Unregulated Gaseous and Particulate Emissions During Active Regeneration of Diesel Particulate Filters

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Context and Objectives

- Diesel Particulate Filter is an efficient solution to drastically reduce particulate emissions
- Diesel soot accumulated inside the DPF must be burnt in average every 600 to 800 kms
- This process named «active regeneration» leads to an increase in pollutant emissions

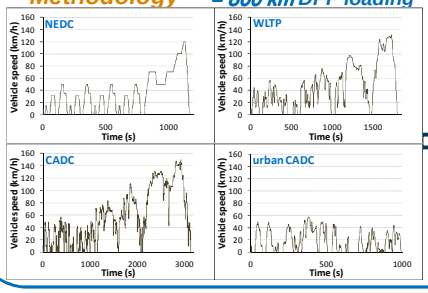
⇨ These gaseous and particulate emissions need to be better defined

Vehicles description

Engine	€5 1.5 Diesel	€5 1.6 Diesel
After-treatment	DOC + cDPF	DOC + FBC
Location	underfloor	close-coupled
Mileage *[km]*	13 000	27 000

Methodology

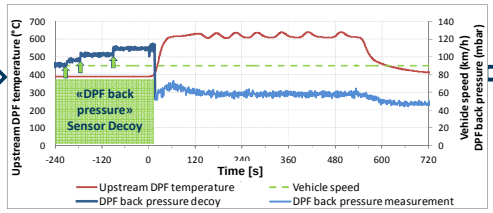
≃ 800 km DPF loading



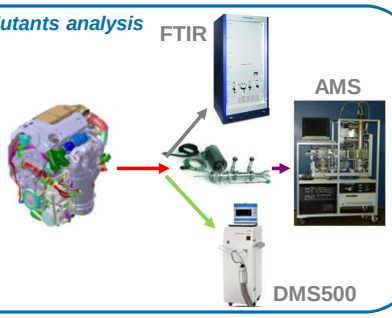
Active Regeneration triggering

Vehicle speed = 90 km/h

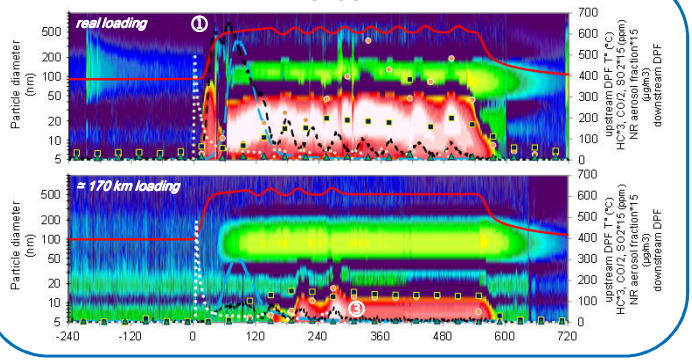
upstream DPF Temperature ≃ 390 °C before regeneration



Pollutants analysis



Vehicle A



Results – Control strategies

- The active regeneration's progress of the two vehicles is similar but their control strategies present different accuracies.
- Regeneration's durations are comparable with length ranging from 8 (vehicle B) to 9 minutes (vehicle A). Moreover, they are more variable with vehicle A.
- Targeted temperatures are close with average upstream DPF temperature of 610 ºC during the whole regeneration.
- The emissions are widely variable, whether it is between the vehicles or between different regenerations with the same vehicle.
- The vehicles characteristics are different (engine, catalysts technologies volumes and locations, actuators,…) with noticeably different mileages and in use lubricants, the observed emissions should not be related to the after-treatment technology only.

Particulate Number
1,E+3 1,6E+4 2,5E+5 4,E+6 6,3E+7 1,E+9
dN/dlogdp/cc

Non refractory aerosol fraction
⇨ Sulfates
⇨ Organic
⇨ Nitrates

DPF temperatures and exhaust gases
Unburnt hydrocarbons
CO ; Upstream DPF T
SO2 ; Downstream DPF T°

Results – Emissions

➢ *Gaseous emissions*

① ⇨ SO_2 is more emitted and variable with vehicle A due to successive desulfations of the DOC, linked to the temperature over/undershoots.

➢ *Nucleation mode*

② ⇨ For the two vehicles, the combined effect of DPF soot load, catalyst poisoning and control strategies contribute to its appearance (presence or delay) and importance (quantity and width).

③ ⇨ The post-injection control can promote the nucleation particles release because of unburnt hydrocarbons, saturation index and after-treatment device temperature increase.

➢ *Accumulation mode*

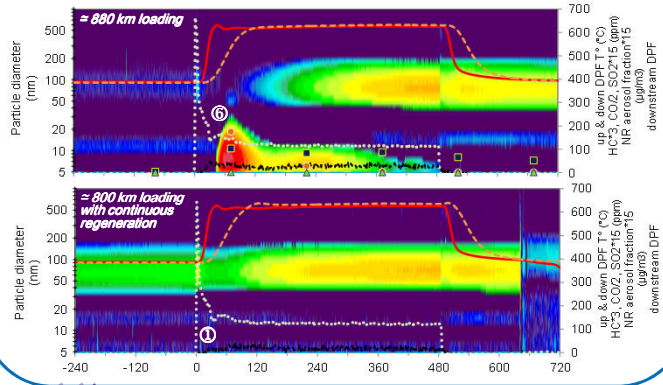
④ ⇨ The accumulation mode is increased during the active regeneration, due to the soot cake removal and the associated filtration efficiency decrease.

➢ *Composition*

⑤ ⇨ The volatile fraction of PM mainly consists in sulfates and various organic species.

⑥ ⇨ These compounds coexist on the two modes. Sulfates further seem associated to the nucleation particles during the active regeneration events.

Vehicle B



Acknowledgements

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Ongoing work

- Emissions comparison of the two €5 Diesel vehicles with a €5 Gasoline Direct Injection (GDI) vehicle during different driving cycles including particles morphology (TEM) and Polycyclic Aromatic Hydrocarbons (PAHs) composition of the particles
- Pursue the work on €6 Diesel vehicles (SCR and NOx trap technologies) and Secondary Organic Aerosols (SOA) precursors

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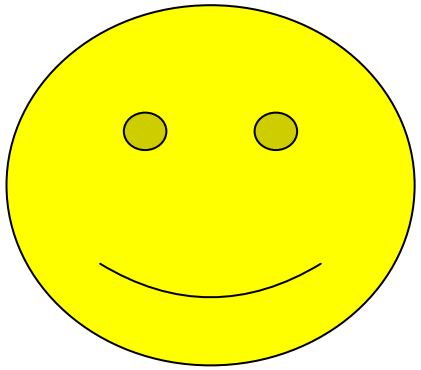

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