Evaluation of a miniaturized exhaust emission measuring system for L category Vehicles measurements in real world driving conditions

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Introduction

Legislation regarding emission standards for L-category vehicles is less strict than passenger vehicles[1] also resulting from a lack of standardized methods of measuring this type of vehicles in real-world driving conditions. The equipment used to measure vehicle emissions while operating in real driving conditions is the Portable Emissions Measurement Systems (PEMS) that has also been incorporated into regulations for Real Driving Emissions (RDE) testing in Europe, which is difficult up to impossible for some motorbikes due to size and weight limitations [2]. SEMS systems have the potential to fill this gap or become a screening tool for identifying high emitting motorbikes. The goal of this study is to demonstrate such a system that includes low-cost ambient gas sensors and an optoacoustic BC sensor[3], and to assess this system in real-world driving conditions for various types of L-category vehicles while focusing on the sensitivity and reliability of the implementation.

Methodology

At first, simulations of Real Driving Emissions (RDE) trips on chassis dynamometer were performed while also using standard lab-test equipment like CVS for sampling and reference instruments such as the MSS. For conducting measurements directly from the exhaust, a dedicated sampling and an adjustable dilution system have been designed to accommodate for small flow and avoid pulsations that are frequently coming from the exhaust of motorbikes. This also makes the use of typical Exhaust Flow Meter (EFM) devices impossible, so other alternatives are explored such as calculations based on transient engine variables (e.g. lambda, MAF, MAP). RDE cycles were subsequently performed with the SEMS system on the road for different motorcycles. RDE testing is designed to capture a wide range of real-world driving scenarios, ensuring that emissions data accurately represent typical driving patterns for each subcategory of L-vehicles.

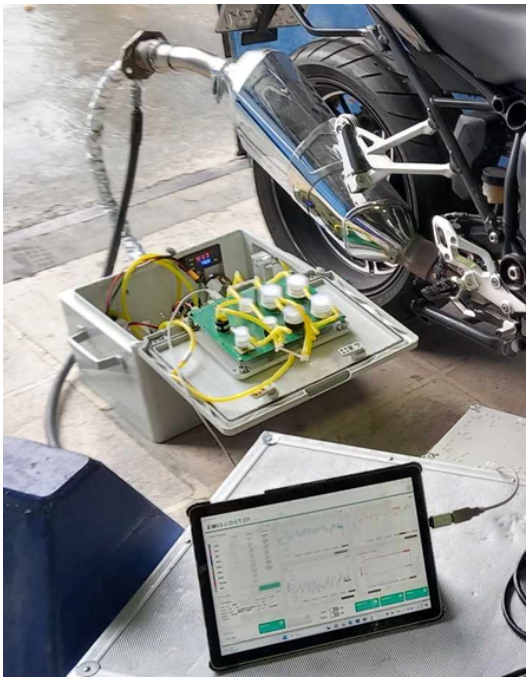

Fig. 1: Experimental setup for motorbike measurements

Results & Conclusions

The emission measurement components of the SEMS comprise commercial electrochemical sensors for measuring CO and NO gases concentration, commercial NDIR analyser for measuring CO2 gas concentration and a prototype optoacoustic sensor for measuring BC mass concentration. Validation of the SEMS system is performed in comparison with PEMS measurements with a WMTC cycle on the chassis dyno. Comparison between chassis and real-world measurements evaluate whether there are significant differences in exhaust concentrations and presumably spot high emitters (especially for CO and BC) among different types of L-category vehicles. This study demonstrates the use of a Sensor-based Emissions Measurement System for main gaseous pollutants (CO2, CO, NO) and BC particles for which no other instrument is available for on-road exhaust measurements. The results contribute towards developing a low-cost portable system for real-driving condition measurements of L-category vehicles for which real-world emission control is rather challenging at the moment.

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