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PN (< and ≥ 23nm) emissions of a Euro 6b GDI vehicle under WLTC and RDE conditions

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Context and Objectives

- Current legislation focuses on solid particles with a $\phi \geq 23 \text{ nm}$ only
 - A lower threshold diameter is expected, in the image of aeronautics for which a $d_{50} = 10 \text{ nm}$ is already defined
 - Aerosol conditioning process (volatile fraction removal, dilution), which may induce artifacts and solid particle losses, is a key step for a robust measurement of such smallest particles
- ⇒ These particulate emissions as well as the potential compatible protocols, still need to be evaluated and defined

Vehicles description

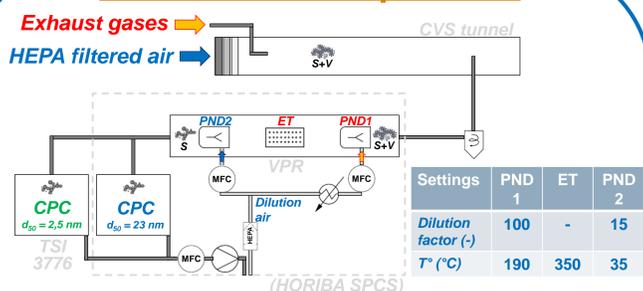
1 European Passenger car model, 3 versions :

n° 1	n° 2	n° 3
Euro 6b 1.2 GDI engine 3WC Mileage = 18 640 km	Euro 6d-TEMP 1.2 GDI engine 3WC + GPF Mileage = 13 880 km	Euro 6d-TEMP 1.5 Diesel engine DOC + SCR Mileage = 5 646 km

Chassis dyno driving conditions

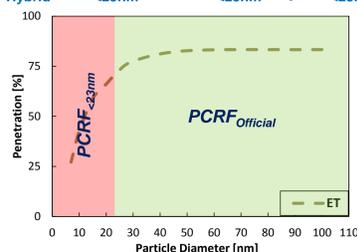
WLTC	CADC	Homothetic RDE
Distance = 23,262 km Duration = 1800 s	Distance = 51,687 km Duration = 3143 s	Distance = 37,7 km Duration = 2593 s

Particle Number protocol

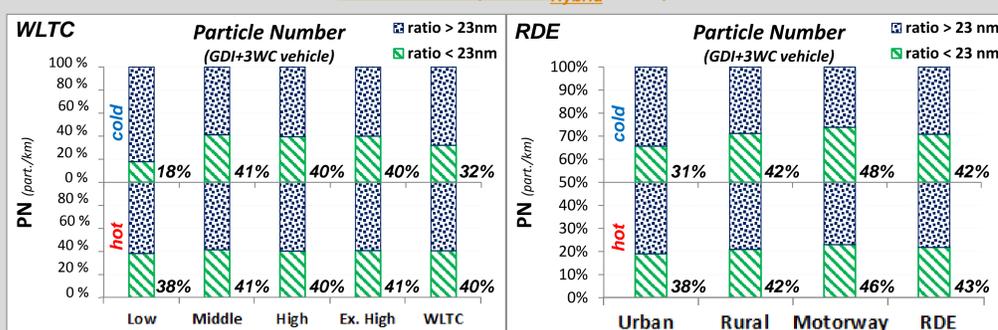


Particle Concentration Reduction Factor

- $PN_{\phi \geq 23 \text{ nm}}$ (SPCS):
 $PCR_{\text{Official}} = (PCR_{30} + PCR_{50} + PCR_{100}) / 3$
- $PN_{\phi < 23 \text{ nm}}$ (CPC_{TSI 3776} - SPCS):
 $PCR_{<23\text{nm}} = (PCR_7 + PCR_{10} + PCR_{15} + PCR_{20}) / 4$
- PN_{Total} :
 $PCR_{\text{Hybrid}} = \%_{<23\text{nm}} * PCR_{<23\text{nm}} + (1 - \%_{<23\text{nm}}) * PCR_{\text{Official}}$



Results (PCR_{Hybrid} corr.)



Conclusions

- Solid particle emissions < 23 nm have been evaluated on chassis dyno with current PMP protocol and CPC, waiting for an official future evolution of the PMP protocol
- VPR is a key parameter regarding to PN results, particularly for the smallest particles:
 - PCR need complementary work to avoid under/overestimation due to particle size impact
 - Dilution Factor also, to avoid potential renucleation phenomenon which could be tricky in case of downstream DPF or GPF measurements, due to their lower need of dilution
- PN emissions of the Euro 6b GDI vehicle mainly consist of 60 % of particles with $\phi \geq 23 \text{ nm}$
- Motorway phase of the homothetic RDE cycle slightly increases the ratio of particles < 23 nm
- Cold start significantly increases the part of PN with $\phi \geq 23 \text{ nm}$, reaching a ratio of 82 % on WLTC
- Homothetic RDE cycle offers an efficient and faster solution to reproduce RDE conditions on chassis dyno

Ongoing work

- Evaluation of the PMP parameters and particle emissions involved by the following versions of the model car, compliant with Euro 6d-TEMP, equipped with two additional powertrain and aftertreatment configurations: GDI with 3WC+GPF or Diesel with SCR
- Pursue the work on particle composition (Black Carbon, particulate bound PAHs) and unregulated gaseous compounds

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