Volatile classification of diesel emitted particulates measured by SMPS and multi-wavelength PhotoAcoustic Spectrometer (4-λ PAS)

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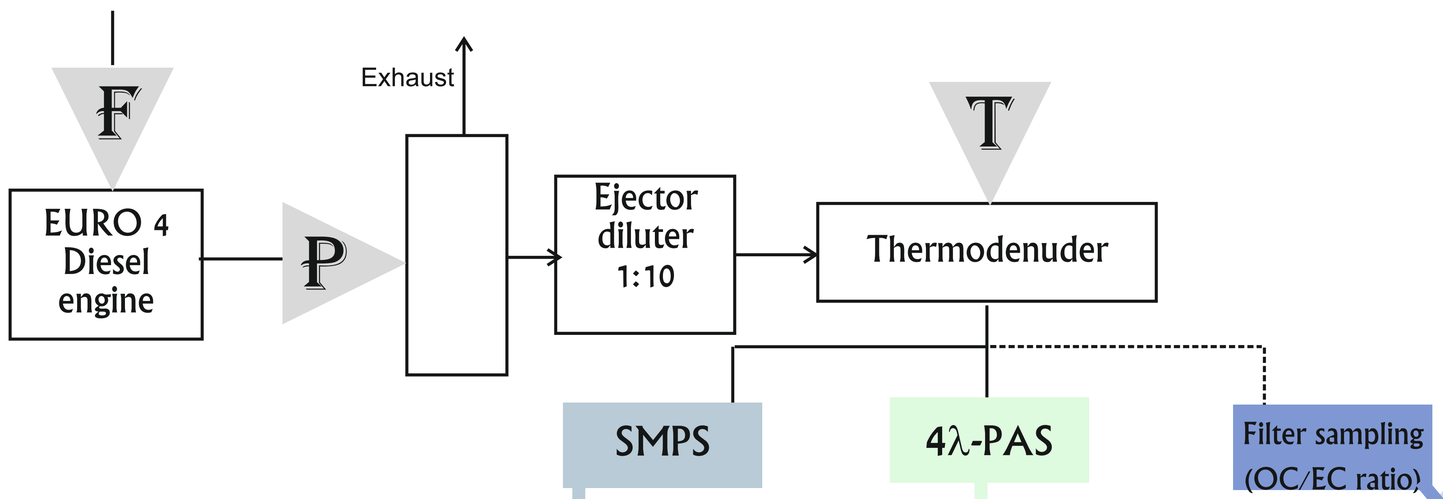
1 Introduction

- Diesel emission standards are limited to the measurement of mass and number concentration of diesel particulates.
- Diesel emitted particles have versatile chemophysical features depending both on the chemical composition of diesel fuel and the operational condition of the engine.
- The chemophysical features of particles are key issues both in air quality and climate forcing studies.
- The Photoacoustic (PA) technique has already proved its applicability in quantifying diesel emission on a mass basis among laboratory and normal driving conditions. Photoacoustic based portable emission measurement systems (PEMS) for in-use vehicle emission measurements operate at a single wavelenth (usually at ~800 nm in order to minimize interferences from exhaust gas components and volatile compounds).
- The PA technique at multiple wavelengths may provide opportunity to obtain information about chemical composition in addition to the particulate mass.

2 Objectives

- Investigation of the raw engine out emission in the function of engine conditions using commercial diesel and its blend with biodiesel.
- Posterior temperature treatment of the sample by a low-flow thermodenuder (TD) to remove the volatile fraction of the exhaust „step-by-step" and thus to widen the range of the investigated chemophysical features.
- Real-time investigation of the size distribution (by Grimm SMPS) and the absorption response (by our recently developed (4 -PAS)).
- Additional filter-based analysis (by Sunset OC/EC analyzer)

3 Set-up



4 Parameters

The raw engine out emission of a four cylinder EURO IV PC diesel engine (2 litres turbo charged, common rail injection system) was investigated.

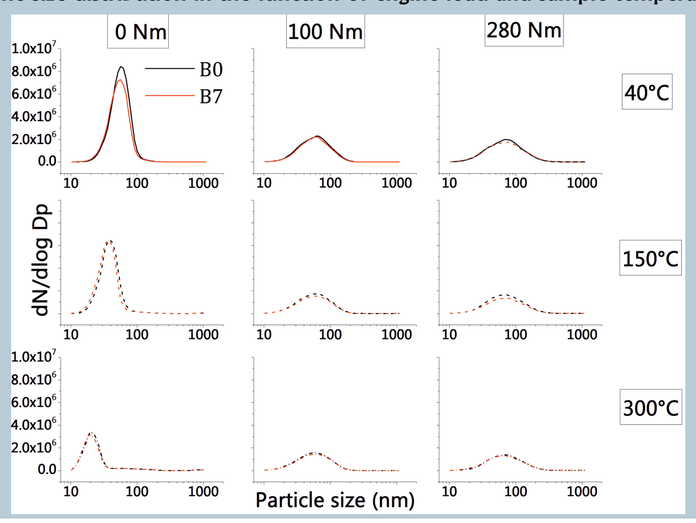
F Two types of fuels were tested:
B0 :commercial diesel acc. to EN 590
B7 : EN 590 including biofuel (FAME) in 7%

P At three characteristic engine conditions (rev/torq)
1. 820 1/s, 0 Nm 2. 3000 1/s, 100 Nm
3. 3000 1/s, 280 Nm

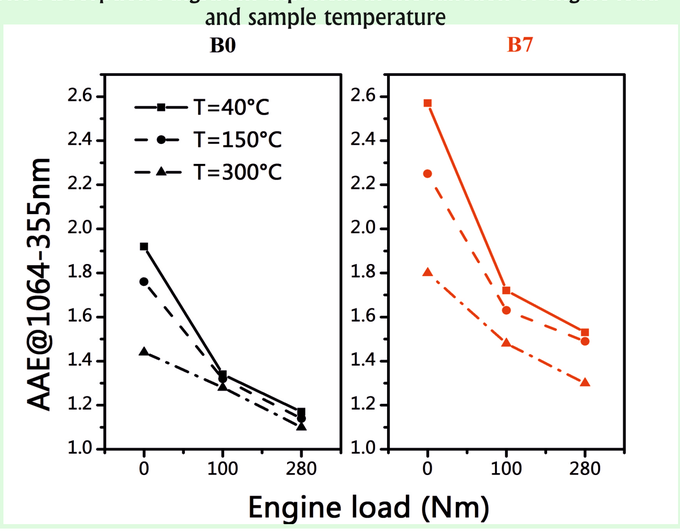
T Posterior tempereature treatment
1. T=40°C 2. T=150°C 3. T=300°C

5 Results

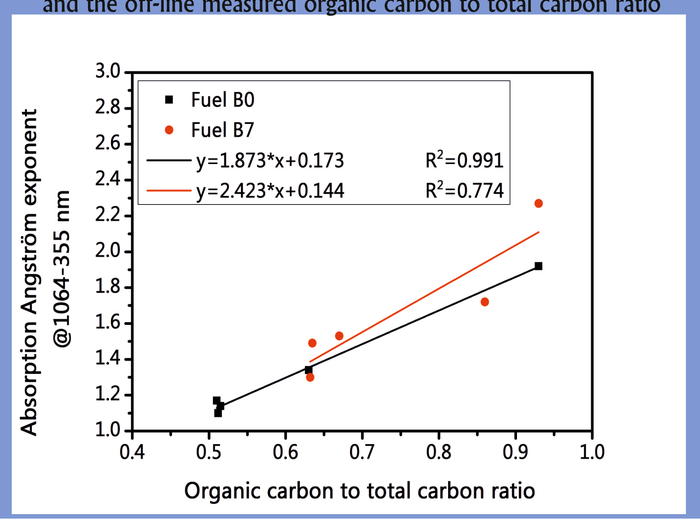
The size distribution in the function of engine load and sample temperature



The Absorption Angström exponent in the function of engine load and sample temperature



Correlation between the real-time measured Absorption Angström exponent and the off-line measured organic carbon to total carbon ratio



6 Conclusion

The engine load and the posterior temperature treatment has significant impact on the size distribution of diesel emitted particles, whereas FAME content has no notable effect on that.

In contrast, the FAME content can substantially modify the absorption characteristics of particles even in relatively low amount in the regulated domain. The absorption Angström exponent values (AAE) of B7 fuel emission are higher than that of B0 fuel at all engine load and sample temperature values.

The measured differences in the AAE values are driven by the organic carbon content of the particles that is confirmed by the reported good correlation between the AAE and organic carbon to total carbon ratio (OC/TC).

Based on our results, two-wavelength PA systems could be a good candidates for the on-line investigation of the OC content which is essential in a context of the toxicicity of diesel particles.

7 References and acknowledgement

1. F. R. Faxvog & D. M. Roessler (1982) Mass Concentration of Diesel Particle Emissions from Photoacoustic and Opacity Measurements, Aerosol Science and Technology, 1:2, 225-234

2. KHAN, M. Yusuf, et al. Characterization of PM-PEMS for in-use measurements conducted during validation testing for the PM-PEMS measurement allowance program. Atmospheric environment, 2012, 55: 311-318.

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