TOWARDS A NATIONAL STANDARD FOR MASS CONCENTRATION AND NUMBER CONCENTRATION OF SOOT PARTICLES IN GERMANY

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Emissions of soot particles, notably from motor vehicles, but also due to other biomass and fossil fuel combustion processes can influence air quality, environment and human health in a serious way. In the course of the introduction of a European Emission Standard (Euro 5b/6) in 2014, a limit value for particle number concentration of automotive emissions from diesel as well as gasoline cars has been realized. At the same time, the limit value for particle mass concentration is still in use as secondary parameter related to older emission standards (Euro 1 – 5). As a result, numerous techniques from various manufacturers are increasingly brought to the market. Thus, different physical principles like electrical sensors for measuring particle number and mass, scattered light and photo-acoustic sensors for determining the mass, or novel exhaust emission condensation particle counters (EECPC) for measuring the particle number are used.

The validation and traceable calibration of those techniques, particularly under metrological considerations, have not been satisfactorily achieved so far. A key component for this task is a highly stable, comprehensively characterized reference soot generator. Therefore, two laboratory setups for generating and measuring soot aerosols were developed and installed at the German Metrology Institute (PTB). The core elements of both systems are propane-driven combustion-based soot generators (CAST) for the production of a stable reference soot aerosol with various size, number and mass distribution. The measuring ranges are: mass concentrations from 0.005 to 300 mg/m^3, number concentrations up to 10^8 cm^{-3} and size ranges from 10 to 500 nm. The combustion process of both soot generators is controlled by means of accurate mass flow controllers, which allows for the generation of stable and monomodal particle number size distributions. The produced soot aerosol is diluted and conditioned by specific, new developed applications like counter flow mixer and laminar flow tunnel and is classified by size before distribution to different devices under test.

The aspired goal of the setups is to offer an independent calibration service for industry that provides the instruments used for the regulatory periodic emissions control and the end users. An additional scope of the setups is to develop a calibration infrastructure for Black Carbon measurement devices in the framework of the EMPIR environmental call in 2016. Here we show studies and results of both measurement setups, in particular regarding the stability of the new PTB-soot aerosol standards as well as the reproducibility of the adjustable operating points of the soot generators. Furthermore, correlations between the gravimetrical and the photo-acoustic soot mass concentrations are shown. Efficiency curves and linearity tests of different condensation particle counters and reference electrometers with regard to the soot particle number are presented.