

Environmentalists' FAQ:

Internal combustion engine generated nano-particles,
DPF- Diesel particulate filters; PM10

*Why do we know **now** about nano-size soot particles, why not earlier? Hadn't they been here all the time?*

- This knowledge is not so new; however, improvement of combustion in the engines by means of high injection pressures has reduced bigger soot (flakes) in terms of mass and left us with extremely tiny ones in big numbers, which may penetrate into alveoli and even pass the barrier of the smelling nerve into the brain.

Why are they airborne for a longer time period than bigger ones?

- Stokes law on settling time of idealised little balls in viscous fluid explains that settling time is inverse proportional to the square of diameter; hence 100 nano-metre particles need 10.000 times more time for settling down than 10µm (PM10) particles.

Why is PM10 to crude a method of measuring? - direly needing to be supplemented

- PM10 includes the mass of all particles less than 10µm, from the tiniest to the big ones. As mass is proportional to the third power of diameter (considering same density of material), a particle of 100nm has only one millionth of the weight of a 10µm-particle – hence, measuring PM10 yields a result which almost completely neglects the very small ones, which are the real harmful particles.

What difference is in generation of particles, big and extremely tiny?

- Aerosols, i.e. airborne particles may have different origins, for instance abrasion of tires, or brakes, clutches; abrasion is a mechanical cause of particles. By mechanical means it is not feasible to generate particles smaller than 1µm. Smaller than 1µm is called Nano-size. 1 nanometre equals 1 thousandth of 1 µm, which in turn is 1 thousandth of 1 metre. In chemical process engineering nano-size particles are generated by fast condensation from vapour; the same happens in the diesel engine due to improvement of fuel efficiency (= more power for less fuel consumption).

Why is upgrading of engines in operation of heavy duty vehicles so important? What about upgrading passenger cars with "filter-cats" or similar?

- Two independent investigations, one in Switzerland and one in Denmark, revealed almost exactly the same, albeit very different locations, that one could get rid of about 75-80% of nano-particles by means of upgrading (=retrofitting) heavy duty vehicles only; on the other hand those devices called "open filters", "filter cats" claiming to eliminate 30% (at their best) are not any more subsidized in the Netherlands, since the Ministry of the Environment conducted an evaluation of effects in real world. Further, only upgrading or retrofitting is likely to bring about an improvement of air quality, because it is not feasible (for financial and manufacturing reasons) that freight forwarders switch to new vehicles (EURO 6) within short time.

How about NO₂, NO_x and all that? Do filters increase the NO₂-level?

- As any chimney sweep may tell you, soot is hard to ignite (ignition temperature some 550 degrees Centigrade); with oxygen in statu nascendi soot can be ignited at lower temperatures. One particular method (called CRT) utilised a well known trick from chemical engineering to make NO₂ disintegrate into NO and pure oxygen, thereby finally leaving an increased ratio of NO₂/NO. NO_x: Long ago, in engine engineering for convenience of measuring, there came about a development to measure NO + NO₂ = NO_x; quite unfortunate, 2 different substances of differing health effects in one basket. It did not constitute any troubles as long as there was no exhaust after-treatment, which changed the ratio of the two! As of now there exist filters, which even reduce the NO₂ level!

What is the interest or stake of members of the VERT-Association?

- They have embarked on filters of the best available technology (BAT), VERT-certified! There is a prize tag for that. In view of the above mentioned environmental effect of upgrading heavy duty vehicles, VERT-members are interested in upgrading, because this segment constitutes a big market for high priced filters. Being in high quality products they could rather be interested in a ban of fake filters as the "filter cats" or "FTF" or similar as they may be called.

What about global warming as under discussion by various environmental organisations?

- Originally, solid aerosols had not been considered in the Kyoto Agreement, only gases had been targeted; scientists had guessed solid aerosols to act contrary to warming, rather to have a cooling effect. In 2002 a group of Stanford University researchers (Mark Jacobson et al) published their findings: The same mass of soot exhibits about 500.000 times the forcing of global warming than CO2! – an uproar followed, NASA, PSI, Courant-Institute tried to challenge and arrived at similar results as Jacobson. Considering the different lifetime in the atmosphere of soot and of CO2 (soot: 2 weeks, - CO2: 100 years, one arrives that elimination of 1 kilogram soot is 1600 times more effective than eliminating 1 kg CO2. We continued then further to diesel engines: Eliminating soot, albeit how advanced an engine may be, there is no absolutely ideal process in nature, is substantially cheaper than reducing CO2 in a rush; Dr Mayer figured on EURO 3, while I checked independently on EURO 5! (cost equivalent to 1 ton of CO2 reduction is about 4,-€)

Meanwhile, US legislative bodies (Congress, 2007 and Senate, 2008) embarked and it would have merits to bring the topic to the attention of European legislators too.

F. J. LEGERER

Manager, VERT-Association