Volatile and Non-Volatile Particles: First Investigations with a PMP-System.

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The homologation procedure for Diesel vehicles for the Euro 5^+ stage in 2011 most likely will be extended to include the measurement of particle number concentrations. The measurement will follow the procedure defined by the PMP (Particle Measurement Programme) group established by the United Nations Economic Commission for Europe (UN-ECE). In order to guarantee an acceptable repeatablity and reproducibility only “nonvolatile” particles should be measured, which is achieved by tight specifications for the sampling, dilution and conditioning of the exhaust gas.
The removal of “volatile” particles is one important feature for a measuring system according to the PMP specifications. A removal efficiency of > 99 % for Tetracontane (C_{40}) particles with diameters above 30 nm must be demonstrated. By this requirement “nonvolatile” particles are defined by the conditioning and measurement procedures, similar to “particulates” in the first Diesel emissions regulations (1972).

The purpose of this work was to gain a better insight into the nature of volatile and non-volatile-particles and to analyze the removal efficiencies of various substances in a system which fully complied with the PMP method.
After the confirmation that Tetracontane (C_{40}) showed a minimum removal efficiency of 99.97 % by the system it was investigated, whether this high efficiency could also be found for typical automotive substances like standard fuels, Biofuels or engine oils. In the same way as C_{40} these substances were atomized, size classified and diluted, and their removal efficiency in the preconditioning unit was determined from the particle number concentrations upstream and downstream of the system, measured with condensation particle counters.
The results of these tests were unexpected: small or even negative volatile removal efficiencies were found for most substances. In further investigations the density and viscosity-temperature-behavior of the investigated substances were determined to shed light on the reasons for the findings. However, despite a series of measurements it was not possible to find correlations or connections between the removal efficiencies and physico-chemical properties of the test substances. Further investigations showed that the bimodal distribution shifts to a monomodal distribution of Nanoparticles. It seems that larger particles are “split” into smaller particles, which results in a huge particle-number growth inside the dilution system.

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REMOVAL EFFICIENCIES OF FUEL AND OIL AEROSOLS IN A PMP SYSTEM – FIRST INVESTIGATIONS

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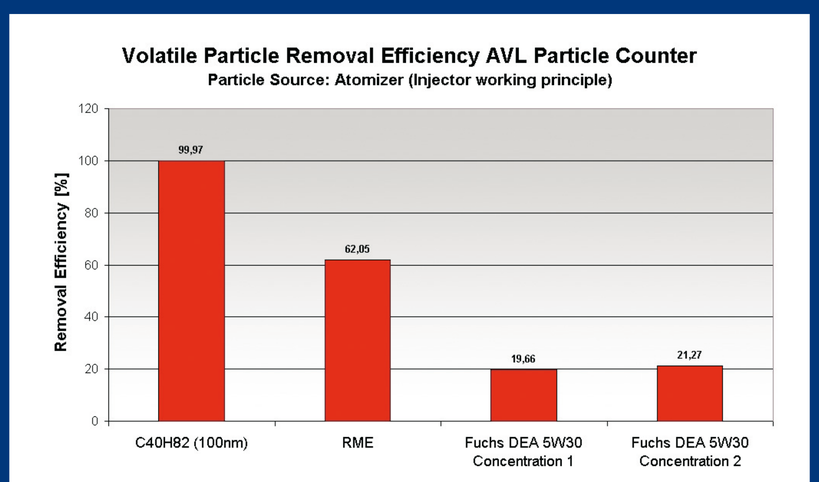
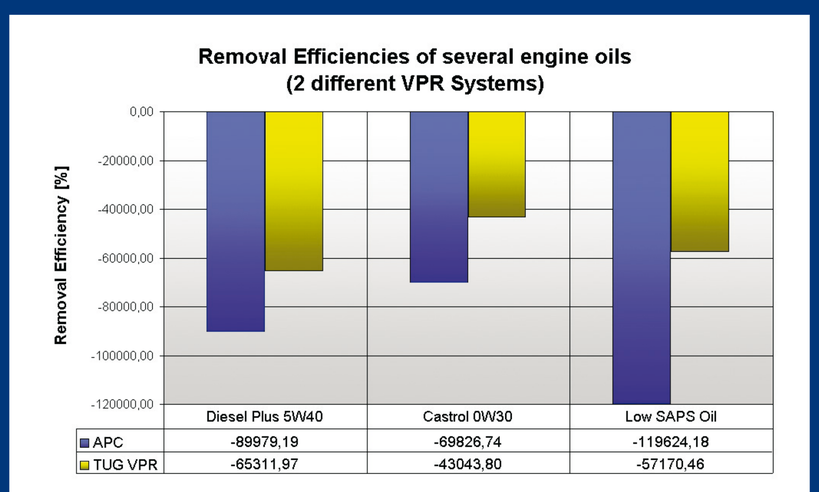


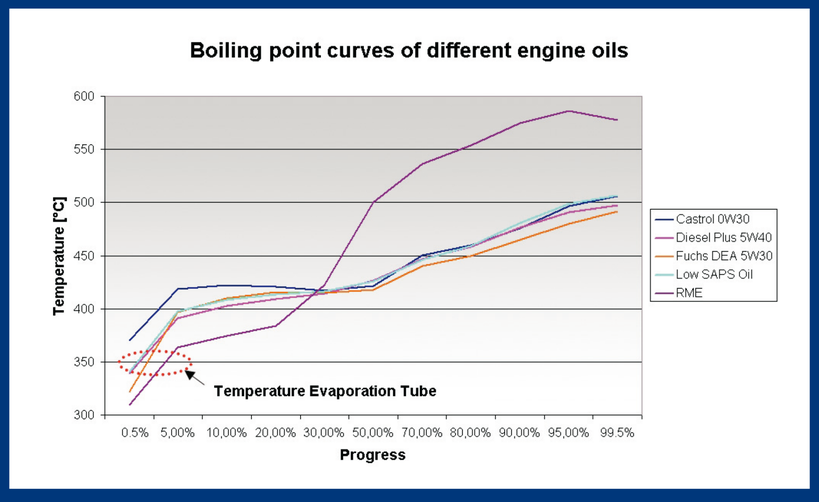
Removal efficiencies for Volatile Particles

Removal Efficiencies of >99 % for Tetracontane should be demonstrated acc. to latest PMP proposal
C40 showed perfect results RME
and engine oil from Fuchs showed low removal efficiencies



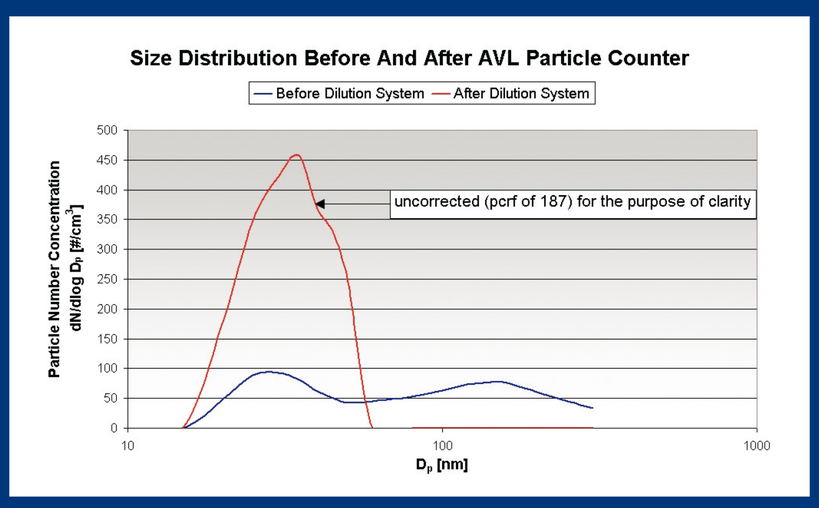
What about the removal efficiencies for other substances?

Negative removal efficiencies for some engine oils were found with two different dilution systems



What are the reasons for the low, sometimes even negative removal efficiencies?

Physicochemical parameters as density, viscosity or boiling range do not show a correlation to the removal efficiencies of the tested substances.



The size distribution reveals the mechanism

The bimodal distribution shifts to a monomodal distribution of Nanoparticles. It seems that larger particles are “split” into smaller particles.
→ Huge particle-number growth inside the dilution system

Conclusion: Fuel and Oil components can contribute to the Non-Volatile Particles as defined by PMP

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