Road to Lab Light-Duty vehicle campaign in terms of Particle Number emission over custom RDE test cycle

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INTRODUCTION

Both Real Driving Emission (RDE) and laboratory (WLTP, performed on a chassis dynamometer) procedures for quantifying particle emissions by number (particle number, PN) are mandated by current automotive exhaust emissions regulations. While the processes of PN emission measurement share similarities, notable differences exist between RDE and WLTP. The former has prescribed boundary conditions, but the characteristics and conditions during each RDE test can vary significantly – and thus it is inherently less repeatable than the latter. In contrast, the WLTP is a highly repeatable procedure in force in the EU since 2017, with narrow limitations in terms of temperature range, driving conditions, and other factors.

A comprehensive Light-Duty (LD) campaign, as part of the EU-funded PAREMPI project, was undertaken to investigate emissions of raw gaseous compounds, as well as particle emissions by mass (particle mass, PM), number (particle number,PN) and the simulation of atmospheric ageing of particles and aerosols from vehicles. This study outlines the 10-nm Particle Number (PN10) and 23-nm Particle Number (PN23) emission results obtained during custom RDE test cycle. Tests were executed both on road and in the laboratory conditions.

METHODS

Most regulated vehicle test procedures require adherence to specific standardized processes, such as a prescribed order of various driving modes or auxiliary usage during the tests. The methodology presented here was intentionally designed to deviate from these boundary requirements and includes additional components. Initial steps involved establishing the test cycle requirements, followed by selecting a reference vehicle (V3, consistent across all campaign cars) to execute the initial run. Subsequently, the test route underwent analysis, considering various output data, including ambient conditions, On-Board Diagnostics (OBD) parameters, driving style, traffic intensity, slope characterization, and, notably, speed characteristics, along with the frequency of stop events.

Upon approval, the test cycle, named 'RDEsim' (with 'sim' denoting simulation on the chassis dynamometer), was duplicated and integrated into the emission system at BOSMAL's chassis dynamometer laboratory no. 2. Finally, six vehicles (see Table 1) underwent testing using the chassis dynamometer facility, traversing the identical 72-minute RDEsim cycle and subsequently replicating the same RDE cycle on the road.

Table 1: Cars used for this study with fuel and propulsion type, Euro emission class

Car number	Fuel type	Specificity	Euro emission class
V1	Gasoline	PHEV	6d
V2	Diesel	PHEV	6d
V3	Gasoline		6d
V4	Diesel		6d
V5	Gasoline	no GPF	5
V6	Diesel	no DPF	4

PHEV = Plug-in hybrid electric vehicle / GPF = gasoline particulate filter / DPF = diesel particulate filter

RESULTS

The investigation encompasses PN10 and PN23 emission data, OBD parameter readings, ambient conditions, and various other factors, for both RDE and chassis dyno tests. The analysis results will explain similarities or differences between the same route executed in real road conditions and a simulated dyno cycle. We will attempt to explain whether PN10 and PN23 results can be compared and if the methodology conducted in this manner deserves attention in future campaigns.

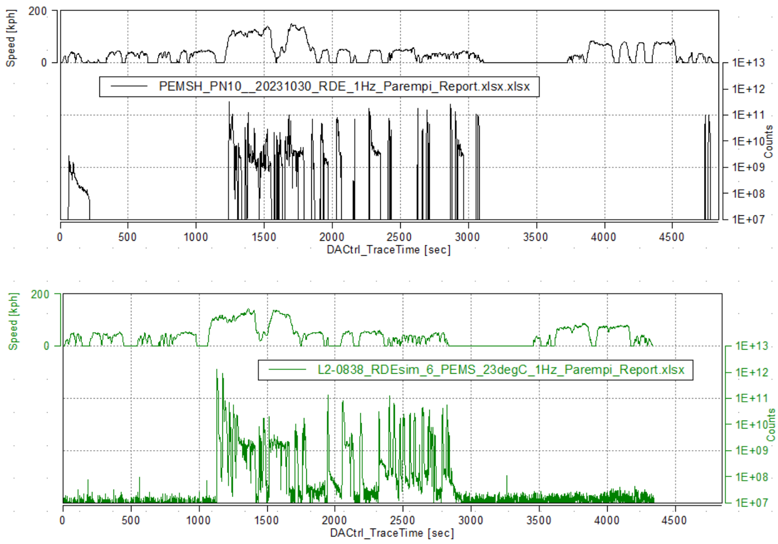

Figure 1: Speed and PN emission chart for the PHEV V1, the upper chart is PEMS RDE test with PN10 measurement while the lower chart is RDEsim test with regulated PN23 measurement.

CONCLUSIONS

This study focuses on the comparison of PN emission testing methodology and the obtained results in real driving conditions on the road and in the chassis dyno laboratory. Preliminary results reveal similarities between RDE tests conducted on the road and those simulated in the laboratory. However, certain distinctions have been identified, necessitating in-depth analysis and individual explanation.

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