNL attendees included Mike Kass, Tim Theiss, Steve Pawel, Chris Janke, Brian West, and Robert Wagner. Butamax was represented by their Fuel Product Manager, Jim Baustian and consultant, Wolf Koch. Edwin Yang from UL was in attendance with Tom Chapin participating via telecom. A research plan was established and the experiments were scheduled to commence in March once the polymer materials had been prepped.

ORNL Hosts Visitor from Toyota

ORNL hosted Takahisa Okazaki, who directs engine test cells for engine calibration at Toyota, as well as a group of visitors from National Instruments (NI) for a visit on March 6th. This was ORNL's first meeting with Mr. Okazaki at Toyota so discussions were broad in order to develop an understanding of Toyota's interest and research needs. ORNL's work on RCCI and spark-assisted homogeneous charge compression ignition (SA-HCCI) was presented

and a number of topics concerning research needs within Toyota were discussed, including particulate matter from spark-ignition (SI) engines, advanced combustion, and engine downsizing.

FEERC Staff Presents at the Biofuels Sessions of the 23rd National Tanks Conference

Mike Kass gave an invited presentation during the Biofuels Session of the 23rd National Tanks Conference on March 20th in St. Louis Missouri. Co-authors were Tim Theiss, Chris Janke, and Steve Pawel. The presentation was entitled "Compatibility Summary of Fueling Infrastructure Materials with Aggressive Ethanol Test Fuels." Approximately 200 attendees participated in the Biofuels Session which focused on ethanol compatibility and leak detection.

Invited Presentation at the ORNL Center for Bioenergy Sustainability (CBES)

Jim Szybist delivered an invited presentation at the ORNL CBES forum on March 15th entitled "Impacts of Emerging Engine and Fuel Technologies on the Efficiency of Future Engines." The CBES is engaged in research and analysis on the environmental impacts and ultimate sustainability of biomass production to biofuels and bio-based products. Dr. Szybist's presentation was intended to familiarize the researchers working on biofuel production with the research topics and concerns of emerging engine technologies in an effort to promote dialogue and collaboration between the two research areas.

FEERC Presents at the Technical Review of the Clean Energy Research Center – Clean Vehicles Consortium (CERC-CVM)

ORNL is a founding member of the University of Michigan led DOE CERC-CVM. Robert Wagner attended the two year review of the CERC and presented an update on ORNL activities to the DOE Executive Committee which includes David Sandalow, the Assistant Secretary for Policy & International Affairs. The review meeting also included presentations by Dr. Huei Peng, the CERC-CVM Director, and Dr. Dawn Manley, Sandia National Laboratories.

FEERC Researcher Appointed Graduate Faculty at the University of Maine

Dr. Bruce Bunting has been appointed Graduate Faculty as an External Faculty member of the University of Main in relationship to biofuels to (1) serve on graduate degree advisor committees, and (2) act as co-investigator on potential research projects.

FEERC Researchers Explain Science of Fuel Efficiency for Middle School Tour

FEERC Researchers Scott Curran, Norberto Domingo, and Sam Lewis toured a large group of local middle school students showing the science behind engine efficiency and alternative fuels. Tours included visits to the large-bore and multi-cylinder advanced combustion engine cells as well as the analytical chemistry laboratory. The FEERC tours were part of a larger tour at the National Transportation Research Center (NTRC).