

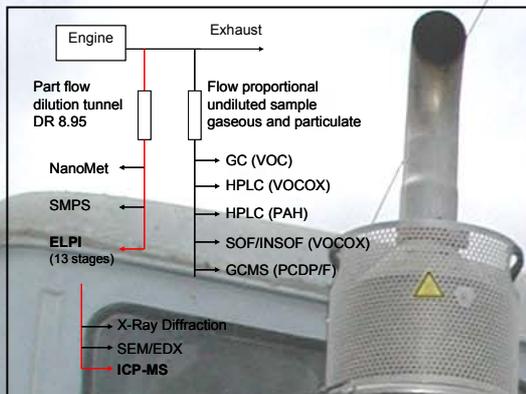
Determination of additive metals in fuel and emissions of diesel vehicles

A. Ulrich, A. Wichser

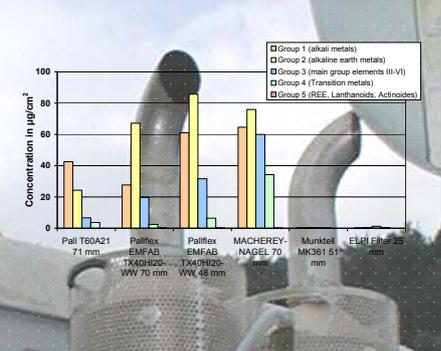
Eidgenössische Materialprüfungs- und Forschungsanstalt, Abt. Anorganische Analytik, Überlandstr. 129, CH-8600 Dübendorf

Particle traps are a suitable tool to minimise soot emission of diesel vehicles. Metal additives can be used to support burn-up of soot from clogged filters. Transition or noble metals as fuel additives or catalytic coating of the filter decrease soot ignition temperature. Fuel additives used in particle traps have to comply with environmental directives and should not support the formation of additional toxic substances. The emission of metal additives from diesel engines with downstream particle traps has been studied. Aspects for the optimisation of sampling procedure and the optimisation of sample preparation and analysis will be described. Determination of additive and coating metals in fuel and aerosol filter samples proves to be challenging with respect to suitable sampling procedures,

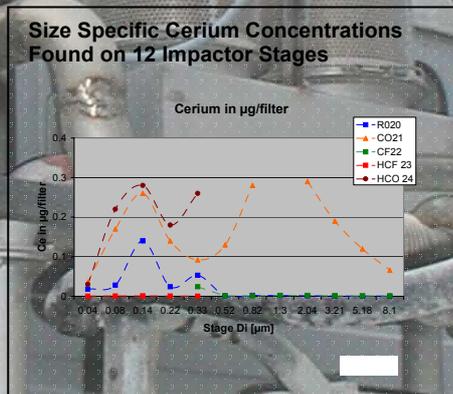
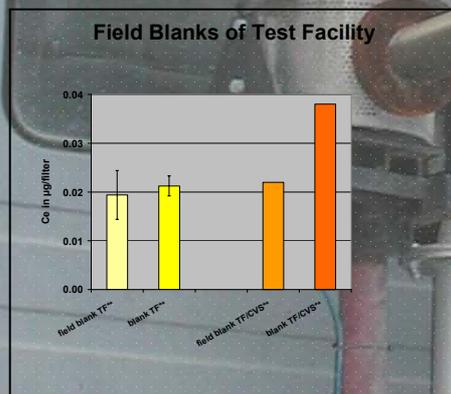
sample preparation and determination techniques. The determination is limited by sampling and sample preparation procedures due to high contamination risk and memory effects. Size classified aerosol sampling using impactors requires contamination minimised sampling and sample preparation. Sample preparation and determination using ICP techniques have to be specifically optimised for each element. Some elements can be directly analysed in fuel using ICP-OES others require digestion. Internal standardisation for ICP-MS is critical because traditionally used internal standard elements are unsuitable due to a release of these elements by oxidation catalysts



Blank Levels for Several Filter Materials



Analysis of Diesel Samples



Analysis of Filter Samples

- Digestion Procedure for ELPI Filters:**
- (1) Cleaning digestion for vessels using ultrapure chemicals
 - (2) Determination of vessel background by ICP-MS.
 - (3) Selection of suitable vessels based on the results of (2).
 - (4) Second cleaning of vessels without appropriate background (repeat at 1).
 - (5) Digestion of weighted filters (field blanks and samples) using ultrapure chemicals
 - (6) Digestion of minimum 5 reagent blanks => detection limits.
 - (7) Determination using ICP-MS (Inductively coupled plasma mass spectrometry)

Mass Balance for Cerium Additive Based on Total Mass per Cycle

	Cerium
Additive quantity	473 mg
Total mass ELPI without trap	2.05 µg
Total mass ELPI with trap	0.037 µg
Total mass exhaust gas with trap	15.37 mg
Total mass exhaust gas with trap	0.27 mg
Deposition in engine	457 mg
Deposition in trap	15.1 mg
Ermittelt into ambient	0.27 mg
Filtration rate in engine	96.7 %
Filtration rate in trap	98.2 %
Total filtration rate system	99.94 %
Emissions factor	0.96 µg/kWh

References:

- [1] A. Ulrich, A. Wichser: *Metal analysis of diesel vehicle emissions*, Proceedings 6th ETH Conference on Nanoparticles, 2002.
- [2] A. Mayer, A. Ulrich, J. Czerwinski, U. Matter, M. Wyser: *Retention of Fuel Borne Catalyst Particles by Diesel Particle Filter Systems*, SAE Technical Paper Series 2003-01-0287, 2003.

Acknowledgement
We would like to thank A. Mayer (TTM Mayer), T. Mosimann (Matter Eng.), Prof. J. Czerwinski and his group (FH Biel) for co-operation during optimisation and sampling for this study.