

SAE 2014 Heavy-Duty Diesel Emissions Control Symposium

Technical Session Schedule

As of 09/23/2014 07:41 pm

Wednesday, September 17

Welcome/Keynote

Session Code: HDD100

Room Bankett High

Session Time: 08:45

Moderators - Andrew Walker, Johnson Matthey Inc.

Time	Paper No.	Title
8:45 a.m.	ORAL ONLY	Welcome/Opening by SAE and Symposium Organizers Archie T. Thomson, SAE International
9:00 a.m.	ORAL ONLY	Keynote Speaker - Emissions and environmental parameters for buses by systems approach Edward Jobson, Volvo Bus Services
9:30 a.m.	ORAL ONLY	Improving Air Quality in Gothenburg - From Bans of Dirty Vehicles to Behaviour Change - The Role and Possibilities of Local Authorities Anders Roth, Gothenburg City
10:00 a.m.		BREAK

Wednesday, September 17

Introduction / Legislation / Global Trends

Session Code: HDD200

Room Bankett High

Session Time: 10:30

Moderators - Andrew P. Walker, Johnson Matthey Inc.

Time	Paper No.	Title
10:30 a.m.	ORAL ONLY	Long Term Impact on Air Quality (ARB-2020 Initiative): California's Comprehensive Program for Reducing Heavy-Duty Diesel Emissions To meet its air quality commitments and climate goals, California must reduce NOx and greenhouse gas emissions from today's levels by an additional 90 percent between 2032 and 2050. Through a mix of regulations and financial incentives, California is implementing comprehensive strategies that include: consideration of new heavy-duty engine standards; in-use regulations that will both accelerate replacement of older vehicles and equipment, as well as better ensure their emission performance; and deployment of advanced technologies. At its core, meeting California's emission reduction targets will require widespread use of zero and near-zero emission technologies and low-carbon fuels. Erik White, California Air Resources Board

11:00 a.m. ORAL ONLY

Review of HD Regulations and Technology Implications

The most stringent requirements in both criteria and GHG regulations are emerging in the US. California is considering tightening HD NOx regulations by up to 90%, and the US EPA will be proposing the next round of GHG tightening in March. The NOx tightening would require significant cold-start and low-temperature deNOx technology, approaching 96% efficiency on the HD FTP cold-start cycle, and 99% on the hot-start cycle. The GHG tightening will likely be guided by the technology demonstrations of the US DOE SuperTruck program, incorporating engine technologies to deliver 50% peak brake thermal efficiency (BTE) and vehicle technologies to deliver an increase of 50% in freight fuel efficiency.

Other significant HD regulations are emerging in the developing countries. China will have 50 ppm sulfur diesel fuel nationwide in January and 10 ppm in 2018. Sales of new China III trucks will be prohibited from January, and Beijing will be adopting Beijing V standards at that time. DPFs will be needed in Beijing city bus and truck applications. In India, a major government advisory committee of oil, vehicle, and environmental representatives recommended Bharat IV fuel (50 ppm) be required nationwide by January 2017, with major regions being phased-in before then. Bharat V (10 ppm) was recommended for 2020 if resources are available for refinery modifications, but implementation should be no later than 2025. In China and India, SCR is being applied for long haul applications, and EGR plus partial filters is the leading approach for mid-size engines.

Other regulatory developments involve the next round of tightening for the European non-road mobile machinery, Stage V, as well as HD truck emissions tightening to Euro VI levels in Japan and later in Brazil, and various levels of GHG tightening regulations throughout the world.

Timothy Johnson, Corning Inc.

11:30 a.m. ORAL ONLY

Euro VI vs. Transport Sector, an Environmental and Climate Success or Not?

The environmental and health impact of individual vehicles/vessels are regulated through various legal acts by the European Commission. For energy efficiency or emissions of carbon dioxide, thus the climate impact the situation is different especially if all modes of transport is included. With the Euro VI regulations the shortcomings of previous emission stages, i.e. real driving emissions, seems to have been solved making road transport a clean choice of transport for the first time. The traditional green modes of transport like diesel rail and inland waterway vessels lag behind, both in stringency and real world emissions but are energy efficient.

Magnus Lindgren, Swedish Transport Agency

Wednesday, September 17

Non-Road Strategies and Future Developments

Session Code: HDD600

Room Bankett High

Session Time: 13:30

Moderators - Claus Dieter Vogt, NGK Europe GmbH

Time Paper No. Title

1:30 p.m.

ORAL ONLY

Off-Road Mobile Machinery Fuel Efficiency & A Total Systems Perspective

Increasing the work per unit of fuel burned of mobile non-road equipment has positive economic and environmental implications through reduced owning and operating costs and lower greenhouse gas emissions. To realize and drive these benefits the enormous diversity in the types and applications of non-road machines and the functions they perform must be considered. The optimization of fuel efficiency, productivity and cost while meeting emissions requirements for off-road equipment can be best achieved by taking a total systems perspective, considering applications, and appropriately tailoring technologies. This presentation will illustrate the benefits of systems optimization using a detailed example of a hybrid hydraulic excavator and examining the benefit of technologies at the component, engine, machine system, and worksite levels.

M. Lou Balmer-Millar, Caterpillar

2:00 p.m.

ORAL ONLY

The Next Liebherr Aftertreatment Solution: Towards Stage V?

The current Stage IV/Tier4f limits for engine emissions of construction machines is enforcing an even more stringent use of after treatment system as seen already during Stage IIIB/Tier4i emission limits introduction. Our Liebherr Machines Bulle proposal is a simple and cost effective approach with no EGR and SCR only (no DOC, no DPF). In addition to this standard Stage4/tier4f solution, this paper will then presented in details our technical solutions and results of a combined SCR on Filter systems currently in development for specific markets needs and preparing any further legislations steps.

Regis Vonarb, Liebherr Machines Bulle SA

2:30 p.m.

ORAL ONLY

Model Based SCR Control - Key to Meet Tier 4 Final with Lowest Calibration Effort

The AGCO Power Inc. located in Finland is as one of the most important suppliers for heavy duty diesel engines mainly used for agricultural and industrial applications. To overcome the challenges for Tier4f / Stage 4 emission regulations for their new engines a high sophisticated SCR control strategy was developed in a close cooperation with the engineering partner AVL.

To handle the wide range of applications (Tractors, Combines, Forest machines, ..) for the different customers (Challenger, Fendt, Massey Ferguson, Valtra, ..) for 8 main engine types (from 3 up to 12 cylinder engines) using two technology routes (EGR + SCR and SCR only) with a minimum calibration effort, a model based approach was used within the whole development phase. Different SCR technologies were analyzed and their behavior transferred into physical models in the AVL MoBEO development environment.

The same model parameters are also used for the real-time models in the ECU (Engine Control Unit), which are one of the core elements for the model based dosing control. Due to this model based approach the additional calibration work for the different EAS configurations is mainly handled by a change in the geometric parameters, as the catalyst properties remain the same.

To overcome production tolerances and aging effects for all relevant components of the SCR system smart adaptation functions were developed by AVL in close cooperation with AGCO Power. These algorithms are only based on the NOx sensors (upstream DOC and tailpipe) and the high sophisticated models of the EAS components, avoiding the deployment of an NH3 sensor.

The main task of these functions is optimized AdBlue dosing with the boundary of not crossing the legislative limits for NOx and NH3 tailpipe emissions and to achieve minimized AdBlue consumption.

Markus Iivonen, Juha Korhonen, Mikko Pesola, AGCO Power; Bernhard Breitegger, Armin Wabnig, Heimo Schreier, AVL LIST GmbH

3:00 p.m. ORAL ONLY DEUTZ Emission Control Solutions for a Diversity of Applications

The challenge for non-integrated diesel engine manufacturers such as DEUTZ is the high diversity of industrial applications. To comply with the current EU Stage IV / US Tier 4 final emission standards, meeting customer's expectations at the same time such as compact design, power density or fuel consumption results in different engine and exhaust aftertreatment configurations.

Furthermore, different customer load profiles and engine power ratings require the development of engine operating modes for thermal management. For specific applications the engine calibration needs to be adopted to ensure e.g passive DPF regeneration.

The presentation provides an overview of the modular technology concepts enabling optimised installation solutions and emphasises the control of the aftertreatment system for trouble-free machine operation.

Markus Müller, Deutz AG

3:30 p.m. BREAK

Wednesday, September 17

Emerging Markets

Session Code: HDD800

Room Bankett High

Session Time: 16:00

Moderators - Joseph E. Kubsh, Manufacturers of Emission Controls Assoc.

Time	Paper No.	Title
4:00 p.m.	ORAL ONLY	Indian Emissions Update <i>Jacob David Raj, Mahindra & Mahindra</i>
4:30 p.m.	ORAL ONLY	Challenge and Solution for Reduction of Emissions from Commercial Vehicle in Beijing <i>In order to reduce the emissions from low speed city bus, Beijing 4 and Beijing 5 heavy duty engine emission regulation have some additional points as Euro 4 and Euro 5 regulation. Cold start emissions and particulate number limit cause a new challenge for engine heat management and performance of aftertreatment system.</i> <i>As largest heavy duty engine manufacture, Weichai Power Co. Ltd. has developed special technical solutions to fulfill the requirement of Beijing market. The first Chinese EU 6 Diesel Engine equipped with DPF has borne by Weichai Power Co. Ltd..</i> <i>Gas engine play more and more role in China city bus market.</i> <i>Qin Li, Weichai Power Co.</i>

5:00 p.m.

ORAL ONLY

Introduction of the Bharat Stage 4 Emission Legislation in India

India is one of the most important emerging nations with the second largest populations in the world. The Indian government has recognized the importance to react to the increasing air pollution due to the fast growing transportation traffic. As a consequence, India has introduced Euro IV based emission norms for commercial vehicles in large cities in April 2010 and is expected to extend the legislation nationwide by 2017. In this presentation the challenges of introducing Euro IV suitable exhaust after treatment systems with SCR technology to the Indian market are addressed and possible solutions presented.

Georg Huethwohl, Albonair GmbH

Thursday, September 18

Welcome/Keynote

Session Code: HDD900

Room Bankett High

Session Time: 08:30

Moderators - Nitin Patel, Volvo Powertrain Corporation

Time

Paper No.

Title

8:30 a.m.

ORAL ONLY

Keynote: Exhaust Emissions and CO2 Regulations for Heavy Duty and Nonroad Engines – an Outlook beyond Euro VI and Stage IV

Global harmonization of emission limits and regulations is the basis for introducing efficient emission control technologies on a global scale with minor regional adaptations. Proportionality between emissions reductions on the test bench and under real world operating conditions, which is a key requirement for air quality control, is being checked with portable emissions measurement systems (PEMS). An emissions test procedure for heavy duty hybrids was recently adopted by GRPE. Since emissions from Euro VI and Stage IV/V engines are already close to zero, further emissions reductions will not significantly improve air quality. Regulations should rather focus on CO2 reductions taking the whole vehicle or machine into account.

Jürgen Stein, Daimler AG

Thursday, September 18

Alternative Fuel and Powertrains

Session Code: HDD500

Room Bankett High

Session Time: 09:00

Moderators - Nitin Patel, Volvo Powertrain Corporation

Time

Paper No.

Title

9:00 a.m.

ORAL ONLY

High Efficient Natural Gas Engine Technologies to Meet the New U.S. Greenhouse Gas Emissions for Commercial Vehicles

The world-wide commercial vehicle industry is faced with numerous challenges to reduce oil consumption and greenhouse gases, meet stringent emissions regulations, provide customer value, and improve safety. This work focuses on the new U.S. regulation of greenhouse gas (GHG) emissions from commercial vehicles and natural gas engines and the most likely technologies to meet future anticipated standards while improving transportation freight efficiency. Over 90% of all U.S. freight tonnage is transported by diesel power and over 75% is transported by trucks. Given the price differential between natural gas and diesel, an increasing number of vehicle fleets and individual owner-operators are transitioning to natural gas.

In the U.S., EPA and NHTSA have issued a joint proposed GHG rule that sets limits for CO₂ and other GHGs from pickup trucks and vans, vocational vehicles, semi-tractors, and heavy duty (HD) diesel and natural gas engines. The proposed rule requires pickup trucks and vans to comply with vehicle CO₂ limits based on chassis dynamometer testing of complete vehicles. For vocational vehicles, the focus is on emission of CO₂ from the engine as measured during the transient test (FTP) for criteria pollutants. Under the proposed rule, semi-tractors would be regulated for both vehicle and engine CO₂ emissions. The tractor emissions would be determined by a vehicle model using aerodynamic, rolling resistance, idling, and weight parameters as determined from component testing protocols. Tractor engine CO₂ emissions would be measured during the steady-state test (SET) for criteria pollutants.

This paper will discuss and compare different approaches to GHG regulation for commercial natural gas vehicles based on considerations of cost, complexity, real-world fidelity, and environmental benefit. In addition, the paper will describe Cummins approach to meeting anticipated GHG standards for vocational engines and semi-tractor engines with technologies including advanced aftertreatment, turbocompounding, waste heat recovery (Rankine) cycles and hybrid power trains. Innovation in component technology coupled with system integration is enabling Cummins to move forward with the development of high efficiency clean natural gas products with a long term goal of reaching 50% brake thermal efficiency for the engine plus aftertreatment system.

Donald Stanton, Cummins Inc.

9:30 a.m.

ORAL ONLY

CO₂ and Energy: Challenges of Future Heavy Duty Propulsion

Challenges of Future Heavy Duty Propulsion:

Some reflections on potential EU White paper consequence of CO₂ reduction and on EU fossil oil availability for EU HD transport toward 2050. Based on this perspective a discussion on HD diesel engine energy efficiency development path & CO₂ reduction challenge towards demanding future targets regarding: sustainable fuel, high efficient engine configuration, combustion process development, utilization of engine configuration /transmission, exhaust heat and brake energy recovery system, as well potential consequence of engine development on potentially changed applications spectra of future HD vehicles.

Staffan H. Lundgren, Volvo (HD)

10:00 a.m.

BREAK

Thursday, September 18

Engine Developments

Session Code: **HDD300**

Room Bankett High

Session Time: **10:30**

Moderators - Gudmund Smedler, Johnson Matthey AB

Time	Paper No.	Title
10:30 a.m.	ORAL ONLY	<p>Developments to Reduce CO2 Emissions from Heavy Duty Engines</p> <p><i>This presentation will cover recent developments in technology to reduce heavy duty engine CO2 emissions, focussing on measures to reduce engine friction, investigations with a high pressure common rail system, and the application of a highly efficient SCR system.</i></p> <p><i>Chris Such, Ricardo UK, Ltd.</i></p>
11:00 a.m.	ORAL ONLY	<p>The Journey from DI-Diesel via HCCI to Partially Pre-mixed Combustion with Very High Thermal Efficiency</p> <p><i>If the production of harmful emissions is prevented already during combustion then the expensive and space consuming Emissions After-Treatment System (EATS) can be removed. The reduction of CO2 emissions can anyway not be achieved with EATS, but requires increased engine efficiency or a fuel with reduced amount of fossil carbon.</i></p> <p><i>The research into Homogeneous Charge Compression Ignition (HCCI) created a completely new foundation for perspectives on clean and efficient engine combustion - fast combustion that improves thermodynamic efficiency - lean premixing for low temperature combustion that reduces emissions of NOx and soot. However, where HCCI is more of an idealized process, Partially Premixed Combustion (PPC) carries the legacy further into practical engines with increased controllability, very high load capability and efficiency as well as unrivaled fuel flexibility.</i></p> <p><i>The presentation discusses the evolution from DI-Diesel through HCCI to PPC. Insights to the coming PPC production engines are given as well as an outlook of how PPC paves the way for new well-to-wheel efficient and clean fuels.</i></p> <p><i>Martin Tunér, Lund University</i></p>
11:30 a.m.	ORAL ONLY	<p>Modeling and Simulation for the Development of the Next Generation of Aftertreatment Systems</p> <p><i>Evolution of diesel aftertreatment systems needs to target complex challenges such as CO2 / GHG reduction, in-use compliance, OBD, reduction of development, installation and operation costs, and integration of emerging technologies.</i></p> <p><i>Modeling and simulation tools help meeting these challenges through in-depth understanding of component performance and interactions, faster calibration process, improved robustness, and overall system optimization.</i></p> <p><i>The presentation discusses the model-based development process, beginning with modeling the system components, followed by integration with control algorithms into a system model, and then into a powertrain or vehicle model. Issues such as in-service conformity, NTE, and system robustness are addressed.</i></p> <p><i>Vadim Strots, Stephan Adelberg, Peter van Horrick, Benjamin Tilch, Lutz Kraemer, IAV GmbH</i></p>

12:00 p.m.

ORAL ONLY

Global Emission Strategy of the New Mercedes Benz Medium Duty Engines

Someday, the story of a well-proven engine concept inevitably comes to an end. In the mid-nineties, the 900 series replaced the legendary engines of the 300 class, which formed the backbone of the Mercedes-Benz medium duty powertrain since 1949. Fifteen years later, Daimler Trucks is now presenting the engines OM 934 and OM 936 of the new developed Medium Duty Engine Generation (MDEG) to replace this likewise successful 900 engine class.

The presentation illustrates selected highlights of the MDEG's thermodynamic concept as well as the technology of catalysis and exhaust gas filtration in consideration of the constraints of the EURO VI and the EU-Stage IV/Tier 4 final legislation.

Uwe Gaertner, P. Benz, M. Ernst, J. Lehmann, Frank Peter Zimmermann, Daimler AG

Thursday, September 18

Catalyst and Substrate Developments

Session Code: HDD400

Room Bankett High

Session Time: 13:30

Moderators - Joseph E. Kubsh, Manufacturers of Emission Controls Assoc.

Time	Paper No.	Title
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1:30 p.m.

ORAL ONLY

Cordierite and SiC Filters for On-Road and Off-Road Heavy Duty Applications

The presentation summarises the development status for this Cordierite and SiC Filters for on-road and off-road heavy duty applications. An outlook will be given on potential filter material options for future post EU VI and Tier V applications. Special focus is on particulate number emission results and pressure drop. For CSF, thin wall filter materials in various test cycles are investigated for filter design. Especially SCR catalysts on DPF require a good selection of the filter material to achieve both a sufficient coating and particulate number test results in on-road and off-road test cycles. The DPF material selection depends also pressure drop performance. To get best compromise between NOx performance and backpressure the coating and material has to be optimised and the mean pore size of the DPF adjusted. Further development work on material and coating optimisation is needed and still on going.

Takashi Aoki, NGK Insulators, Ltd.; Stefan Fischer, Yasuyuki Furuta, Kathrin Heil, NGK Europe GmbH; Tom Kondo, NGK Insulators, Ltd.; Adolf Schaefer-Sindlinger, Claus Dieter Vogt, NGK Europe GmbH; Kazuya Yuuki, NGK Insulators, Ltd.

2:00 p.m.

ORAL ONLY

Future Challenges and Incoming Solutions in the Global Catalyst-based Emission Control Area

Emission control legislation in the developed markets of Europe, North America and Japan has resulted in the reduction of millions of tonnes of potential emissions from Heavy Duty Diesel (HDD) vehicles, leading to major environmental benefits. In order to meet the regulations, sophisticated catalyst-based systems have been developed which typically reduce emissions of CO, HC, NOx and Particulate Matter (PM) by over 90%. These systems typically comprise a Diesel Oxidation Catalyst (DOC), Catalysed Soot Filter (CSF), Selective Catalytic Reduction (SCR) catalysts, and an Ammonia Slip Catalyst (ASC).

Despite the very high efficiencies of these systems, which are maintained for half a million miles and more, there is continued drive for further improvements to enable, for example, additional increases in fuel efficiency, which is a key driver in the HDD area, particularly in the on road sector. There are also proposals from California's ARB for an optional, much tighter, NOx standard on the 2020 timeframe. This presentation will outline the routes that may be taken to increase system NOx conversion efficiencies even further.

The current regulations in the non-road area can generally be met with simpler systems, mainly due to the higher legislated PM emission level and the absence of a specific Particle Number requirement. This presentation will discuss the differences between the on road and non-road legislation and outline the emission control systems that have resulted from these differences. Likely future systems in the non-road sector, particularly driven by the expected European Stage V regulations, will also be outlined.

Looking at the broader, global market, emission levels corresponding to EUIV are coming into force in China and India, and this paper will discuss the systems being used to meet the regulations in these markets. We will also look ahead to the kind of emission control architectures likely to be used in these markets as they move to EUV and then EUVI compliance.

Andrew P. Walker, Johnson Matthey Inc.

2:30 p.m.

ORAL ONLY

Future Aftertreatment Concepts for Heavy Duty Application

With Euro VI being in place, drivers for further development of exhaust aftertreatment systems will be primarily fuel efficiency, cost reduction and durability improvements. Performance enhancements of individual components are possible and ongoing. In order to cope with reduced exhaust temperatures new system approaches are favourable. Among these, SCR on filter concept is the most advanced. Open questions and challenges will be discussed and analyzed. This includes filtration efficiency, filter regeneration, NO2 performance as well as ash and soot effects. Also, the standard muffler layout has to be questioned.

Andreas Geisselmann, Umicore AG & Co. KG

3:00 p.m.

BREAK

Thursday, September 18

On Road Strategies and Future Developments

Session Code: HDD700

Room Bankett High

Session Time: 15:30

Moderators - Chris Such, Ricardo UK, Ltd.

Time

Paper No.

Title

- 3:30 p.m. ORAL ONLY** **How will the European LDD Industry Cope with Incoming RDE Regulations?**
Richard Dorenkamp, Volkswagen AG
- 4:00 p.m. ORAL ONLY** **A Bumpy Road Towards Euro6: How Scania did it and the Experience after 2 Years in the Field**
In 2008, Scania started to develop an exhaust aftertreatment system for Euro 6. For Euro 5, Scania had taken the decision to go for heavy EGR with a two-stage EGR cooling solution enabling Euro 5 without SCR. But for Euro 6, it was obvious that EGR alone would not be a successful technical strategy. In 2011, Scania, as the first OEM in the heavy truck industry, launched a ready-to-order truck fulfilling Euro 6 emission standards, featuring a combined EGR and SCR solution. Today, Scania deliver Euro6 trucks with SCR-only and believe that is the path to go in the future. In the presentation, Scania Euro6 development is described along with the strategy behind it and the first two years of field experience is shared.
Magnus Mackaldener, Scania AB
- 4:30 p.m. ORAL ONLY** **Potentials and Challenges for Next Generation HD Diesel Engines**
To meet Euro VI emissions requirements has been the central development focus for the current generation of HD diesel engines in the past. Today, after having achieved this challenging target reliably, the development focus changes. Facing significantly increased product cost as well as upcoming legal fuel efficiency respectively CO2 emissions targets, now improved fuel efficiency as well as the reduction of product cost are the main development targets of next generation HD diesel engines.

In this presentation AVL will highlight the potentials and challenges of advanced technologies for next generation HD diesel engines, like high advanced air handling, consequent engine downspeeding, advanced aftertreatment systems, waste heat recovery, etc...
Heimo Schreier, Lukas Walter, Marko Decker, Helmut Theissl, AVL LIST GmbH