Abstracts

Session 3 – Fuels and Lubrication, Part 2

EMISSIONS FROM HEAVY-DUTY DIESEL ENGINE WITH EXHAUST GAS RECIRCULATION USING OIL SANDS DERIVED FUELS

Stuart Neill

National Research Council Canada

ABSTRACT

The oil sands deposits in Alberta contain approximately 1.6 trillion barrels of bitumen, a naturally occurring viscous mixture of hydrocarbons. Approximately 20 percent of these bitumen reserves are recoverable with current technology. In 2002, the Canadian oil sands industry produced approximately 800,000 barrels of bitumen and bitumen-derived crude oil per day, and production is expected to increase to almost 2 million barrels per day by 2011. It is estimated that up to 75 percent of the oil sands production in 2011 will be exported to the U.S. market.

The presentation will discuss the unique characteristics and properties of oil sands derived crude, which reflect the bitumen source and the upgrading processes that the bitumen undergoes, as well as the emissions behavior of diesel fuels containing oil sands components.

In a recent study, the exhaust emissions from a single-cylinder version of a heavy-duty diesel engine with exhaust gas recirculation (EGR) were measured using 12 diesel fuels derived from oil sands and conventional sources. Exhaust emissions were measured using the AVL eight-mode steady-state test procedure. Particulate matter (PM) emissions for all test fuels were accurately modeled by a single regression equation with two predictors: fuel total aromatics and sulfur content. Similarly, NO_x emissions were found to depend on fuel total aromatics and density. In summary, the PM and NO_x emissions were significantly affected by key compositional fuel properties, but the crude oil source did not play a role.

DEVELOPMENT AND DEMONSTRATION OF FISCHER-TROPSCH FUELED HEAVY-DUTY VEHICLES WITH CONTROL TECHNOLOGY FOR REDUCED DIESEL EXHAUST EMISSIONS

Brad Adelman and Mike May

Ricardo

Teresa Alleman

National Renewable Energy Laboratory

Adewale Oshinuga

South Coast Air Quality Management District

Bernard Treanton

California Energy Commission

Greg Barton

Automotive Testing Laboratory

Ralph Cherrillo and Ian Virrels

Shell Global Solutions

ABSTRACT

The objectives of this study are to modify two 2002 Model Year Cummins ISM engines (equipped with exhaust gas recirculation [EGR]) to achieve 1.2 g/hp-h NO_x emissions and 0.01 g/hp-h particulate matter (PM) over the heavy-duty Federal Test Procedure (FTP) cycle using Fischer-Tropsch (F-T) fuel, optimized combustion, lean NO_x catalyst (LNC) with secondary injection, and a diesel particulate filter (DPF). After their performance is proven in a test cell, the plan is to install the modified engines and aftertreatment systems in two vehicles and operate the vehicles in a commercial application. The program is sponsored by the South Coast Air Quality Management District, the California Energy Commission, the U.S. Department of Ener-gy, and the National Renewable Energy Laboratory

This presentation covers the first phase of the work — the optimization of the en-gine and aftertreatment systems to demon-strate the targets in an emissions test cell.

The effect of F-T fuel on the base engine was first evaluated over the heavy-duty diesel FTP cycle. In comparison to a low aromatic California Air Resources Board ultra-low sulfur diesel fuel, a 4.5-percent decrease in NO_x and a 17.6-percent decrease in PM were measured.

To achieve a major reduction in engine out NO_x emissions, the chosen strategy was to increase the EGR rate and employ an LNC. To tolerate higher EGR rates, the combustion bowl was modified to increase the bowl volume (decreased compression ratio is possible due to the superior ignition qualities of F-T fuel) and air motion. Increased EGR rate and combustion modi-fications lead to a further 25-percent de-crease in NO_x but a 30-percent increase in PM.

An exhaust aftertreatment system con-sisting of an LNC and catalyzed DPF was then installed. The efficiency of catalyzed aftertreatment is improved with virtually sulfur-free F-T fuel. Secondary F-T fuel was added to the exhaust to facilitate the LNC performance. The exhaust aftertreatment led to a further 19-percent NO_x reduction and 95-percent PM removal Composite emis-sions of 1.168 g/hp-h NO_x and 0.005 g/hp-h PM were achieved over the heavy-duty FTP cycle.

FUEL FORMULATION EFFECTS ON DIESEL FUEL INJECTION, COMBUSTION, EMISSIONS, AND EMISSION CONTROL

André Boehman, Mahabubul Alam, Juhun Song, Ragini Acharya, Jim Szybist, and Vince Zello

Pennsylvania State University

Kirk Miller

ConocoPhillips

ABSTRACT

This paper describes work under an Ultra Clean Fuels project entitled "Ultra Clean Fuels from Natural Gas," Cooperative Agreement No. DE-FC26-01NT41098. In this study we have examined the incremental benefits of moving from low-sulfur diesel fuel and ultra-low sulfur diesel fuel to an ultra-clean fuel, Fischer-Tropsch diesel fuel produced from natural gas. Blending with biodiesel, B100, was also considered. The impact of fuel formulation on fuel injection timing, bulk modulus of compressibility, in-cylinder combustion processes, gaseous and particulate emissions, diesel particulate filter regeneration temperature, and urea selective catalytic reduction NO_x control has been examined. The primary test engine is a 5.9L Cummins ISB, which has been instrumented for in-cylinder combustion analysis and in-cylinder visualization with an engine video-scope. A single-cylinder engine has also been used to examine in detail the impacts of fuel formulation on injection timing in a pump-line-nozzle engine in order to assist in the interpretation of results from the ISB engine.

A REVIEW OF VEGETABLE OIL RESEARCH AT PENN STATE

Kraipat Cheenkachorn, Kimberly Wain, Waleska Castro, Wallace Lloyd, and Joseph M. Perez

Pennsylvania State University

ABSTRACT

This presentation will review current projects at Pennsylvania State University on the use of vegetable oils as fuels, hydraulic fluids, and engine oils. Research is being conducted on such alternative fuels as B100, B20, and VPO B20. A hydraulic fluid project to convert farm and construction equipment on campus will be described as will efforts to develop high- temperature lubricants and next-generation lubri-cants containing minimal sulfur and phosphorus. Studies of the effect of coatings on friction, wear, and deposits will be discussed.

THE IMPACT OF OIL CONSUMPTION MECHANISMS ON DIESEL EXHAUST PARTICLE-SIZE DISTRIBUTIONS AND DETAILED EXHAUST CHEMICAL COMPOSITION

John Stetter, Nathan Forster, Jaal Ghandhi and David Foster

University of Wisconsin – Madison

ABSTRACT

Detailed exhaust emission data have been taken from a Cummins N-14 single-cylinder research engine in which the oil consumption was varied by different engine modifications. Low-sulfur fuel was used, and oil consumption was varied by modifying the intake valve stem seals, the exhaust valve stem seals, the oil control ring, and combinations of these modi-fications. Detailed measurements of exhaust gas particle-size distributions and chemical composition were made for the various oil consumption configurations for a range of engine loads and speeds.

The data indicate that the particle-size distribution is impacted by oil consumption of the engine. Furthermore, the nature of the change in particle-size distribution depends on the mech-anism of the oil consumption. For example, the diameter of the maximum particle concentration shifts from being smaller than, to being larger than, the base engine case for different oil con-sumption modes and different operating con-ditions.

The particulate mass was measured with TEOM and traditional gravimetric filter me-thods. Filter data for elemental carbon/organic carbon, sulfates, and trace metals have been taken and are being analyzed. The trace metals in the particulate mass serve as the basis for assessing oil consumption at the dif-ferent operating conditions. The results of these analyses will be presented.

IMPACT OF THE FUEL-BORNE CATALYST MMT ON DIESEL PARTICULATE FILTERS AND LEAN NO_X TRAP PERFORMANCE

David Human

Ethyl Petroleum Additives

ABSTRACT

This presentation builds on the work summarized by Ethyl at the DEER 2002 Conference by examining the role that MMT can play in catalyzed diesel particulate filter systems and lean NO_x traps (LNT's) using a contemporary Model Year 2002 medium-duty Cummins 5.9L ISB diesel engine. Balance point and filter loading were investigated at a series of engine speed and load combinations, with soot accumulation and balance point being reduced in all cases. Soot accumulation was affected as MMT lowered the amount of elemental carbon emissions (dry particulate). MMT was also found to protect lean NO_x traps by scavenging the fuel sulfur and engine oil-derived phosphorus and incorporating them into the ash. Improvements in LNT performance and durability were demonstrated using MMT in ultra-low sulfur fuel.