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The 4th International Exhaust Emissions Symposium 22-23 May 2014, Bielsko-Biala, Poland

Trends in automotive emissions, fuels, lubricants, legislation and test methods – present and future

A brief overview from the perspective of the International Organising Committee
Dr. Piotr Bielaczyc, Joseph Woodburn

The 4th International Exhaust Emissions Symposium, organised by BOSMAL Automotive Research and Development Institute Ltd (hereafter BOSMAL) and the Polish Society of Combustion Engines (hereafter PTNSS, from its Polish acronym) took place on the 22nd and the 23rd of May, 2014. The symposium was the latest in a series of scientific meetings organised at BOSMAL over the past few years.

Introduction

Notwithstanding decades of improvement in the industry, concern over the impact of vehicles on air quality remains high. Emissions of greenhouse gases from road vehicles remain very high on the political agenda; emissions of particulate matter are coming under increasing scrutiny as a form of pollution with wide-ranging negative impacts; certain as-yet unregulated gaseous emissions are potential air quality risks. Looking to the longer term, the security of the oil supply and broader energy usage concerns have become very much part of the automotive development landscape. Concern over gaseous and solid pollutants – perhaps most infamously CO_2 – has become a concern for all major global markets, not just the United States and European Union.

The response to this has been the introduction of various pieces of legislation, some imposing increasingly strict emissions limits; others various mandates, incentives and quotas regarding fuel consumption and the types of fuels used. Now, following revelations that emissions from real vehicle usage are generally poorly reproduced in the laboratory, test methods themselves are changing: first in the laboratory (e.g. the WLTP/C; USA CFR 1065/1066 procedures); furthermore, real driving emissions have increased in importance to the point where RDE/PEMS measurements will soon be a legal requirement. Randomised laboratory test cycles also remain a possibility, although probably only for particle number measurements. The introduction of particle number limits and increased scrutiny of particulate emissions from engine types other than Diesel represents a somewhat new and challenging direction in emissions testing and control. These factors exert massive pressure on vehicle and engine manufacturers (both light duty and heavy duty), their suppliers and the oil and fuel industries. Other, allied fields such as R&D and fuel additive and lubricant

suppliers also find themselves subject to the same forces. Many of the aforementioned problems are shared by the various stands of the industry – passenger car and light commercial vehicle/heavy duty/off road/marine – and many of the proposed strategies and technical solutions have multi-segment applicability.

However, the market is dictated not only by political and technical factors, but also by consumer demands, which are themselves also evolving. Something both legislators and the general public have in common is the goal of reducing fuel consumption, without any sacrifices in terms of durability or safety. Responding to this pressure, a broad range of advanced engine technologies, catalytic aftertreatment systems, revised fuel types, bespoke lubricants and friction inhibitors, etc have been introduced. These strategies are often interrelated: low sulphur fuel is required for aftertreatment system compatibility; advanced engine design has impacts on required lubricant properties, etc. Fundamental changes to the propulsion strategy for on-road vehicles (e.g. fuel types/the implementation of advanced electromechanical systems - hybrids) represent a revolution in the industry. All these advanced technologies must be developed, tested, approved and certified. In the case of hybrid powertrains, accurately quantifying the real world CO_2 emissions benefit is of particular importance.

Mindful of the above, and with a proven track record of organising scientific meetings [1-11], BOSMAL was pleased to announce its 4th International Exhaust Emissions Symposium, which took the following title: 'Trends in automotive emissions, fuels, lubricants, legislation and test methods – present and future'. In general, the event built upon the successes of the past, and included the very latest developments in the aforementioned fields and their implications for the various branches of the industry. Through the formation of business and personal relationships – and the potential for information sharing and collaboration that results – the various branches of the industry can advance together towards their goals. It is for these reasons that BOSMAL decided to organise another event of this type.

The 4th International Exhaust Emissions Symposium: background, aims and structure

This fourth symposium was hosted as a direct result of the multi-dimensional successes of the previous emissions-related events hosted at BOSMAL [1-11]. Furthermore, this event was organised within a project with European Union Regional Development Fund funding to establish a Centre of Automotive Competence at BOSMAL. This project is within the framework of the Regional Operation Programme for the [Polish] Silesian Voivodeship for the years 2007-2013. The purpose of this centre of competence is to offer innovative, commercial R&D services in the area of automotive powertrain development, specifically: engines, their components and systems, materials and consumables. This investment will facilitate the transfer of technology and innovation for the good of the regional economy. In terms of action of the ground, this project has lead to the construction of new test facilities at BOSMAL: a heavy duty engine test stand (maximum power 520 kW) for testing conventional engines and hybrid powertrains under static and dynamic conditions, together with full exhaust emissions measurement equipment; a dynamic powertrain test stand with equipment for recording and analysing vibration; a scanning electron microscope (SEM) installation capable of working at low vacuum pressure, equipped with EDS and WDS modules; a fluorescent X-ray spectrometer with wavelength dispersion – WDXRF, for the analysis of advanced powertrain construction materials.

The aim of the symposium, was to repeat the successes of the past, by bringing together experts and specialists in a professional yet informal atmosphere, so that they might exchange information and learn from one another. Given the importance of human contact in scientific collaboration and business relationships, a social programme was integrated into the two-day event, providing ample networking opportunities.

With the assistance of PTNSS and the various patrons and sponsors of the event, steps were taken to begin to arrange the event and invite both speakers and attendees. Following preliminary negotiations dating as far back as summer 2012, the organising committee received an excellent response from invited speakers, including high-level representatives of international organisations (see the programme for details of all speakers).

Submissions to the conference were divided into three categories: keynote addresses (for which more time was allocated), presentations (delivered to the plenary audience in timeslots from 10-30 minutes) and written only entries (a presentation, in many cases accompanied by a poster). Entries from all three of these categories were accompanied by short written abstracts, which both aided the organisation of the event and add to the archive value of the proceedings.

The event was held over two days, divided into five thematically themed sessions, four of which featured keynote addresses. The first session, entitled 'Introduction, Context & Agenda' contained two keynotes: Peter Mock/Vicente Franco (The International Council on Clean Transportation – Europe, Germany), Professor Flemming Cassee (Royal Dutch Institute for Public Health and the Environment, the Netherlands); 'Automotive Emissions & Emissions Legislation', with featured one keynote address: Alessandro Marotta (European Commission Joint Research Centre – Ispra, Italy); 'Emissions Reduction Methods and Aftertreatment System Development for Light and Heavy Duty Applications', which featured a keynote from Dr. Timothy V. Johnson (Corning Incorporated, USA); 'Nanoparticle Emissions from Internal Combustion Engines', which consisted only of presentations; and finally 'Fuel and Lubricant Development' which featured one keynote speaker: Dr. Thomas Wallner (Argonne National Laboratory, USA).

The keynote speakers were specially selected and allocated further speaking time in order to allow the speaker to explore a topic in depth, briefing attendees on a topic deemed to be of wide-ranging interest to the industry and of great relevance to the overall topic of the event.

The remaining presentations served to provide details, highlights and insights from industry and academia, thereby rounding out the sessions and providing a range of perspectives on each of the topics mentioned in the session titles. The written only entries were in many cases accompanied by posters, which were prominently displayed in the area where delegates spent the coffee breaks. Together, the three submission types (keynote, presentation, written only) make up the proceedings of the event.

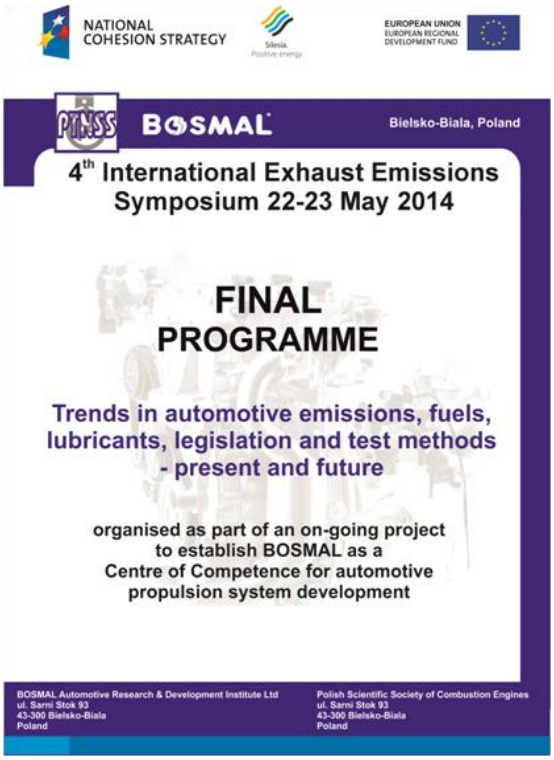
The event itself

The event commenced on the morning of the 22nd of May, in BOSMAL's conference room (following registration of delegates). A number of delegates had participated in BOSMAL's scientific meetings before, but there were a number of new faces, including those who were visiting Poland for the first time. Around 120 delegates attended, representing 55 firms from 16 countries and 3 continents. Organisations participating in the event included firms from the automotive and fuel industries, governmental agencies, consultancies and engineering service providers, non-profit organisations, technical

universities and the European Commission. The sessions of the first day were punctuated with coffee breaks (which also served as the poster presentation sessions and networking time) and lunch. The breaks also allowed attendees to inspect BOSMAL's recently-upgraded exhaust emissions laboratories, as well as engine test stands. The end of the first day – the evening of the 22nd of May – saw delegates attend the Symposium Dinner & Musical Soirée, hosted at a specially selected location close to Bielsko-Biala. As before, this evening event formed an important part of the symposium and proved a great success with friends old and new.

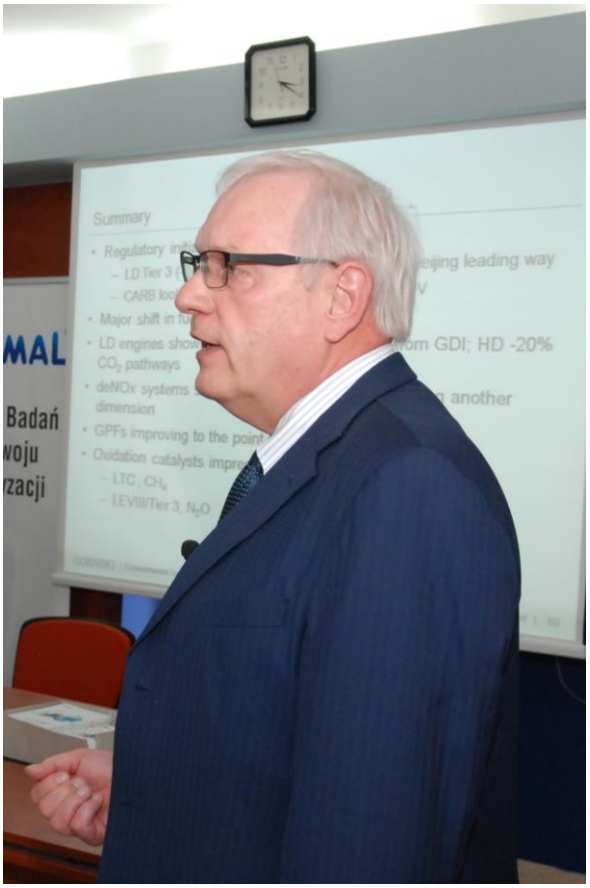
Dr. Piotr Bielaczyc (BOSMAL), chairman of the International Organising Committee greeting delegates during registration

The final programme, which lists all keynotes, presentations and written only entries, together with listings of all authors and their affiliations, can be found in the proceedings. A full list of firms and organisations in attendance at the symposium is also presented.

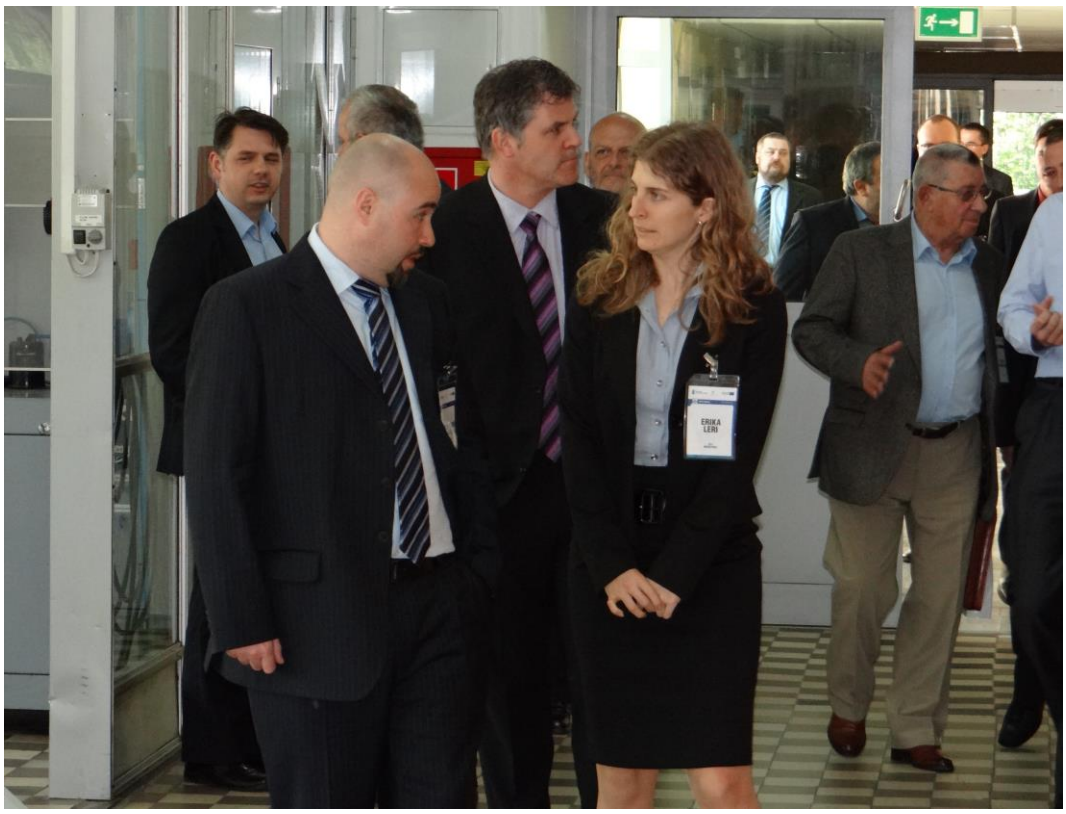


Dr Timothy Johnson (Corning, USA) participating in a discussion following one of the presentations

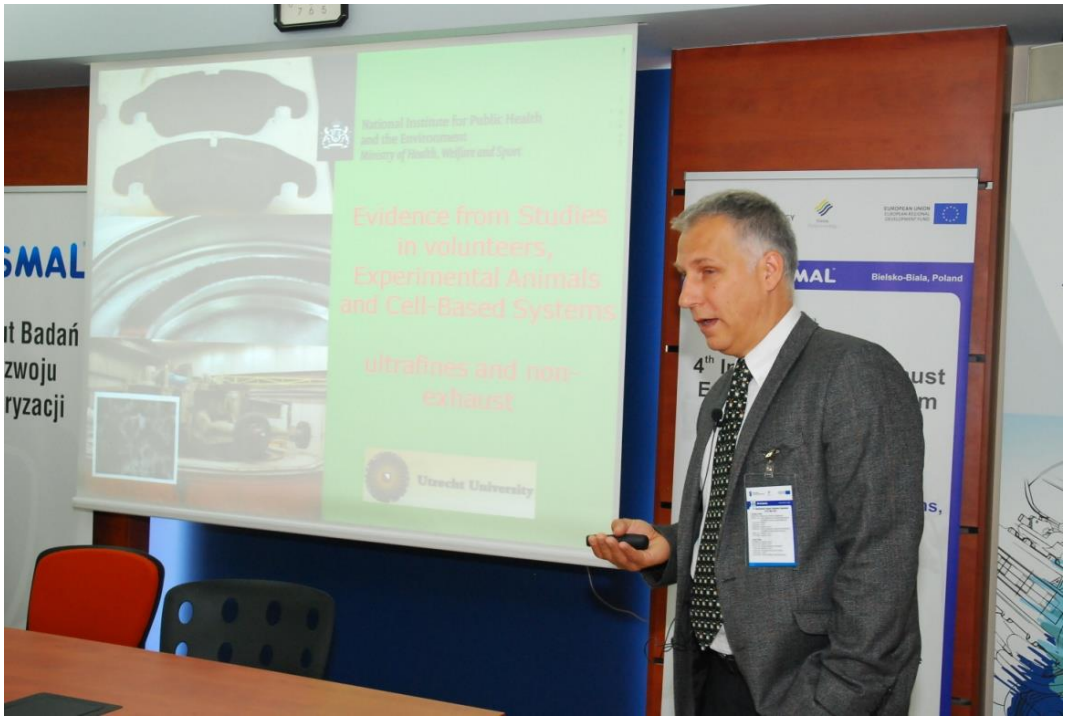
Vicente Franco (The International Council on Clean Transportation Europe, Germany), one of the keynote speakers, addressing delegates during the first day of the symposium



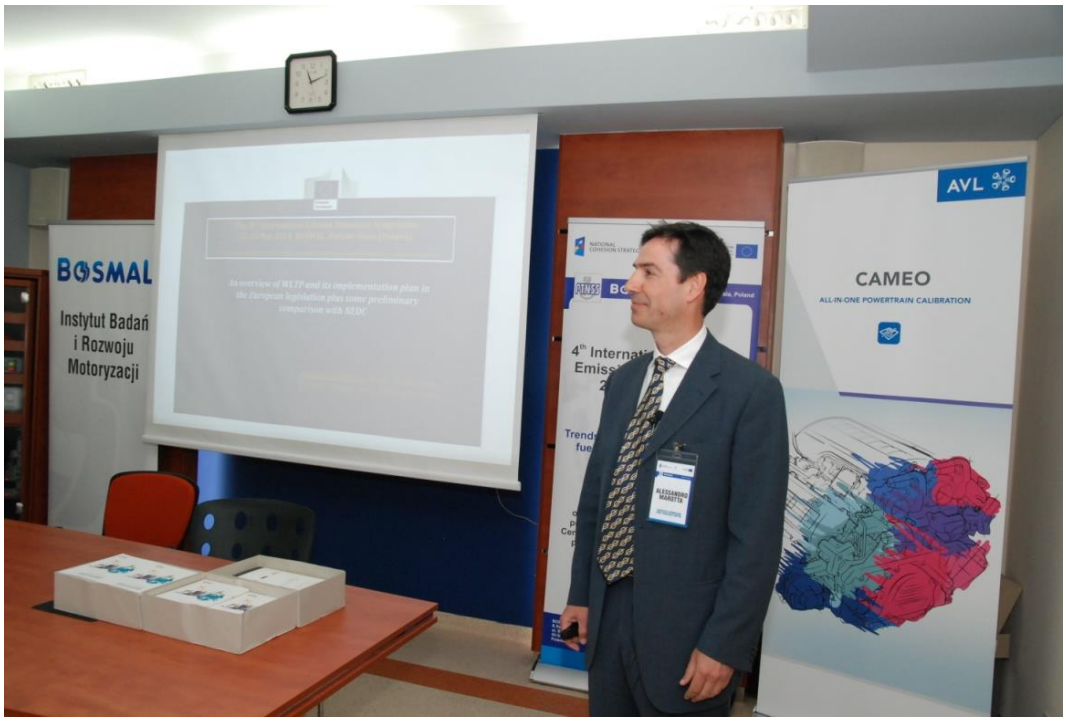
Dr. Timothy V. Johnson (Corning Incorporated, USA) one of the keynote speakers, addressing delegates during the first day of the symposium



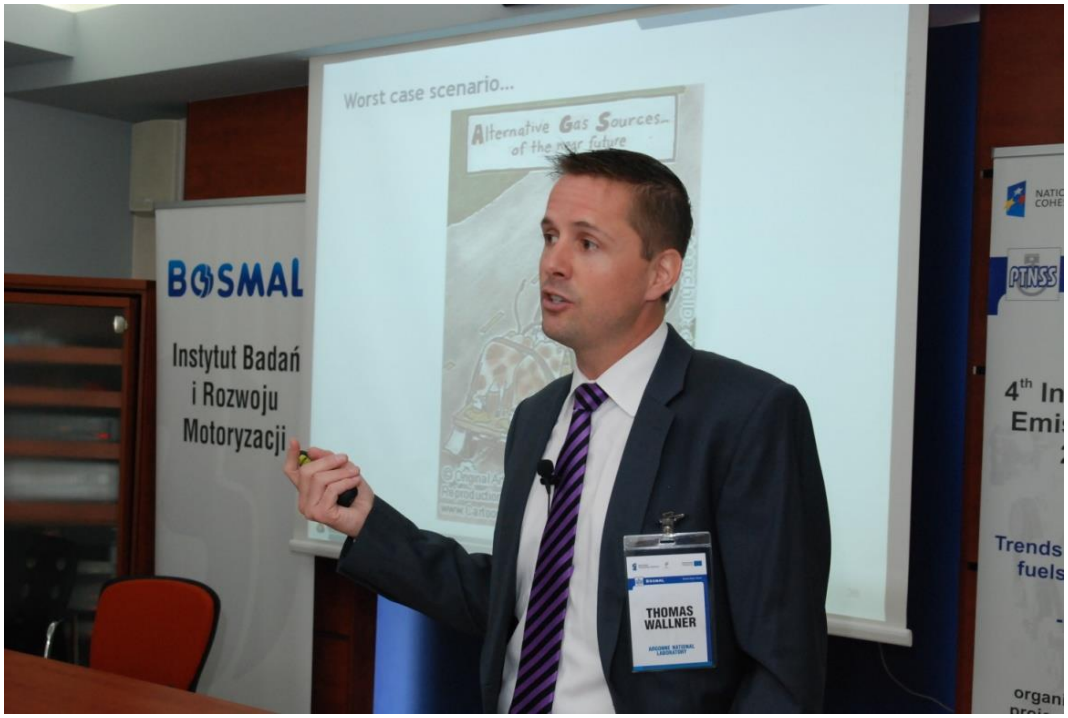
A scene from one of the coffee breaks



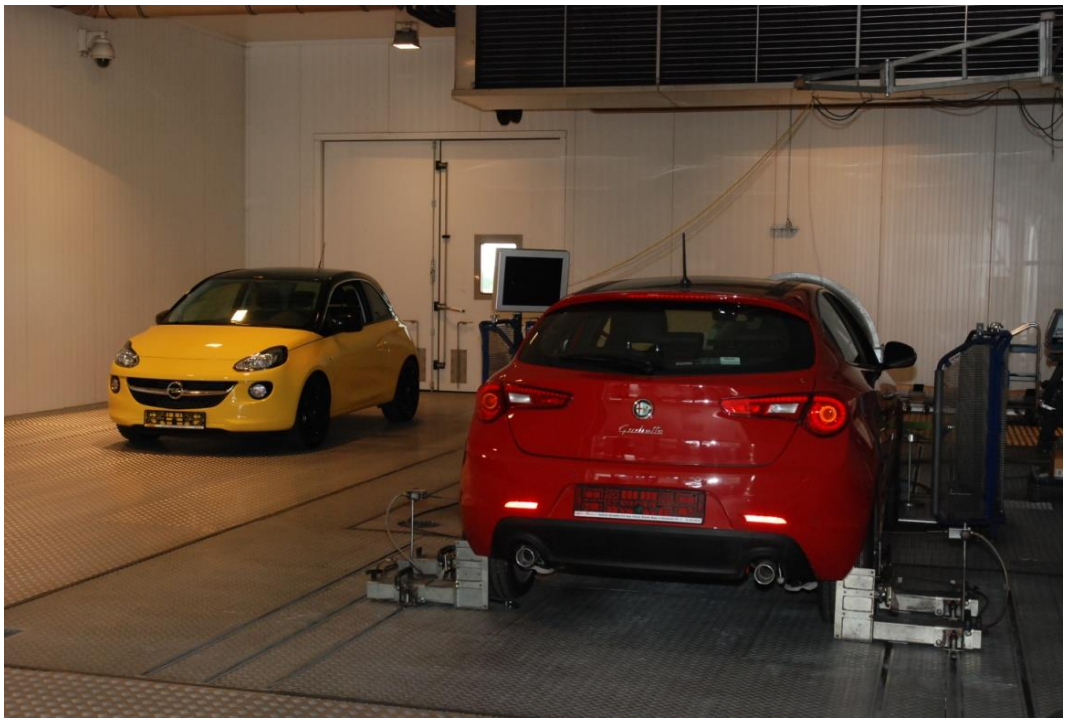
Professor Flemming Cassee (Royal Dutch Institute for Public Health and the Environment - RIVM, the Netherlands) delivering his keynote address on the adverse health effects of traffic-derived emissions



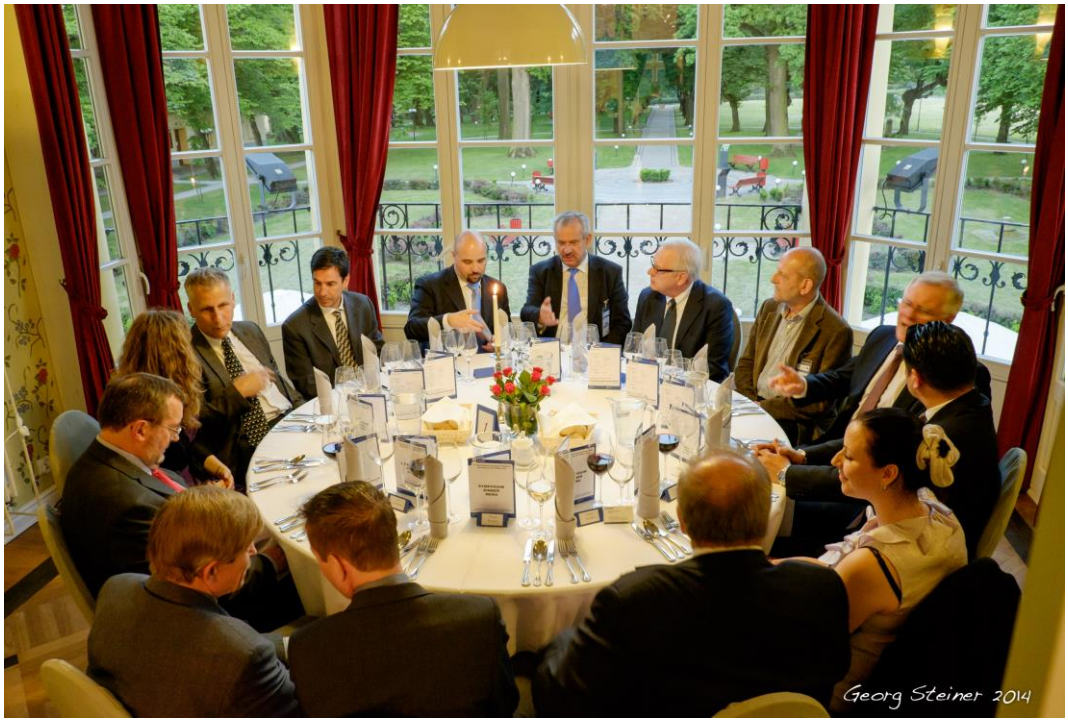
Alessandro Marotta (European Commission – Joint Research Centre, Italy) delivering his keynote address of the development of the WLTP (GTR 15)



Dr Thomas Wallner (Argonne National Laboratory, USA) delivering his keynote on the development of engine fuels



A view of the exhaust emissions laboratory at BOSMAL



A scene from the Symposium Dinner & Musical Soiree (Photograph by Georg Steiner)

Professor Jerzy Merkisz (Poznan University of Technology/PTNSS/BOSMAL, Poland) delivering his summary presentation to close the event

The second day continued where the first day had left off, but the topic moved from 'traditional' engine hardware to what can now also be considered to be types of engine component: fuels and lubricants. Following that session, Professor Jerzy Merkisz (Poznan University of Technology/PTNSS/BOSMAL, Poland) closed the event by delivering a summary and adding some fascinating notes from his own research on real-world emissions (a topic which had surfaced many times during the preceding sessions). This interesting presentation has also been archived in the symposium proceedings.

Finally, guided tours of BOSMAL's test facilities were conducted, so that delegates might see all of BOSMAL's test facilities and departments (which extend well beyond engine/emissions research, as mentioned in the earlier paragraph on the Centre of Automotive Propulsion Competence).

Some brief comments on the technical message of the symposium

Overall, it could be said that four topics dominated the technical content of the symposium, namely: nanoparticle emissions from combustion engines; the WLTP; real driving emissions; and fuels and lubricants as powertrain components. (This list could be extended to include several other important topics, but for the time being will be limited to these four.) The aforementioned topics surfaced in multiple keynote addresses presentations and written only entries, sometimes concurrently. Brief technical overviews of each of these topics follow:

· *As a combustion-propelled mechanical system with many moving parts, of mass of order 10^3-10^4 kg, moving over suboptimal terrain at speeds of up to around 40-50 meters per second, particulate emissions from vehicles are an inevitability – and not only from the engine. The issue of nanoparticle emissions from internal combustion engines has evolved greatly over the years – both in terms of the emissions levels (which have now been reduced by orders of magnitude in many cases) and the scope of interest (no longer limited to Diesel engines). Concurrently, new test methods*

have been devised and a large body of toxicological evidence has been accumulated on the impact of such emissions. Legislation has evolved significantly in response to changes in technology and scientific information on the adverse effects of particulate; direct injection petrol engines are now a the focus of upcoming changes in European legislation.

- *The term 'WLTP' has been in use for some years, but very recent developments and formalisations in the development of this programme mean that this in fact no longer exists. GTR 15: Global Technical Regulation No. 15 has come into being and so 'GTR 15' is now a more appropriate term for developments and planned implementations in this area. The main planned target is regarding CO_2 emissions and fuel consumption, since for at the Euro 6 level emissions limits for regulated pollutants are not cycle-specific.*

- *The term real driving emissions (RDE) has been deployed to refer to efforts to reduce the disconnect between laboratory testing (and results) and real world scenarios. A considerable body of evidence attest to the fact that laboratory test procedures, particularly type approval, represent a best case scenario and that a range of emissions (including, perhaps most controversially, CO_2/fuel consumption) are considerably higher in real life than according to the results of laboratory tests. Equipment is now available to measure emission in the field and this will soon be a legal requirement in the EU. However, much remains to be done to characterize the correlation between real world emissions and laboratory emissions. Additionally, despite recent changes in the legislation, many details remain at least somewhat uncertain regarding RDE and RDE testing.*

- *Since fuel and lubricants are of vital importance – to the point where they can be considered to be powertrain components – R&D work on fuels and lubricants has become arguably as important as research on engine hardware, etc. As well as technical and engineering requirements, there is strong pressure to switch to fuels which are cleaner and more sustainable in terms of life-cycle emissions. The most obvious candidates in this area are natural gas and biofuels - one of the main trends for both petrol and Diesel is an increasing proportion of biofuels blended into the mix in many jurisdictions – ethanol in the case of petrol and FAME in the case of Diesel, although other options exist: Obviously, the function to be played by lubricants is that of reducing friction and engine damage, with additional obligations in terms of heat transfer and the removal of deposits in some cases. All three of these roles can have an influence on fuel consumption. There is a delicate balance to maintain regarding keeping friction low while maintaining long-term durability and engine performance. Finally, lubricants must also be compatible with the vehicle's aftertreatment system.*

N.B.: Addy Majewski of Dieselnet (Canada), who attended the symposium, has published a technical summary, available at the following location: https://www.dieselnet.com/news/2014/05bosmal.php.

The Polish journal *Przegląd Techniczny* is publishing a short summary in Polish (issue 13/2014).

Closing comments; archiving of Symposium Proceedings

The 4th International Exhaust Emissions Symposium was a great success, echoing previous events [1-11], but developing the concept to an even higher level. The International Organising Committee expresses its thanks to all those who were involved, from organisers and sponsors to speakers, attendees and those working behind the scenes with logistics. The International Organising Committee extends its thanks to Dieselnet for making its technical summary open access.

All presentations delivered during the symposium, together with their abstracts, have been archived in the following publication: 'Symposium Proceedings – Trends in automotive emissions, fuels, lubricants and test methods – present and future', ISBN: 978-83-931383-7-1, published by BOSMAL on CDROM. Film reportage is also presented on a DVD. Both of these discs will be included as attachments to the next issue of PTNSS' scientific journal Combustion Engines (3/2014).

Further information

A deeper analysis of the technical message of the symposium will be published in due course. Dieselnet's summary is already available at the aforementioned URL; Przegląd Techniczny's summary in Polish is in press. For further information on this 4th symposium and previous events of this type hosted at BOSMAL, contact the chairman of the International Organising Committee, Dr. Piotr Bielaczyc (piotr.bielaczyc@bosmal.com.pl). For information on PTNSS and its activities, see http://www.ptnss.pl/english.htm. For further information on any of the topics addressed in submissions to the symposium, contact the author/s of the presentation in question.

References – summaries and proceedings of previous events of this type hosted at BOSMAL

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