



Verein zur Durchführung der ETH-Nanopartikel-Konferenz
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Report on the 23rd ETH Nanoparticles Conference

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www.nanoparticles.ethz.ch

This year's "ETH-Conference on Combustion Generated Nanoparticles", was held in time, in view of the high actuality of the topic worldwide and with great international participation from physics and chemistry to the engineering sciences, from all fields of medicine and biology, and from air pollution control authorities, with important scientific and technical contents in an atmosphere of open discussion; it is to be hoped that this year's important topics will also have an effect on the breadth of air pollution control policy, as this conference has done for years.

The figures: this year, too, the conference was on the same level as in 2018, with almost 380 registered participants from 34 countries. Switzerland's share of 39% shows the internationality. More than one third of the participants came for the first time. The average age of the participants is low.

48 topics on new results from 9 overlapping fields were presented in the plenum, in addition 88 posters of impressive quality were exhibited, which were discussed and evaluated in the three detailed poster sessions. This means that the conference library now comprises around 2200 documents, all of which are accessible online and are available in several large libraries marked ISBN 978-3-033-07379-1. The basic themes of the conference sessions are adapted to the current situation:

- Aircraft, marine and other non-road sources
- Ambient air particles
- Biomass combustion and biofuels
- Emission control of diesel and gasoline vehicles
- Emission upgrade for in-use vehicles
- Enforcement and post Euro 6 legislation
- Environmental impact and global warming
- Health effects
- Nanoparticle formation and transformation
- Particle filters and deNOx technologies
- Particle metrology and chemical characterization
- Secondary emissions

The importance of health-impacts is steadily increasing; in addition to the evidence of cardiovascular and cerebrovascular mortality causes and carcinogenicity, neurotoxic questions are increasingly being raised, such as the causes of Parkinson's and Alzheimer's and, most recently, effects via the gastrointestinal tract and via the skin.

Numerous contributions have been devoted to the shocking deliberate damage to particle filters and deNOx catalysts in vehicles caused by software and hardware manipulation by manufacturers and operators, which has become known since the Diesel scandal 2015, and an exhibition on new measuring instruments and new emission reduction technologies has shown that this conference does not take place in the crystal palace of science, but has an immediate effect on the technology, so that it can be said without exaggeration that scientific research and the development of technical solutions are closely linked at this location and always ahead of environmental policy.

The daily press, by the way, although informed in advance, takes little notice of this conference and therefore generally does not understand where the foundations are laid and where risks are identified at an early stage; this has been shown in embarrassing clarity in the newspaper literature of recent years after the Diesel scandal, in which a sensationalist press has dedicated the door to technical-scientific laymen and a wealth of talk shows, which - perhaps deliberately - has led to confusion and to a large number of miscarriages with serious consequences. This 23rd ETH-NPC has also addressed this issue. For the specialist press, however, the conference is becoming increasingly important, and health issues caused by exhaust emissions, as well as climate impacts, are gradually being recognized as economic factors and are therefore being taken seriously.

In 1997, the ETH-NPC was launched as a one-day workshop with 26 participants to discuss burning issues in the development and evaluation of particulate filters in an interdisciplinary group of experts - issues that had become important for the retrofitting of construction machinery with particulate filters in the Swiss NEAT tunnel construction, where priority was given to the elimination of the alveolar fraction of respirable solid particles. Step by step it became the central global meeting of scientists and engineers in the fields of generation, measurement, elimination and control of pollutants from combustion and has essentially introduced two decisive facts into the general discussion and formulation of exhaust emission regulations, namely particle size - that is why we are already talking about nanoparticles in the title - and particle count as a measure of exposure dose and as a sensitive metric for the evaluation of technical measures. Today, the EU, China and India assess emissions by the number of particles as they were developed at this conference and that is the only reason why we now have particle filters in over 100 million vehicles on the road in Europe.

It is a special conference, hardly comparable to any other: it is academic, but transdisciplinary; free from commercial or technical interests, but highly focused on the goal of eliminating exhaust pollutants; it represents the responsibility of science and technology for society as a whole without subjecting itself to sometimes narrow, regulatory constraints; it is future-oriented in the sense of best available technology; it is pragmatic without losing the stalks of science and it is free of charge for the participants, an example of Swiss hospitality, embedded in the symbolically open architecture of the venerable ETH main building.

Prof. Dr. phil. Gian-Luca Bona, CEO of the Swiss Federal Laboratories for Material Science and Technology, EMPA

opened the conference with a plea for sustainable mobility technology with the appeal to break away from the ill-considered, almost populist, false lures of electromobility and once again to "go over the books" thoroughly in order to work out solutions that meet all the important criteria.

Prof. em. Dr. theol. Wolfgang Lienemann, Ethicist at the University of Bern

has hit the right note with a keynote speech on "Environmental Ethics in the High Risk Society" to characterize the work of this conference and at the same time pointed to the problems that arise when ethical criteria are violated, namely problems that can quickly assume global proportions in our technically and economically dominated world.

Prof. Dr. med. Nino Künzli, as Chairman of the Federal Commission for Air Pollution Control

responsible for public health, Prof. and Deputy Director of the Swiss Tropical and Public Health Institute, TPH, Basel, Prof. of Public Health of the Medical Faculty at the University of Basel as a specialist for environmental epidemiology, has dealt with the role of science in an "open word" using Dieselgate as an example. Science is not allowed to retreat into the study rooms and laboratories, but has to answer questions to society and assume responsibility, because "professor" comes from (lat) profiteri = confess and not from (ital) profittare. He referred to the preceding presentation of Prof. Lienemann.

Dr. Imad Khalek, Senior Program Manager-Emissions R&D at the Southwest Research Institute, SWRI in San Antonio, Texas,

who enriched the conference with important contributions from the very beginning, was the dinner speaker and took the opportunity to give the relaxed ETH-NPC community a future task with an urgency that went certainly "under the skin" of many: "it is no longer just about reducing emissions of new engines, it is rather about sustainable emission-free mobility. And even this must not be left to lay preachers in political offices, but the engineering future and research must implement the best solutions in their diversity and optimal adaptation, and that is not electric mobility. That shall also be part of the concept of this conference, which wants to help shape the future".

To present the abundance of contributions here, even in brief, would go beyond the scope or lead to inadmissible selectivity. In general, it became apparent that research has "ignited" in many places and is penetrating further into depth everywhere, which also makes it understandable that all good scientific contributions conclude with the demand "more research is needed". How good that the engineers have always understood not to wait for it, but to develop functional and cost-effective solutions on the basis of the knowledge secured in each case.

This is how we see the highlights this year

- All new diesel engines in Europe today are equipped with highly efficient filters and DeNOx systems, i.e. nanoparticle emissions are reduced by a factor of 1000 and NOx emissions by a factor of >100 compared with the 1990s. This applies today to some 100 million vehicles on European roads, thanks only to the conference's principle of counting ultra-fine solid particles; these principles have now been adopted by Korea, China and some Latin American countries and will also apply in India from January 2020 - but still not in the US and still not for all petrol engines, let alone CNG engines that emit even smaller particles.

- Combined emission reduction systems were also developed for retrofitting, the upgrade of the existing fleet, in principle for diesel engines of all kinds down to passenger cars and one of these systems received a highly endowed prize of 1.5 million Euros from the EU Commission, whereby it could be shown that the exhaust reduction was even more efficient than with most OE systems. It is therefore possible to retrofit or upgrade the fleet. But this upgrade, which we would so urgently need to push ahead with improving air quality, will not come because, while governments are outbidding each other with the closure of city centers and a dirigisme bordering on a planned economy, no one is taking the opportunity to make consistent use of these technologies.

- But do these systems work so perfectly in practice? Various groups in the nanoparticle network in the Netherlands, Belgium, Spain and Switzerland have shown that over 10% of filters and probably even more deNOx systems do not work well. You don't notice that, because since 2013 the legislation has renounced periodic controls in the belief in electronic on-board self-control. An initiative from the ETH-NPC network has taken up this challenge under the term NPTI = new periodic technical inspection and within 2 years has developed a new measurement standard for number measuring instruments and already 5 exhibitors have presented such devices. One session was dedicated to this topic. Thus it was shown once again that relevant questions from this network can be quickly and sustainably solved.

- The importance of the "solid ultrafine particles" is increased by the realization that their surfaces can be activated by physical, chemical and biological effects of various kinds, that on the surface of these soot particles (200 m²/g), carcinogenic PAH and metal oxides are deposited, in gasoline engines more than in diesel engines, and enter cells that way where they could become loose and cause harm. This phenomenon called "trojan horse" effect explains the direct effect on cells, even cell nuclei and DNA in the entire organism, yes, that this threat even has epigenetic effects. New analytical methods provide new insights and new methods for the targeted generation of aerosols with defined coatings enable in vitro research on human cell cultures - an impressive exhibit of the Universities of Bern and Windisch. It is a bad thing that the official air pollution control concepts do not seem to or do not want to acknowledge this, but rather stick to the traditional principles of the sum parameters PM2.5, NOx, THC and the like, thus misleading or slowing down the introduction of possible technical measures.

- The schizophrenic public debate on the demonization of diesel has been exposed and the imbalance of limit values, which overestimate NO2 and far underestimate nanoparticles, has been recognized. Too late, one must add, because the pile of broken glass is irreversible, as is the completely superfluous destruction of assets and the loss of confidence in the reliability of technology and administration.

- Particulate emissions from aircraft engines have been identified and measured; a Swiss initiative of the FOCA, supported by extensive research work by EMPA, DLR and American research groups, has achieved a certification protocol of new engines by an ICAO framework, published in March 2019 to become in force 2013.

- Particulate emissions from ships are finally in focus and the IMO is starting an attempt to go beyond desulphurization and denitrification and target black carbon. The dramatic effects of the melting of polar ice

due to soot deposits can obviously no longer be overlooked. But how long will this take if no convincing technical measures are presented - the engineers will be challenged. The implementation of such special measures will become easier in protected areas such as the Baltic Sea, the North Sea and perhaps soon in the Mediterranean Sea. Everywhere in these areas, governments can push through stricter demands with sensitive sanctions.

- The contact with the world of biological-medical research, to which two sessions are dedicated and which plays an important role for the interaction of engineers with physicians and biologists, can hardly be depicted any more, since it is expanding at an incredible rate. The presentations were carefully selected to show the progress made in the overall assessment, but also to provide some in-depth insights into fascinating individual projects such as the amazing causal relationship between UFP and diabetes on effects in the intestinal tract - so far we have only talked about the lung, or the exploration of an access route via the follicles in the skin, which, in intact form, we had previously regarded as impermeable. **And for the first time, a large epidemiologic study in Canada with >1Mio participants over 1996-2012 concluded that "UPF exposures appear to have important long term public health impacts (e.g. for the number of UFP a 2-5% increased risk per 10'000/cm³ for myocardial infarction) independent of PM2.5 and NO₂".** If we sub-total all this, where are the total costs of exposure to the urban atmosphere or vice versa, what can we spend to avoid all these problems?

- In the Focus Event six members of the leadership group of this conference tried to put their concerns into words, to show which gaps in research and legislation should and could be closed and thus to provide indications which could be used and implemented in a big new attempt as the post Euro6 legislation represents.

Over the 22 years we have learned that breaks must be frequent and long and that these opportunities promote communication, especially when coffee and culinary energy snacks are served by the ETH Mensa team - thanks to the SV who also hosted the conference dinner in the Mensa.

All authors make their work available for the conference homepage for an unlimited period of time; this is one of the conditions of the conference; the download is also free of charge at any time. In this way, the website now contains an electronically navigable keyword library with 2199 technical papers. On this website there is also a photo gallery and a video that tried to capture the special atmosphere of the conference for those who were unable to attend this time.

After each conference, a CD will also be produced containing all the contributions that have attracted the interest of several major libraries. The CD bears an ISDN identification and the contributions can therefore also be quoted scientifically. In addition, the Springer journal "Emission Control Science and Technology" offers all authors the opportunity to publish their contributions as "full papers" following a peer review process.

Five prizes were sponsored

- Prizes for the three best posters (600, 400, 200 Fr) were donated by Dr. med. O. Brändli from the Swiss Lung Foundation/Wald. The first prize went to G.A. Kelesidis and A. Bruun from ETH Zurich for their contribution to "Impact of Organic Carbon on Soot Light Absorption". The second prize went to S. Jain of CSIR National Physical Laboratory in New Delhi for her contribution to "Seasonal Variability of PM 2.5 Composition and its Sources over Delhi, India" and the third prize went to T.N. Jensen and S. Koust from the Danish Technological Institute Aarhus for their contribution to "Real Time Measurements of Cost efficient Filter Solutions for Small Construction Machines" - adding that given the high quality level of the posters it is becoming increasingly difficult to select the three best out of 88.

- The Trojan Horse Award for outstanding contributions to cell-level toxicity (2000 Fr), donated by Dr. med. J. Schiltknecht of the Environmental Protection Physicians, was split this year and went to Dr. S. Katsumi from the ESAR in Japan for his poster "Characteristics of Chemical Composition for Ultrafine Particles Collected at Narita International Airport" and to D. Dumitru from the University of Lille for his lecture on "a Novel Methodology for the Analysis of the Particulate/Gas Phase Partitioning in Combustion Emissions".

The ETH-NPC does not charge participation fees; on the one hand, this is due to its reputation as an academic conference, the patronage of the ETH and the FOEN, and on the other hand, it serves to ensure that as many young scientists and engineers as possible can attend the conference and communicate and

discuss their results. The conference thus remains young and ambitious young doctoral students will be the decision-makers in the foreseeable future; but the "old hands" are just as important and the colorful mix of disciplines and disciplines is characteristic.

Are 23 conferences not enough?

The ETH-NPC has achieved a great deal with this large interdisciplinary expert group (more than 2600 corresponding experts), it has provided the arguments to enshrine the particle number limit value for the homologation of European vehicles in law, and it is only because of this that we have more than 100 million highly efficient particle filters on the road today in Europe. But there are many important tasks ahead of us, even if at ETH-NPC we concentrate only on particles, their formation, their biological effects, technical measures for their elimination, legislation and control - not only for new vehicles and not only for diesel engines, but also for gasoline engines, aircraft engines, locomotives and ocean-going ships. Many of these tasks are or at least should be a priority for human health, but unfortunately in most cases this has by no means "leaked" to the level of environmental policy - let us just remember that the recognition of the carcinogenicity of combustion soot from Percival Pott dates back to 1775, that in 2012 the World Health Organization (WHO) declared the exhaust gas from internal combustion engines to be carcinogenic according to Class 1 (such as asbestos) and that to date only one authority in the world, namely the Dutch Gezondheidsraad, has reacted to this with a proposal to tighten the limit values.

So much remains to be done.

And so we invite you to the 24th ETH Nanoparticles Conference
on 22-25 June 2020 in the main building of ETH Zurich

Last but not least:

Only through the support of numerous sponsors, authorities, companies and private individuals can we fulfil this task and therefore we would like to take this opportunity to thank the 33 sponsors, particularly the ETH and the FOEN, the 19 exhibitors of the 23rd ETH-NPC, the VERT-Association and the colleagues of the ETH-NPC-Association to support our task to make mobility sustainable and free of pollutants.

June 25, 2019
Andreas Mayer
Board-Member of the ETH-NPC