Abstracts

Session 1 – Emerging Diesel Technologies

REDUCTION OF EMISSIONS FROM A HIGH-SPEED FERRY

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ABSTRACT

Emissions from marine vessels are being scrutinized as a major contributor to total particulate matter (TPM), SO_x, and NO_x environmental loading. Fuel sulfur control is the key to SO_x reduction. Significant reductions in the emissions from on-road vehicles have been achieved in the last decade, and the emissions from these vehicles will be reduced by another order of magnitude in the next 5 years: these improvements have served to emphasize the need to reduce emissions from other mobile sources, including off-road equipment, locomotives, and marine vessels. Diesel-powered vessels of interest include oceangoing vessels with low- and medium-speed engines, as well as ferries with high-speed engines, as discussed below.

A recent study examined the use of intake water injection (WIS) and ultra-low sulfur diesel (ULSD) to reduce the emissions from a high-speed passenger ferry in southern California. One of the four Detroit Diesel 12V92 two-stroke high-speed engines that power the Waverider (operated by SCX, Inc.) was instrumented to collect intake airflow, fuel flow, shaft torque, and shaft speed. Engine speed and shaft torque were uniquely linked for given vessel draft and prevailing wind and sea conditions. A raw exhaust gas sampling system was utilized to measure the concentration of NO_x, CO_2, and O_2, and a mini-dilution tunnel sampling a slipstream from the raw exhaust was used to collect TPM on 70-millimeter filters. The emissions data were processed to yield brake-specific mass results. The system that was employed allowed for redundant data to be collected for quality assurance and quality control. To acquire the data, the Waverider was operated at three different speeds in the open sea off Oceanside, California.

Data have shown that the use of ULSD along with water injection could significantly reduce the emissions of NO_x and PM while not affecting fuel consumption or engine performance, compared to the baseline marine diesel. The results showed that a nominal 40-percent reduction in TPM was realized when switching from the marine diesel to the ULSD. A small reduction in NO_x was also shown between the marine fuel and the ULSD. The implementation of the WIS showed that NO_x was reduced significantly by between 11 and 17 percent, depending upon the operating condition. With the WIS, the TPM was reduced by a few percentage points, which was close to the confidence in measurement.

CATERPILLAR INC., HEAVY TRUCK CLEAN DIESEL PROGRAM

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ABSTRACT

The DOE Heavy Truck Clean Diesel (HTCD) program is a 5-year program aimed at demonstrating 50-percent thermal efficiency while complying with the 2007 and 2010 emissions regulations. The development program includes the evaluation of multiple technical solutions and culminates in the demonstration of the emission-compliant engine system in a truck chassis. This demonstration truck will be used for assessment of drivability, emissions compliance on various driving cycles, noise studies, etc. The other aspect of the demonstration truck is the integration of the various engine subsystems onto the engine and into the truck chassis in a manner that is suitable for multiple original equipment manufacturers.

POWERTRAP ä : ULTRAFINE PARTICULATE MATTER CONTROL WITHOUT PERFORMANCE PENALTIES

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ABSTRACT

The PowerTrap™ is a non-exhaust temperature dependent system that cannot become blocked and features a controlled regeneration process independent of the vehicle's drive cycle.

The system has a low direct-current power source requirement available in both 12-volt and 24-volt configurations. The system is fully programmable, fully automated and includes Euro IV requirements of operation verification. The system has gained European component-type approval and has been tested with both on- road and off-road diesel fuel up to 2000 parts per million.

The device is fail-safe: in the event of a device malfunction, it cannot affect the engine's performance. Accumulated mileage testing is in excess of 640,000 miles to date. Vehicles include London-type taxicabs (Euro 1 and 2), emergency service fire engines (Euro 1, 2, and 3), inner city buses, and light-duty locomotives. Independent test results by Shell Global Solutions have consistently demonstrated 85- 99 percent reduction of ultrafines across the 7-35 nanometer size range using a scanning mobility particle sizer with both ultra-low sulfur diesel and off-road high-sulfur fuel.

DEVELOPMENT AND DEPLOYMENT OF ADVANCED EMISSION CONTROLS FOR THE RETROFIT MARKET

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ABSTRACT

Bringing a diesel retrofit product to market involves two primary phases: development and deployment. Critical product development steps include technology selection, system integration, laboratory and durability testing, and regulatory agency verification work. This initial product development phase is then followed by a deployment phase, which consists of building and managing the infrastructure for installation, distribution, service, sales and warranty support. Building relationships with regulators and air-quality program developers is also a critical aspect of the deployment process. A successful path to market requires close cooperation between developer, distributor, customer, and regulator.

Cleaire Advanced Emission Controls has developed an integrated NO_x and particulate matter (PM) control system called "Longview," which can be applied to a wide variety of engines and applications. In April 2003, Longview became the first broadly applicable, combined NO_x and PM emission control system to be verified by California Air Resources Board. Longview is verified to reduce NO_x by 25 percent and PM by 85 percent. Key elements of Longview include a NO_x reduction catalyst, a catalyzed diesel particulate filter, a reagent injection system, and a combined controller/datalogger called the "MLC®." Key criteria for the end-user are affordability, minimal impact on vehicle operations, and ready access to qualified service and support facilities. Important features for regulators and grant programs are verifiable emission reductions and cost-effectiveness.

Cleaire is a division of Cummins West, Inc., the exclusive distributor of Cummins Incorporated products in central and northern California. While Cleaire has been focused on the development of the system, it has also worked with its parent to develop the criteria to become an "Authorized Cleaire Distributor." Excellent results in the test cell and proven durability in the field are thereby combined with an organization competent to handle sales, installation and service activities to support the product.

The paper will discuss the basic design features of the Longview system, present laboratory and field test results, and discuss the key process steps required for successful launch and support of retrofit emission control systems.

FUEL ADDITIVE STRATEGIES FOR ENHANCING THE PERFORMANCE OF ENGINES AND ENGINE OILS

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ABSTRACT

Chevron Oronite is developing and has commercialized fuel additives designed to reach the fuel/lubricant interface at the cylinder wall and impart performance improvements to both the engine and the engine oil. One such product is a gasoline-additive friction modifier that provides an immediate fuel economy benefit due to reduced friction between the piston ring and cylinder wall, a further improvement as it accumulates in the oil, as well as assisting wear protection and improving power output. In addition to these more obvious benefits, equal attention was given to avoiding harm issues such as in fuel handling, intake system deposits, combustion chamber deposits, and negative impacts on the engine oil.

We have designed diesel fuel additives that are intended to work similarly in a variety of diesel engines. The program has provided information about additive characteristics needed to reach the cylinder wall, despite engine design efforts to prevent fuel from doing so. As the candidate additives have reached the wall and sump intact, further work has shown that a functionalized molecule can provide the intended benefit upon reaching the cylinder wall and oil in this manner. We are now in the process of modifying the additive chemistry and getting dose/performance responses in a variety of engines.

TRANSIENT, REAL-TIME, PARTICULATE EMISSION MEASUREMENTS IN DIESEL ENGINES

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ABSTRACT

An instrument was developed to measure transient particulate mass emis-sions from diesel engines. This instru-ment, while based on laser-induced incandescence, allows measurements at 10 Hz. Using such an instrument, measurements were performed in the exhaust of a 1.7L Mercedes-Benz engine coupled to a low-inertia dynamometer. Comparative measurements performed under engine steady-state conditions show the instrument to agree within ±12% of measurements with a scanning mobility particle sizer. Moreover, the instrument showed far better time re-sponse to a step change in engine operation when compared with a TEOM 1105. Similar measurements performed over an urban driving cycle revealed that the instrument does not yield negative mass concentrations, unlike a typical TEOM.