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Influence of Fuel Sulphur on the Formation of ultrafine Particulates in Diesel

Experimental conditions

Tests were performed on a regulatory chasis dyno with a 406 HDi vehicle. Two configurations were tested : without post-treatment system and with DPF system (SiC honeycomb DPF – oxydation catalyst upstream DPF – ceria-based fuel additive). PM emission is measured in steady state conditions(50 - 100 – 120 km/h) by weighing regulated filter, and by sizing (SMPS) ; chemical analysis allows to determine SOF/IOF ratio.

Effect of DPF on PM emission

Without DPF system PM emission is observed whatever the vehicle speed, the regulated filter is black and PM size is mainly near 90nm.
With DPF system, at 50km/h no PM emission can be mesured. At 120km/h a higher mass of "PM" is collected than without DPF system. In this case regulated filter is not black but yellowish.

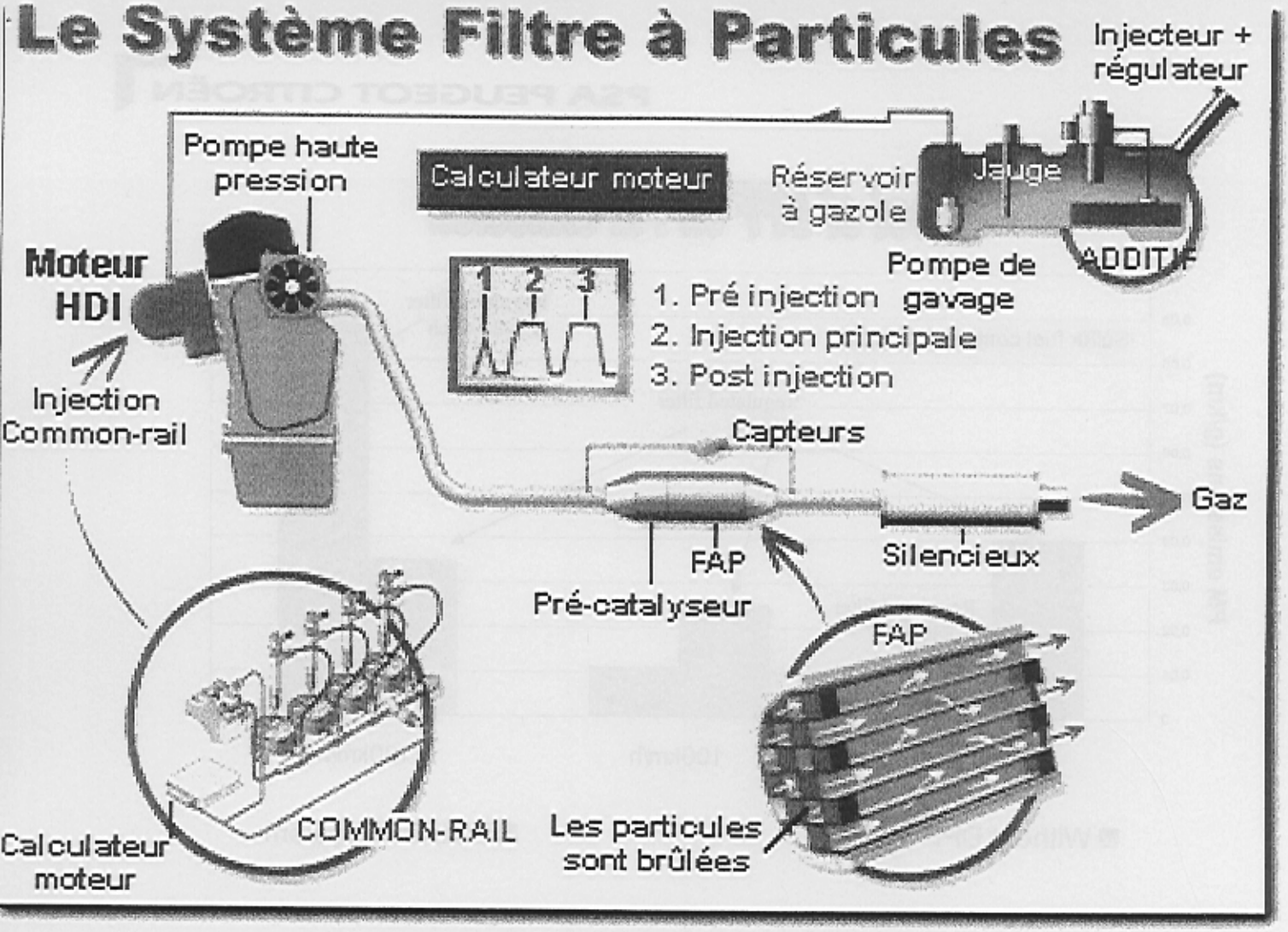
Because of the color of regulated filter, we suspect that the emission observed at 120km/h is not Diesel soot but a secondary PM emission. Chemical analysis demonstrates that this secondary PM emission is mainly composed of sulfate and SOF adsorbed on it. In order to reduce this amount of secondary emission a low level sulfur fuel is tested.

Fuel sulfur content effect on secondary PM emission

The 120km/h steady state test is performed with 4 types of fuel : 500ppmS – 300ppmS – 50ppmS – less than 10ppmS. As expected with low level fuels (50ppmS and less than 10ppmS) no PM emission can be measured.

As a conclusion

☞ High level sulfur fuel induces secondary PM emission downstream DPF which is supressed with low sulfur fuel (less than 50ppmS)
☞ Other tests are performed to cover all the range of operating conditions to determine a possible threshold.



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Experimental conditions

- Vehicule : 406 HDi - DPF : SiC filter - Additive : EOLYS
- Chassis dyno with dilution tunnel
- PM collected on regulated filter
- PM size measured by SMPS (10-800nm)
- Compositional analysis of PM : SOF/IOF
- PM measurement on steady state : 50 - 100 - 120km/h

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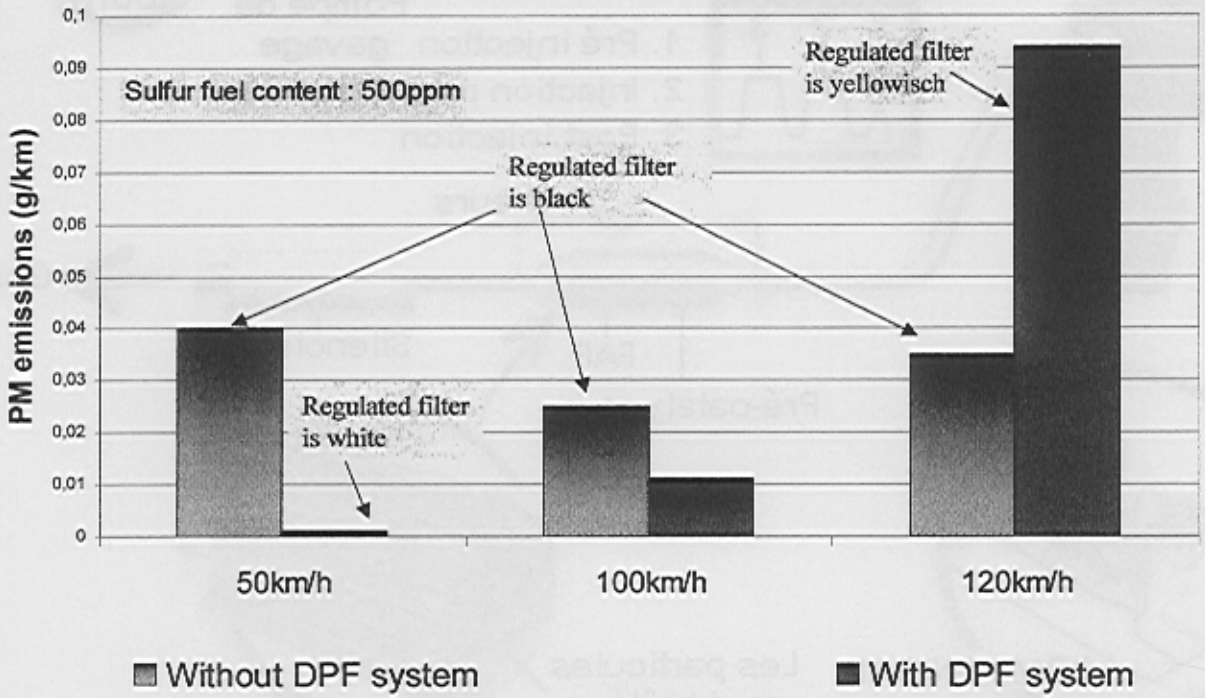
Effect of DPF on PM emission



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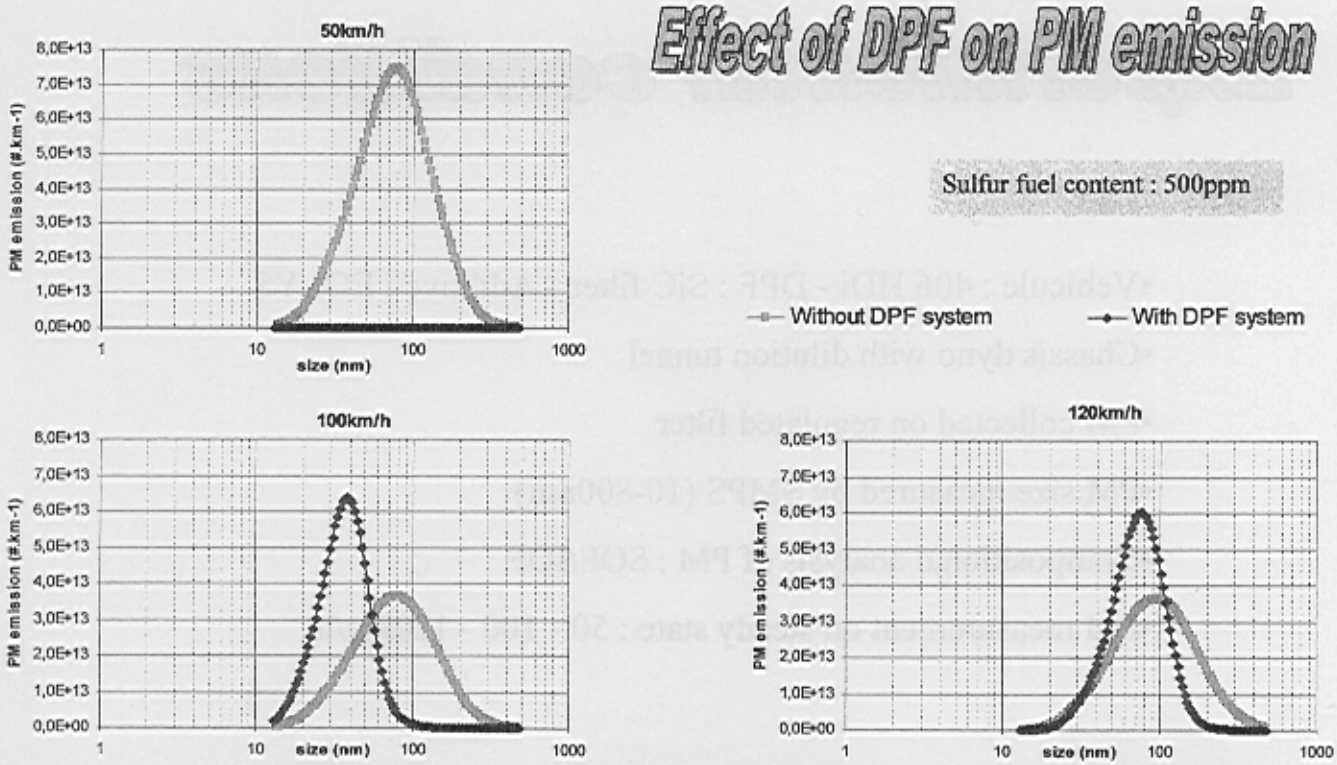
Effect of DPF on PM emission

Sulfur fuel content : 500ppm



International ETH Workshop on Nanoparticle Measurement 9-10/08/99

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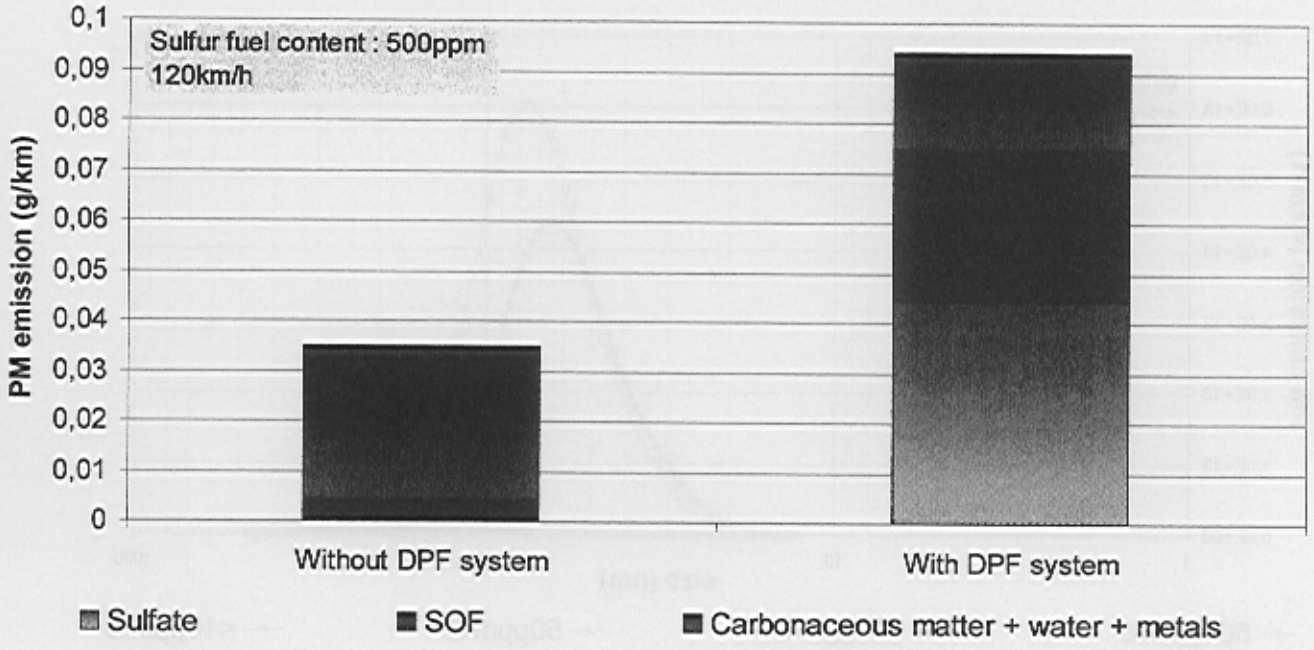
Effect of DPF on PM emission



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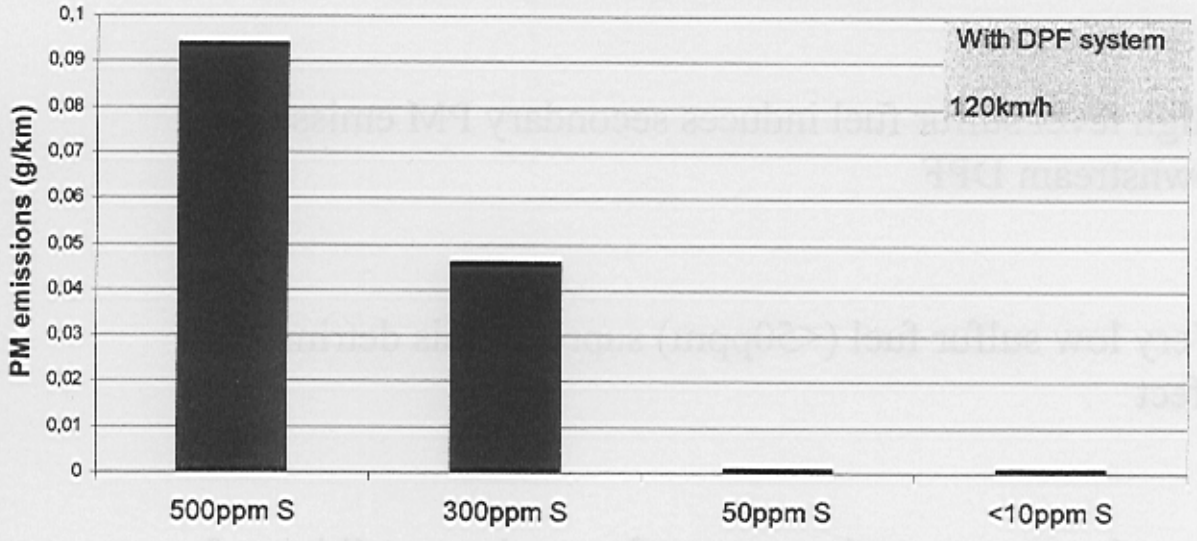
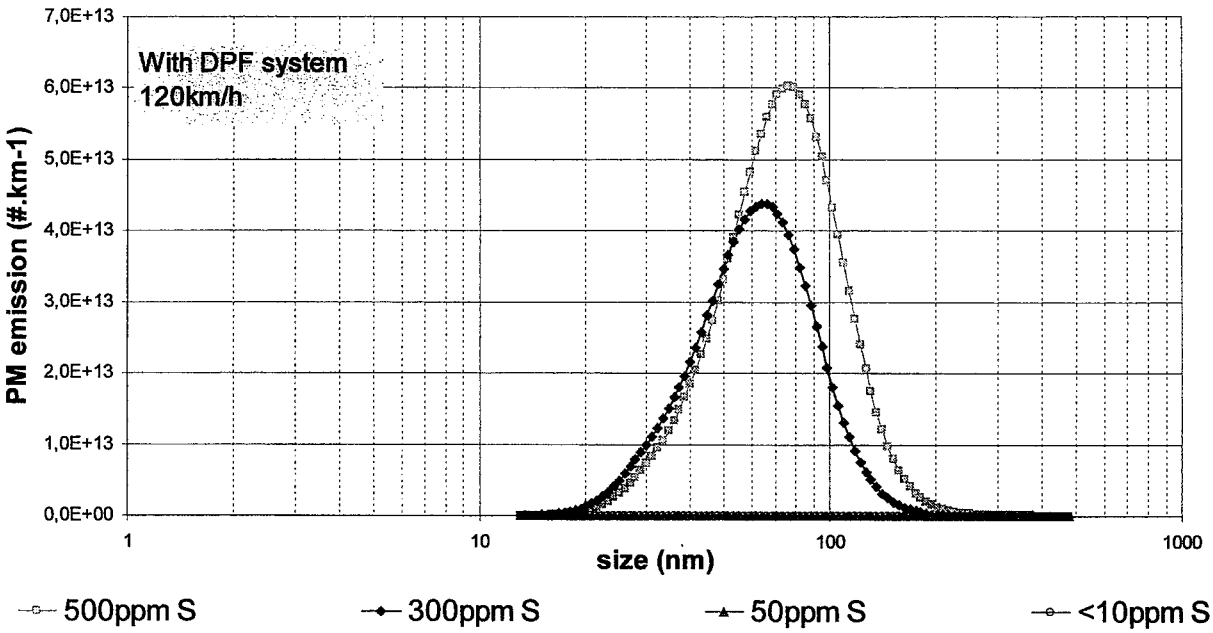
Fuel sulfur content effect on secondary PM emission



Fuel sulfur content effect on secondary PM emission



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Conclusion

- High level sulfur fuel induces secondary PM emission downstream DPF

- Very low sulfur fuel (<50ppm) supreses this detrimental effect

- Ongoing tests covering range of operating conditions, for threshold determination and for other compounds (nitrates,…) effect evaluation.