



## 21<sup>st</sup> ETH Conference on Combustion Generated Nanoparticles

19<sup>th</sup>-22<sup>nd</sup> June 2017, ETH Zürich

At the Swiss Federal Polytechnic Institute (= ETH) the 21<sup>st</sup> Conference on Combustion Generated Nanoparticles was held from June 19<sup>th</sup>-22<sup>nd</sup>, three days of intense learning and mutual exchange of knowledge. As in previous years the conference was attended by more than 400 persons from 33 countries, almost filling the lecture room's full capacity. In 1997 this conference had been initiated as a 1-day workshop with only 26 participants. The objective had been a very practical one: International experts of rank should scrutinize the state of the art of particle filters for exhaust of diesel engines and the methods of their evaluation; this should be done in view of improving the air in tunnel construction. Although the Swiss people had voted for building a new railway tunnel to transit the Central Alps through Gotthard, construction hinged on satisfying requirements of the Swiss Occupational Health Authority (SUVA); SUVA had given prioritised the elimination of alveolus penetrating solid particles. Meanwhile, the conference became a yearly meeting event of engineers and scientists of various related disciplines, practitioners in research, industry and administration, for presenting and discussing most recent results in different fields as there are the generation, the method to measure and of controlling the elimination of noxious substances from combustion.

After the opening of the conference by G. d'Urbano, FOEN (=Swiss EPA) this year's Key Lecture was given by G. Kadijk, TNO, The Netherlands on "Chances and High Risks with Highly Effective Emission Control Technology"; in fact the risks connected with catalytic "after-treatment". First time in records of emission, thanks to decoupling of combustion cycle and detoxification of exhaust it was feasible to reduce CO<sub>2</sub> (up to 8%) while important noxious substances PN and NO<sub>x</sub> are almost completely eliminated. However, only improvements in legislation and execution by means of periodic control of all vehicles will bring this benefit to the public. Of course, in view of the public mood due to meanwhile well known manipulations by some of the automotive industry this topic attracted top attention.

In the following a few facts from the contributions to the conference: While until now there was the belief that alveolus penetrating nano-particles being characteristic features of diesel engines, recent findings brought some more facts to light:

Vehicles driven by natural gas or gasoline engines emit sometimes similar to diesel engines alveolus penetrating particles, same order of magnitude. Apart from soot, adherent cancer generating substances, like PAH or heavy metals from lubrication-abrasion are important. It's hard to estimate the overall influence, as there exist many more gasoline engines than diesel and we have no statistical overview of operating times and their employments.

A rough cross estimate by comparing various contributions yields 500 million vehicles emitting 10<sup>25</sup> nano-particles/year, a number beyond imagination, big or small? OECD estimates 4 million premature deaths, i.e. 10'000 per day to double in foreseeable future. "Premature death" a measure of the medical profession, for laymen only the top of an iceberg: chronic illness, crippled birth, loss of public productivity causing reduced public services for instance health services. Will highly efficient filters be enough?

Only vehicles? What about aircrafts? Again comparing conference contributions, we arrive at about 25'000 airplanes for public traffic and transportation emitting a total of  $10^{26}$  nano-particles per year, exceeding land vehicles by one order of magnitude, which are excepted from international climate treaties – and this happens below 3000 ft. On initiative of the Swiss Federal Office for Civil Aviation one has begun to monitor aircraft emissions worldwide by PN. A particular shocking result was reported: emissions from Airport Los Angeles drifting south exceed those of three heavy traffic superhighways, which together with the Harbour Long Beach had been regarded as principal as sources of South Los Angeles air pollution.

Ships, high seas: The world's shipping fleet produces as much soot emissions as all the land vehicles together; marine particle emissions are shockingly high as one may learn from many contributions to this conference, the total PN-emission reaching  $10^{26}$  nanoparticles per year, partly to be attributed to poor quality fuel burnt; soot deposits on the North Polar Cap primarily stemming from marine shipping are to be blamed primarily for the melting of the ice cap.

Impressive numbers, facts, were surprisingly in accordance; scope of tasks to be done multiply, which became apparent from the variety of contributions;

Originally 12 categories announced were finally broken down to 8 sessions:

- Fundamentals
- Ambient air
- Aircraft and airports
- Non-road sources (including marine s. and general combustion)
- Diesel and gasoline engines (internal combustion engines)
- Particle filters
- Particle metrology and instrumentation
- Health effects
- missing: *Legislation* –

FOCUS EVENT: The third day's afternoon is filled by the 'Focus Event', dedicated to problems arising with effecting and executing legal and administrative regulations, originally only from Swiss viewpoint, later generally; a particular topic usually bypassed in academics environment, despite its importance. This time there was a slightly different approach, the question in view of the public mood: "Will Diesel Technology Survive?" Invitations had been extended to eight experts of rank: existing sceptical doubts towards the present DeNox-technology were brought forward as well as scepticism towards overoptimistic expectations regarding e-mobility's contribution to improvement breathing air. A special observation from Zurich: On hot spots, NOx from diesel emission is decreasing very slowly, while particles decreased distinctively to one third in course of 10 years following the introduction of particle filters.

Diesel engines will remain indispensable for the high-sea fleet, where filter-solutions are still missing, while on the other hand technologies to eliminate noxious emissions of road and non-road are proving close-to-perfect -- if everything works.

However, what to do, if besides technical failures, aging or poisoning of catalysts, if there occur aimed manipulations on hard- or software? The answer is: New periodic technical inspection (NPTI), which is fitted to the new technologies! The closure-lecture was done by the key lecturer who had opened the conference; it was dedicated to that topic, resulting in a very strong message of the conference.

and more highlights:

Health: Epidemiology, for a long time resistive to changes in view of their tiresome working method, is closing in, as investigations near streets of dense traffic level are under way. In biology, toxic effects on the placenta have been presented. However, despite evidence, rule makers are far away from accepting that they ought to introduce some limit values for nano-particles in ambient air. On the other hand, PN has become one of the legal measures of characterisation of emission quality of

internal combustion engines. Why measuring with 2 different yard-sticks? This latter question will remain as our companion.

Contributions from megacities, maybe India, Iran, South America, were depressing; Switzerland is attempting aid by means of transfer of technology and of cooperation in research. However, long life time of fleets, difficulties in administration when executing the law and even unscrupulous plays of power by large industries come into play to make efforts contra-productive. We must not resign because air does not acknowledge boundaries and we all will suffer from climatic effects and particle emissions.

Authors provide their contributions on the Conference homepage for indefinite length of time, as is condition of submission; download is possible at any time, under [www.nanoparticles.ethz.ch](http://www.nanoparticles.ethz.ch); there is a library, electronically navigable by key words, at present 1938 papers. After each conference a CD is produced containing all contributed papers; successively, this CD finds the interest of well known libraries, bearing an ISDN number, papers are quotable. Furthermore, Springer-Publishing offers to all authors to publish as "full paper" in the periodical "Emission Control Science and Technology" after peer review.

There were 4 rewards sponsored, three of them for the best poster (600; 400; 200, CHF) by Dr O. Brändli, and one called Trojan Horse Price (CHF 2'000) by Dr.J. Schiltknecht for an exceptional contribution to biology:

- L. Durdina, EMPA, 1<sup>st</sup> price for poster, aircraft emission
- L. Rubino, Opel, 2<sup>nd</sup> price for poster to gasoline particle filters
- V. Abramesco, Technion Haifa, 3<sup>rd</sup> poster price for particles in diesel driven railways trains.
- The Trojan Horse Price went to P. Baltzopoulou/APTL Thessaloniki, for research on toxic effects of diesel exhaust by means of a cell culture on a gas/liquid interface simulating our breathing air.

Participation at this conference is free of charge, no conference fee, which is quite unusual, when considering nowadays prospering conference industry charging remarkable fees. The Federal Polytechnic Institute's patronage as well as that of FOEN (= Swiss EPA) may be gratefully acknowledged as making a significant contribution to the academic ideal of public learning. This way ambitious young people on the begin of their respective careers have a chance to attend, who otherwise would be prohibited; in the foreseeable future these persons will be decision makers; right now they may be "young doctors" exposed to experienced learned persons of rank, who in turn notice how to articulate for interested newcomers (frequently, learned people cultivate a language not understood outside of their own guild). Furthermore, there is a mixture of disciplines and branches of business to be observed, such that the conference is far from the peril to get sterile; even representatives of nine engine manufacturers were present this time.

Achievements: The ETH-NPC, as this conference's acronym is, may present remarkable achievements thanks to a big interdisciplinary community of 2600 corresponding experts: It's the cradle of the PN-criterion, the number limit of particles which is now legal criterion of homologation in Europe. 100 million highly efficient particle filters are now on European roads. Even if the ETH-NPC would constrain itself to solid particles and nothing else, the generation of them, their biologic effects, how to eliminate them or only methods to reduce them, technical methods and legal methods to enforce as well as control measures for all sorts of thermal conversion, even then there remains plenty of work to be done. Consider only, gasoline engines, high seas marine- and aircraft-propulsion!

Thanks to sponsors of all sorts, government, industry, private persons, enthusiastic volunteers this conference has convened in the past and is about to continue; on behalf of the organisational committee the organization committee is expressing thanks to all of them and is hoping that in turn, sponsors will benefit from the progress of knowledge accomplished.

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