Online Conference

11th VERT Forum

Technologies and Policies towards Zero-Impact Combustion Engines

March 25th 2021






About the VERT Forum

The annual VERT Forum this years as e-conference is a one-day conference in cooperation with EMPA, the Swiss Federal Laboratories for Materials Science and Technology.

VERT and EMPA. Scientists and practitioners discuss the latest trends of Best Available Technology to minimize health- and climate-impact of combustion engine exhaust.

Cordially invited are members of

- environmental and municipal traffic authorities'
- manufacturers, owners, and operators of buses, HD and LD commercial vehicles, construction machinery
- manufacturers, owners, and operators of vessels, locomotives and airplanes
- public transport, harbor and airport management
- regulatory authorities and research institutes
- manufacturers of emission control technologies
- manufacturers of emission measurement equipment. The new format of the conference will leave lots of opportunities for discussions, questions,

Registration

Registration via email to kaethi.frenkel@bluewin.ch.
There is no participation fee
The conference will start at 9.00 and last until 18.00 including breaks, panel discussions , Q&A sessions with the speakers.
The final program will be distributed beginning 2021.

E-Conference venue

The conference will be together with EMPA on a professional and experienced e-conference platform including service and hotline for any technical problem
For registered participants exist the opportunity to view most of the presentations online and get the opportunity to contact speakers and participants

Exhibition

For any online exhibition on the VERT 2021 e-conferences please contact volker.hensel@aurigna.com.

Year by year about 120 experts attend the VERT Participants come from all over the world, e. g., USA, UK, China, Israel, India, Iran, South Korea and China. Talks focus on

- best practice cases in cities and regions from all over the world on retrofit projects, e. g., for buses, construction machinery, heavy-duty and light-duty commercial vehicles, locomotives and vessels
- research projects and the latest scientific findings new regulations
- organizational approaches like low emission zones
- emission monitoring projects and technologies

Please find presentations of former conferences and a video about the last event at www.vert-dpf.eu in the events section. Talks will also be published there after the conference.

VERT Forum e-conference program (9.00 - 18.00)

09:00 - 10:30 am

Welcome

N. Heeb, Empa
L.C. Larsen, VERT

KEYNOTE LECTURE

- Synthetic renewable fuels – future contributions to and consequences for the global energy system
  K. Boulouchos, LAV-ETHZ

RESEARCH AND DEVELOPMENT

- New fuels, new risks – the chemistry and toxicity of synthetic fuels
  N. Heeb, Empa
- New evidence of soot particles affecting past and future clouds and climate
  Z.A. Kanji, ETHZ
- Sub-23 nm particles – do we need to consider them?
  H. Burtscher, FHNW
- Virus Filtration – VERT research and application proposals
  A. Mayer, VERT Association

10:30 - 11:00 am

Q&A session break (chat with the speakers)
(incl. PN-PTI demonstration video)

11:00 - 12:45 am

NEW deNOx- AND FILTER APPLICATIONS

- Robust aftertreatment systems for large engines and marine applications
  H. Noack, UMICORE
- Emission aftertreatment by BAUMOT for future diesel engines operated with CO2-neutral syn-fuels
  S. Beinkämpen, BAUMOT
  Th. Heinze, HTW Saar

HIGH EMITTERS AND PN REDUCTION IN NON-ROAD MACHINERY

- Particle number measurements within periodic technical inspections: A first quantitative assessment of the influence of size distributions and the fleet emission reduction
  M. Schriefl, AVL
- High emitters dominate PN emissions of petrol LDV fleets – an urgent problem
  C. Dominguez, Mexico
- Emission technology of non-road mobile machinery in the EU and other markets
  F. Jaussi, LIEBHERR
- Handheld Machines Network HaMaSNet - contributions to the occupational health protection
  J. Czerwinski, AFHB/VERT
- ATS system for low temperature aftertreatment performance in HD applications
  B. Kahlert, J. Oesterle, PURITECH

12:45 - 13:45 pm

Q&A session break (chat with the speakers)
(incl. So that the air is good for breathing - documentary of particle filter technology)

13:45 – 15:00 pm

NEW LEGISLATION AND TECHNICAL INSPECTION

- Regulatory limits for ocean vessels
  C.G. Torres, BUNKER
- First global regulatory limits for aircraft engine particle mass and number emissions
  T. Rindlisbacher, BAZL
- The pros and cons of SCR & DPF retrofit in German low emission zones
  *V. Schlickum, UVK Ber*lin
- vehicle upgrade solutions for clean air in emission hot spots
  H. Borgmeier, HJS
- Introduction in the Netherlands of the PTI particle number test at low idle in 2021 to check DPFs
  L. Zuidgeest, Ministry NL

15:00 - 15:30 pm

Q&A session break (chat with the speakers)
(incl. video and statements from VERT Focus Event March 2018 about the NPTI project)

15:30 - 17:00 pm

- Low emissions of modern diesel vehicles
  J. Demuynck, AECC
- EU towards Post-Euro VI/6
  A. Dimaratos, Aristotle University Thessaloniki
- Requirements for post EU VI/6 emission – the DUH-perspective
  A. Friedrich, DUH

VERT PROJECTS IN EMERGING MARKETS

- CALAC+ in Latin America and the Nanoparticle Conference in Mexico City
  B. Lang, Swisscontact
- DPF Retrofit for HDV in low emission zones, for construction and railway in Israel
  A. Zalzberg, SVIVA
- VERT-research projects and worldwide market support for air quality
  V. Hensel, VERT

17:00 - 18:00 pm

- Panel Discussion
- Closing remarks and summary
  L.C. Larsen, VERT

VERT Forum e-conference program abstracts

L. Larsen
VERT President

Dear VERT Members and others it may concern.

Over the past decade the international VERT Association has consciously worked to increase awareness of verified emission reduction technologies with specific emphasis on best available technology for particulate filtration and NOx abatement for diesel engine applications. It is now widely accepted that particle emissions in all sizes do not apply for diesel engines alone but for combustion engines in general. VERT are therefore active in development projects highlighting problems and various solutions from small handheld equipment to large stationary & marine applications. VERT have successfully contributed to the introduction of a New Periodic Testing Inspection (NPTI) system to ensure that products and technologies are not only function efficiently during test & validation, but also during normal operation over time. NPTI has not just been developing a scheme checking In-Use compliance, but a validated system to ensure correct testing procedures, protocols and precise operational measuring equipment. This journey of traditional diesel retrofit will continue in close conjunction with other emissions related areas that can exploit the benefits of VERT`s exceptional experience.

K. Boulouchos
ETHZ , Switzerland

Synthetic renewable fuels – future contributions to and consequences for the global energy system

The de-carbonization of the Global Energy System within a few decades is indispensable in order to keep global warming at maximum 2 degrees Celsius. Renewable primary energy will be a key element of the energy carriers portfolio through both direct (battery electric vehicles) and indirect electrification based on hydrogen and synthetic hydrocarbons. We foresee that renewable fuels will in the long term dominate the sectors of long-haul transport, industry and seasonal storage (power-topower). Such fuels can be produced by bioenergy (to a limited extent) and mainly through solar-thermochemical processes or electrolysis from solar and wind energy. For conversion to propulsion energy electro-and thermochemical (combustion) technologies will compete, most probably with varying outcome depending on the application. Specifically for combustion engines potentials for further minimization of pollutants are promising as the fuel structure can be designed “freely”. Research on new combustion modes and exhaust after-treatment methods will be, however, necessary for near “zero”- environmental impacts.

N. Heeb EMPA,
Switzerland

New fuels, new risks – the chemistry and toxicity of synthetic fuels

Atmospheric CO2 levels rise faster than ever, up to 2 ppm or 16 Gt per year. Thus, low- or no-carbon fuels, or synthetic fuels produced from CO2 are the only way to further use our large fleets of combustion engines in a sustainable way. But new fuels bring new risks. The chemistry of alternative fuels and fossil fuels can differ considerably. This requires adaptions of the engine and the converter technology. Oxygenated fuels might decompose to genotoxic and reactive carbonyl compounds like formaldehyde, affecting the overall toxicity of exhausts and their impact on men and the environment. Such risks should be assessed in advance.

New evidence of soot particles affecting past and future clouds and climate

Aerosol catalyzed formation of cloud droplets and ice crystals in the atmosphere is of crucial importance to Earth’s climate. Yet, these processes remain insufficiently understood. In particular, the contribution of anthropogenic aerosol particles such as soot for cloud formation and climate is largely unconstrained. During their atmospheric lifetime, soot particles undergo atmospheric aging processes, altering their cloud forming potential. Using global climate model simulations that encompass new laboratory findings of ozone-aged soot acting as cloud condensation nuclei and aqueous sulfuric acid-aged soot as ice nucleating particles reveal on the one hand a reduction in the shortwave cooling by anthropogenic aerosols, and on the other, an increased warming in response to a doubling of carbon dioxide.

Z.A.Kanji
ETHZ , Switzerland

Sub-23 nm particles – do we need to consider them?

The present number concentration limit with its 23 nm cutoff has been established in the framework of the PMP program for diesel powered vehicles and later extended to Gasoline Direct Injection (GDI) vehicles. Cutoff and the limitation to solid particles have been introduced to allow a stable and reliable measurement. The main goal was to enforce particle filters. In this sense this was very successful. Meanwhile most diesel-powered vehicles have very efficient particle filters. As most of the solid particles, emitted by diesel engines are larger anyways, the cutoff at 23 nm was not very problematic. However, GDI- as well as PFI engines and also CNG fueled engines emit much smaller particles. The size distribution peaks in the range of 10-60 nm. Usually, 20-50 % of total GDI particles are below 23nm, and these are not considered by the current regulation. This led to the discussion, if the 23 nm threshold should be decreased to 10 nm. In the framework of the HORIZON 2020 project ‘SUREAL 23’ this has been investigated. Results will be discussed.

H. Burtscher
FHNW , Switzerland

Robust aftertreatment systems for large engines and marine applications

Emission limits for diesel engines in the on-road sector have been tightened greatly since the 1990s. Hence, their relevance for harmful emissions could be significantly reduced using catalysts and filters. As a consequence the introduction of stricter emission limits also for Non Road Mobile Machinery has been pursuing globally during the last decade. Based on previsions, the number of NRMM is expected to see a constant long term growth. While land based applications in North America and Europe below 560 kW make use of well proven aftertreatment concepts from the automotive industry and can rely on the availability of ultra-low sulfur diesel fuels, the requirements and boundaries for Large Engines above 560 kW are somewhat different, in particular in the marine sector. In this presentation general challenges and potentials of aftertreatment systems in the Large Engine segment will be discussed. While focusing on the various system functions that are required under the relevant operation conditions, other aspects such as fuel type, fuel quality and pressure drop are also highlighted.

H.Noack
UMICORE, Germany

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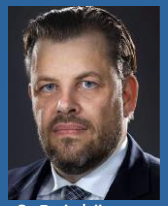


S. Beinkämpen
BAUMOT
Germany

Emission aftertreatment by BAUMOT for future Diesel engines operated with CO2-neutral syn-fuels

With the introduction of the EURO 6 targets and the conversion of the NEDC test cycle to the WLTP test cycle, the emission requirements were tightened to such an extent that technical measures in exhaust gas aftertreatment became necessary to achieve the targets. Nitrogen oxide emissions in diesel vehicles in particular are significantly reduced by SCR technology (Selective Catalytic Reduction) of the chemical reaction of ammonia, obtained from urea, with nitrogen oxides. Synthetic fuels could have a positive effect on emission reductions. Synthetic fuels are initially characterized by the substitution of crude oil with gas, coal or biomass. A special type of fuel among synthetic fuels is the eFuel, which uses a power-to-liquid synthesis process to replace crude oil with regenerative energy and CO2 from the atmosphere. In this case, the eFuel burns in the internal combustion engine mathematically climate-neutral.

Mario Schriefl
AVL

Particle number measurements within periodic technical inspections: A first quantitative assessment of the influence of size distributions and the fleet emission reduction

The enforcement of more stringent type approval emission standards de facto mandate manufacturers to equip vehicles with particle filters, which reduces the particle number concentration in automotive emissions to levels below typical ambient concentrations. Soon, the overall automotive particle emissions will be dominated by highly emitting vehicles with malfunctioned after-treatment systems, making tests of in-service compliance with emission standards inevitable. These tests are especially relevant for diesel-powered vehicles because broken diesel particle filters can increase the particle emissions by several orders of magnitude. For spark-ignition vehicles, the possible effect is significantly lower, and the implementation of corresponding tests is technically challenging. In this paper, particle number concentration measurements at idle speed for the identification of vehicles with malfunctioned particle filters have been studied. The results from a dedicated measurement campaign indicate that low cost equipment can be used for the identification of highly emitting diesel vehicles. The effectiveness of under-discussion instrument specifications has been evaluated employing simulations based on measured particle size distributions. Finally, an assessment of the potential impact of particle number measurements during periodic technical inspections on the fleet emission was performed. The corresponding results demonstrate that the enforcement of these measurements can reduce the overall particle emissions of the actual fleet by more than 80%.

High emitters dominate PN emissions of petrol LDV fleets – an urgent problem

In Mexico City, Nanoparticle (NP) emission measurements from Gasoline Light Duty Vehicles (LDV) have been implemented since 2018. These measurements have been carried out using 115 TESTO equipment's in 55 Emission Verification Centers, during the inspection and maintenance process. PN emissions were measured together with other air pollutants using a shaft dynamometer in a short cycle at 25 km/h /50% and 40km/h/ 25% of load. Every vehicle registered in Mexico City has to compliance this test twice a year (more than two million vehicles). The results showed that more than 15% of the vehicles measured presented PN emissions greater of one million P/cc. Therefore, this issue is an urgent problem for the assessment of air pollution in megacities.

C. Dominguez Manjarrez
GESSPA, Mexico

Emission Technology of non-road mobile machinery in EU and other markets

Since years the objectives of engine development are given by the regulations limiting pollutants emitted by diesel engines. Although it started later for non-road than for on-road, successive reductions of the limit-values did bring the non-road engines to the same level as HD on-road vehicles. This convergence of regulatory requirements logically leads to the convergence of applied technical solutions, where the non-road sector could benefit from synergies although on-road vehicles have the advantage of higher production volumes. This model, however, is unfortunately limited by the specifics of the globalized market for non-road mobile machinery. Increasingly stringent anti-pollution standards have shifted the complexity from the engine towards the exhaust after treatment system. Therefore the new challenge will be to simplify and increase the reliability of these systems in the interest of the end user. As the engines themselves become simpler, the robustness and reliability of the entire AGN system is the dominating challenge, since legal inducement can stop a machine working in case of simple failures like sensor damages.

F.Jaussi
Liebherr;
Switzerland

Handheld Machines Network HaMaNet - contributions to the occupational health protection

Handheld Machines Network (HaMaNet) was established in 2011 as a knowledge exchange and a discussion group between authorities, industry and academia. Different useful inspirations and activities were performed since the foundation of HaMaNet. The presentation explains the problems and challenges of HaMa concerning emissions reduction, shows some technical results, gives perspectives of further activities and suggests including all small non-road machines in the scope of the activities.

AFHB/VERT,
Switzerland

VERT Forum e-conference program abstracts

B. Kahlert
PURITECH,
Germany

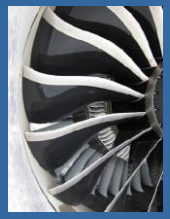
ATS system for low temperature aftertreatment performance in HD applications

The future emission legislation for HD on-highway applications in Europe, North America, Japan and China as well as national funding guidelines for vehicle upgrade systems require emission reductions in the temperature range between 160°C and 180°C. Current Euro-VI emission control systems for HD applications do not meet this requirement. The development and on-road testing of an ATS (SCR + DPF) system for on-highway HD applications is presented, which achieves NOx reduction of >85% in the temperature range between 160°C and 180°C. This is achieved by a combination of different components, which together lead to advanced low light off temperature performance. Central components for a high low light off temperature performance are. Heat-up system for AbBlue heating, Advanced SCR Mixer Technology for low temperature mixing performance, Low temperature SCR formulations / novel SCR catalyst design, low temperature cold start catalyst
Road testing with PEMS was carried out with a modern refuse collection vehicle..

C.G.Torres Padilla
BUNKER-Holding,
DK

Regulatory limits for ocean vessels

While there are different ways to address the emission reduction targets within the maritime industry, there is no doubt that to meet those new targets; an introduction of new fuels to propel vessels in the future is required. The challenge that the introduction of new fuels brings, is one that needs a lot of attention and focus. Creating and testing new fuels and delivering a proof of concept, is challenging enough, getting the fuels that could be a viable alternative to be available at the volumes and at the multiple ports that would be required to replace traditional fossil fuels, is a more complicated task. As we are already experiencing with LNG, developing the logistics capabilities to deliver it on mass quantities and at multiple ports, is taking time and a significant investment, we should use this as a baseline to understand what lies ahead in terms of time and investment. Planning and engaging in this part of the challenge early on is very critical to achieving the emission reduction targets that, at the moment, seem very far into the future.



T.Rindlisbacher
BAZL Bern,
Switzerland

First Global Regulatory Limits for Aircraft Engine pm and pn Emissions

Emissions from aircraft gas turbines are regulated with global standards. Presently regulated are emissions of oxides of nitrogen (NO and NO2), carbon monoxide, total unburned hydrocarbons and smoke (a non-visibility criteria for emission plumes). Substantial development work for new aviation particle emission standards has been done in Switzerland in collaboration with international partners and expert groups from SAE and ICAO. The international activities culminated in the first global measurement standard for non-volatile particle mass and number, published in ICAO Annex 16 Volume II, applicable to all in-production engines from 1.1.2020. Government bodies and engine manufacturers made huge efforts to establish a particle emissions performance database for many of the current and most recent engine types, which was key to develop regulatory limits. In February 2019, the ICAO Committee on Aviation Environmental Protection (CAEP) adopted the first global regulatory limits for non-volatile particle mass and number emissions, which will be applicable for new engines from 1.1.2023.

The pros and cons of SCR&DPF retrofit in German Low Emission zones

Presentation of the German retrofitting project for public transport
- The case for SCR retrofitting in in-use public transport
- Successful case studies

The importance of backpressure and exhaust temperature. Furthermore presentation of governmental retrofit programs for cars, heavy duty vehicles and buses. Berlin has started the program to retrofit public transport with SCR systems and demonstrated reduction of NOx-emission under real life operation conditions by 75 % in public buses, In addition programs to retrofit SCR and particulate filter have been performed for passenger ship and refuse collection vehicles, which showed reliable results for vehicles of 3,5 to gross vehicle weight. Emission Technology of non-road mobile machinery in EU and other markets:

V.Schlickum
UVK Berlin,
Germany

Vehicle Upgrade Solutions for Clean Air in Emission Hot Spots

Retrofit is nowadays often considered as an old hat, as it has started more than 30 years ago to remove soot emissions from older equipment in operation. Retrofit, or more precisely, "upgrading" stands for the modernization of diesel vehicles in service, which can be upgraded to reach compliance with even highest ambient air quality standards. This presentation provides an overview and insight into some of the latest technical developments and best practice examples, certification schemes, investments and efficiencies. It is also an appeal and recommendation to all stakeholders, authorities and decision makers to implement upgrading as one of the best interim solutions in air quality plans, in particular in terms of implementation time and money.

H.Borgmeier
HJS, Germany

Introduction in the Netherlands of the PTI particle number test at low idle in 2021 to check DPFs

In November 2019 the regulations were published in the Netherlands to make it possible to check diesel particulates filters (DPF) with a particle counter. As a result of this, this test has become available for roadside inspections by the police and for inspection stations of the Dutch Road Vehicle Authority RDW starting from 1 January 2020. Next step is to make the particle test for DPF's mandatory for the PTI of diesel cars. The regulations for this are now being prepared. Various manufacturers are working on the development of a PTI particle counter. Instruments can now be offered at the Dutch Measuring Institute NMi for type approval. Target date for introduction of the PTI particle test in the Netherlands is 2021.

L.Zuidgeest
Ministry,
The Netherland

VERT Forum e-conference program abstracts

J. Demuynck
AECC, Belgium

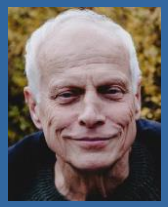
Low emissions of modern diesel vehicles

European Union legislation on light-duty vehicle emissions has undergone major changes in the last years with the introduction of RDE and WLTP. The gap between diesel vehicle emissions in laboratory tests compared to those in use has been addressed and modern diesel technology demonstrates low emissions while driving on the road. he objective of the work presented is to further show low diesel NOx and particulate emissions capability across a wide range of operating conditions, from in the city up to on the motorway. To achieve the objective, a combination of deNOx technologies was implemented on a mild-hybrid diesel passenger car together with a Diesel Particulate Filter. Results on the road show consistent low emissions over the wide range of driving conditions. Tests on renewable fuels, e.g. HVO, to reduce the carbon footprint on a Well-to- Wheel or Lifecycle basis, show there is no negative impact on pollutant emissions.

A. Dimaratos
Aristotle
Univerity, Greece

EU towards Post-Euro VI/6

The first European emission legislation appeared in the 1970's and since then many steps have been made in order to render vehicles cleaner. Euro 1 to 6 for light-duty vehicles and Euro I to VI for heavy-duty ones have brought a drastic reduction of pollutant emissions from road transport, accompanied by a significant increase in legislation complexity. However, the reported emission performance at the lab-based certification stage was not reflected in real driving conditions, leading to the introduction of the RDE test procedure. The post-Euro 6/VI legislation aims at ensuring that vehicles remain as clean as possible, in terms of a wider range of exhaust gas species, under all driving conditions and throughout their entire useful lifetime, tested and monitored within a less complex, but most effective, framework



A.Friedrich
DUH, Germany

Requirements for Post EU VI/6 Emission – the DUH-perspective

In spite of more and more detailed emission regulations the gap between the emissions at the laboratory test and real world measurements grew in the past. The cost for the certification test went up. The focus should be in the future on enforcement, not to lower the emission limits. The question of durability should more in the focus.

B.Lang
Swisscontact,
Switzerland

CALAC+ in Latin America and the Nanoparticle Conference in Mexico City 2019

The Climate and Clean Air in Latin American Cities (CALAC+) Program has been working in Bogotá, Mexico City, Lima and Santiago, building the capacity of decision makers and stakeholders through knowledge transfer and exchange of successful experiences in introducing cleaner urban transport – in terms of soot and other air & climate pollutants – and addressing off-road machinery's decontamination. Among numerous virtual and face-to-face events that have been facilitated last year, one of the most relevant was the 1st Latin American Conference on Nanoparticle Emissions in internal Combustion Engines, held in Mexico City in October 2019. This must be a top priority, considering that air pollution is the main environmental health risk in the Americas, with costs associated to externalities in the range of 2 - 4% of developing countries' GDP.

DPF Retrofit for HDV in Low Emission Zones, for construction and railway in Israel

During the last five years Israel has initiated plans to reduce particle emissions from transportation. New regulations had made Israel a nationwide Low Emission Zone (LEZ) for diesel buses and trucks under emission standard Euro IV. Last year the city of Haifa started operating a LEZ, banning small trucks, and commercial vehicles under emission standard Euro 4. Jerusalem started operating a similar LEZ for the city center as of January 2020 that will be expanded to the entire city by mid-2020. The government is subsidizing filter retrofits and provides grants for early scrapping with more than 60 million Euros. During the last 3 years some 6,000 older buses and trucks were retrofitted with a DPF. The Israeli government is working towards additional particle emission reduction from diesel vehicles, construction machinery and trains.

A.Zalzberg
SVIVA, Israel

VERT-research projects and worldwide market support for air quality

Since 1993 VERT has been a pioneer in the field of emission elimination from internal combustion engines. The introduction of the particle limit value into EURO VI and Stage V and the current introduction of vehicle testing with particle number measuring devices (NPTI) in the field are only examples of the global influence for best available technologies. The presentation will give an insight into the current worldwide activities that have been initiated on the basis of VERT criteria.

V.Hensel
VERT, Germany

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