Technical Highlights for August 2012

Fuel Consumption and Cost Saving of Natural Gas as Alternative Fuel in Class 8 Heavy-Duty (HD) Trucks

The fuel consumption and greenhouse gas emissions of natural gas as alternative fuel in HD class 8 trucks have been investigated under consistent simulated drive cycle conditions. Fuel efficiencies, fuel costs, and payback periods have been compared between diesel and natural gas in both conventional and hybrid HD trucks. The study shows that although trucks powered by natural gas have higher fuel consumption, their carbon dioxide (CO_2) emissions and costs are lower than comparable diesel trucks. Both diesel and natural gas powered hybrid trucks have significantly improved fuel economy, reasonable cost savings and payback time, and lower CO_2 emissions under city driving conditions. However, under freeway-dominant driving conditions, the overall benefits of hybridization are significantly less. Based on payback period alone, non-hybrid natural gas trucks appear to be the most economic option for both urban and freeway driving environments. The results have been documented by Z. Gao, T. J. LaClair, et al. entitled "Fuel Consumption and Cost Saving of Class 8 Heavy-Duty Trucks Powered by Natural Gas" and submitted to the 92nd Transportation Research Board Annual Meeting.

Impact of Premixed Charge Compression Ignition on Light-Duty (LD) Diesel Fuel Economy and Emissions of Particulates and Nitrogen Oxide (NO_X)

The potential impact of premixed charge compression ignition (PCCI) on LD diesel fuel economy and emissions has been studied in urban drive cycle simulations of conventional and hybrid LD vehicles. Both simulated vehicles were assumed to have diesel engines capable of operating with either conventional diesel combustion (CDC) or PCCI. The allowed speed-load range for PCCI was constrained based on previous experimental engine studies of PCCI at the Oak Ridge National Laboratory (ORNL). In the simulated conventional vehicle, PCCI significantly reduced fuel consumption and emissions by reducing the need for lean NO_X trap (LNT) and diesel particulate filter (DPF) regeneration. However, additional benefits appear to be possible if ways of extending the PCCI operating range can be developed. More optimal engine control strategies would also help increase the potential benefits of PCCI in hybrid electric vehicles (HEVs). The results have been documented in a paper coauthored by Z. Gao, C. S. Daw, et al. entitled "Simulating the Impact of Premixed Charge Compression Ignition on Light-Duty Diesel Fuel Economy and Emissions of Particulates and NO_X," and invited by the *Journal of Automobile Engineering*.

ORNL Demonstrates Improved Efficiency and Availability in a Small Volume Combustion Single Cylinder Reciprocating Engine

Mike Kass, Brian Kaul, and Dean Edwards recently completed a small seed money effort to demonstrate improved operational range and efficiency in a 5cc engine by using a ceramic cylinder liner in place of the standard steel one. Preliminary studies had showed that the incorporation of a ceramic liner affected the combustion by increasing the exhaust temperature significantly. To better assess fuel efficiency under constant load, static thrust experiments were performed by equipping the engine with a propeller, thereby enabling constant speed (and hence torque). At 6,000rpm and nearly identical fueling conditions, the exhaust temperature of the engine was raised from 155°C to 250°C by using the ceramic liner. Accompanying the temperature increase was a 5% improvement in fuel efficiency and an estimated increase in the flow exergy from 25.7kJ/kg to 63.1 kJ/kg. This study represents the first achievement of improved fuel efficiency and availability in a miniature-sized reciprocating engine by incorporating ceramic materials.