Abstracts

Session 8 – Emerging Diesel Engine Technology

DIESEL EMISSION CONTROL – LAST 12 MONTHS IN REVIEW

Timothy V. Johnson
Corning Incorporated

The presentation aims to bring the audience up-to-date on the state of diesel emissions control in the last year. Topics to be covered include recent studies on: the nature of nanoparticles from internal combustion engines, diesel particulate filter technology developments, selective catalytic reduction, NO_x adsorber progress and issues, and integrating NO_x and particulate material control into feasible systems. Discussion of key issues facing the industry will also be included.

FRENCH PERSPECTIVE ON DIESEL ENGINES AND EMISSIONS

Stéphane Nino
Aaqius & Aaqius

Diesel is a high-stakes market for European engines manufacturers: almost 45 percent of passenger and light commercial (<5 ton) cars are diesel in Europe, even more in France.

The French car manufacturers -- PSA and Renault -- account for a large part of this production; this is why they are very impacted by EURO regulations for emissions reduction. Thus, they were among the first to develop solutions to meet these standards, and Peugeot even took advantage of it to be the first to market a car equipped with a diesel particulate filter with additive: the Peugeot 607.

Today, diesel vehicles have to comply with EURO 3; the next steps (EURO 4 and EURO 5) will enforce even more stringent levels for particulate matter and NO_x in 2005 and 2008. Low-sulfur level in gazole will also have to be reached.

To meet these standards, lots of programs are being conducted throughout Europe by the European Commission. If Sweden, Switzerland, and Germany were usually the first countries to be concerned by environment, today all Europe has taken over. This is especially true in the field of public transportation, which plays a key role in experimenting with available technologies for more than 15,000 buses equipped with depollution systems.

A closer look at the strategies of the bus and truck engine manufacturers shows that the games are still open, and everyone is mixing both known and proprietary technologies to fulfill technical and economical requirements.

EUROPEAN DIESEL ENGINE TECHNOLOGY: AN OVERVIEW

Stephen Brueckner
AVL Powertrain Engineering, Inc.

Modern, high-technology diesel engines have become extremely popular in Europe. What are some of the reasons for this success? Numerous market factors influence customers' buying preferences. But the market share approaching 50 percent would not be possible without the latest diesel engine technology.

Several key market factors will be reviewed, including legislation, cost, and vehicle performance. Reduction of exhaust emissions and fuel consumption of diesel engines is crucial to their continued sales growth. Current diesel engine technology and future trends to reduce engine-out emissions, improve performance and aftertreatment efficiency, and enhance control system capabilities will be discussed.

UPDATE ON DIESEL ENGINE WASTE HEAT RECOVERY UTILIZING ELECTRIC TURBOCOMPOUND TECHNOLOGY

Ulrich Hopmann
Caterpillar, Inc.

A cooperative program between the U.S. Department of Energy Office of Heavy Vehicle Technologies and Caterpillar is aimed at demonstrating electric turbocompound technology on a Class 8 truck engine. The goal is to demonstrate the level of fuel-efficiency improvement attainable with the electric turbocompound system. The system consists of a turbocharger with an incorporated electric motor/generator on the turbo shaft. The generator extracts the surplus power at the turbine and feeds it back to a crankshaft-mounted electrical motor. The electric turbocompound system also provides more control flexibility in that the amount of power extracted can be varied. This allows for control of engine boost and thus air/fuel ratio.

The paper presents the status of development of an electric turbocompound system for a Caterpillar heavy-duty, on-highway truck engine. Layout of the system architecture, the turbocharger design features, and the development of a system control strategy is shown. Furthermore, engine simulation results are presented, and development of electrical machinery is described.

THERMOELECTRIC TECHNOLOGY FOR AUTOMOTIVE APPLICATIONS

Aleksandr S. Kushch, John C. Bass, and Mark Hauerbach
Hi-Z Technology, Inc.

and

Richard A. Bergstrand, Lew Plummer, David Furrow, and Mike Melvin
PACCAR Technical Center

A thermoelectric generator (TEG) waste heat recovery system for Class 8 diesel trucks is under development by Hi-Z Technology and PACCAR. The TEG was assembled and tested at Hi-Z and integrated by PACCAR into the exhaust system of a Kenworth truck, which is equipped with a Caterpillar 550-hp diesel engine. The TEG is mounted on the truck frame under the cab. The shock absorption system developed by PACCAR reduces the mechanical impact of the harsh road environment. The inlet of the TEG is connected with the engine exhaust via an 80-inch insulated pipe. TEG cooling plenums are integrated into engine cooling system by means of flexible hoses. An additional heat exchanger is installed into the coolant line in order to reduce the coolant temperature. The test truck is equipped with the data acquisition system that allows recording of all the engine parameters (speed, load, rpm, temperatures, etc.)

A test truck with a TEG has already completed a test run that is equivalent of about 100,000 miles and is continuing. No TEG mechanical damage or internal resistance change has been recorded yet.

A self-powered cab/space heater needed to minimize cold weather truck idling has also been demonstrated by Hi-Z. The D1LC heater manufactured by Espar has been modified by integration of two HZ14 thermoelectric modules (TEM) and pin-type heat sinks. The heater uses diesel/gasoline as the fuel and uses about 22 W of electric power when operated at a high thermal output mode; it releases 2 kW of thermal energy. The TEM's were sandwiched between two flat sides of the heat exchanger and the heat sinks. The circulation blower conveys the ambient air through the heat sinks ensuring TEM cooling and drives the heated air into the cab.

The TEM's generated about 26 W of electricity, which is more than sufficient to make the unit self powered. The self-powered heater was assembled and tested with a DC/DC converter and a battery. During startup, a battery supplied power for the igniter, blowers, and pump. After 2 minutes, the TEM generated sufficient electric power and also recharged the battery.

A similar unit can be converted into a larger auxiliary power (APU) unit by adding more thermoelectric modules. Diesel-driven APU's can be used as an anti-idling device, saving considerable fuel and reducing pollutant emissions.

ATTAINING TIER 2 EMISSIONS THROUGH DIESEL ENGINE AND AFTERTREATMENT INTEGRATION –

STRATEGY AND EXPERIMENTAL RESULTS

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Detroit Diesel Corporation

The feasibility of diesel engines to meet the stringent emissions regulations of 2007 and beyond is an important consideration for light trucks and other personal transportation vehicles. Integrated engine and aftertreatment systems have been developed at Detroit Diesel Corporation for multiple engine and vehicle platforms. Tier 2 emissions technologies have been demonstrated with significant fuel economy advantage compared to the respective production gasoline engines while maintaining excellent drivability.

The performance and emission results were achieved by integrating advanced combustion strategies with prototype aftertreatment systems. The system development methodology included the integration of experimental and digital tools. Further, the experimental development approach included systematic testing on steady-state dynamometer, transient dynamometer and chassis dynamometer test beds.

CUMMINS/U.S. DEPARTMENT OF ENERGY LIGHT TRUCK DIESEL ENGINE PROGRESS REPORT

John Stang, David Koeberlein, and Michael Ruth
Cummins

Cummins has studied requirements of the light-truck automotive market in the United States and believes that its proposed V-family of engines meets those needs. Design and development of the V-family engine system continues. The engine system is a difficult one, since the combined requirements of a very fuel-efficient commercial diesel with the performance and sociability requirements of a gasoline engine are needed.

Results of testing have shown that the engine can meet requirements for fuel economy and emissions in the Tier 2 interim period from 2004 to 2008. Advanced results show that the full Tier 2 results for 2008 and beyond can be achieved on a laboratory basis.

Various results of ongoing system development are shown, including air-handling system, noise, overhead system dynamics, and overall vehicle performance. General aftertreatment system design direction is discussed.