MetroPEMS: Metrology for portable emission measurement systems. Project goals and preliminary findings

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Nitrogen oxides and particulate matter emitted by vehicles are among the most important components of urban and suburban air pollution. They are associated to multiple damages to human health, to negative impacts on agricultural yields, and particulate matter emission, which is dominated by black carbon, has important effects on climate change by acting as a negative radiative forcer. Therefore, controlling vehicle exhaust emission has been in the agenda of regulatory bodies around the world since the last decades and significant progress has been achieved in reducing emission by the introduction of stricter regulations and controls. However, the type approval (TA) of light duty vehicles (LDV), traditionally done in dynamometer test benches has proven not to be representative for real driving conditions. In order to tackle this issue, real driving emission (RDE) tests have been introduced by legislation since 2017 in Europe.

Portable emissions measurement systems (PEMS) are used for on-road TA real driving emission of LDVs. The implementation of RDE measurements is complementary to stationary in-laboratory dynamometer test over the current Worldwide Harmonised Light Vehicle Test Procedure (WLTP), from which not-to-exceed conformity factors are defined for nitrogen oxides (NO_x) as well as for particle number (PN). These conformity factors established by the regulation are revised periodically and have been reduced in each revision. Although, the regulations are revised continuously, there are few metrological specifications nor infrastructure available to guarantee SI-traceable calibration of PEMS.

The MetroPEMS project addresses the three key components of a PEMS system: i.e. modules for the determination of (i) NO/NO_2 concentrations and (ii) PN, as well as (iii) exhaust mass flow. By studying existing commercial PEMS devices and comparing the performance of their components with known and fully traceable laboratory standards, the project will develop uncertainty budgets for each of these three key parts. Furthermore, based on these uncertainty budgets, the major contributing elements to the uncertainty of the PEMS device will be identified, and best practices will be developed to improve the underlying factors of these uncertainties and to improve comparability. Based on the deeper understanding of the uncertainty sources, this project will develop and intends to qualify a ‘golden’ PEMS (gPEMS) instrument, which will represent the best available level of accuracy that can be achieved and will use the procedures developed in the project. This qualification will make use of the project’s newly developed gas and particle standards, optical transfer standards, exhaust mass flow standards and metrologically sound calibration procedures. The gPEMS is going to be based on a commercial instrument that will be also validated with available procedures on a chassis dynamometer and constant volume sampler (CVS) system set-up. This will be done in order to maximise knowledge transfer and applicability for end-users.

The MetroPEMS project is creating the metrological capabilities that will provide traceability for PEMS calibration. More information about the project can be found at https://metropems.ptb.de