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PMP LD Inter-Laboratory Exercise

Interesting Observations and Lessons Learned

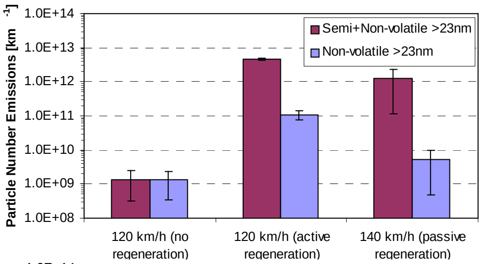
J. Andersson[1], B. Giechaskiel[2], P. Dilara[2]

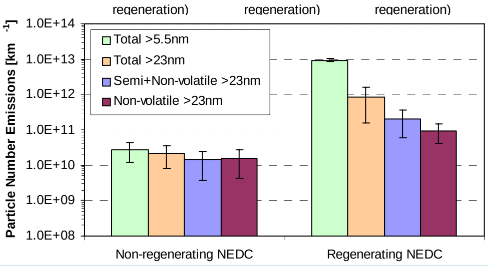
Experimental Set-up

Samples were thermally treated by hot dilution at 150°C and passage through an evaporation tube (ET) at 300°C. Particle numbers >23nm counted by twin 3010D CPCs placed before and after the ET enabled semi-volatile (pre-ET) and solid particles (post-ET) to be compared. An EEPS connected directly to CVS measured size and concentration of total volatiles, semi-volatiles and solids.

Regeneration (Figures 1 and 2)

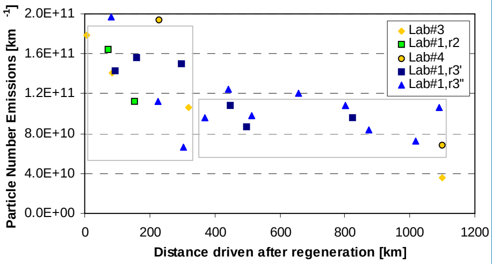
No regeneration at 120 km/h: Low porosity DPFs have very low particle number emissions (<10^9/km) during normal cruise operation.
Active regeneration at 120 km/h: Increased solid particle emissions to an average ~10^{11}/km over a 20 minute steady state.
Passive regeneration at 140 km/h: Showed limited solid particle emissions (<10^{10}/km).
Semi-volatile particle emissions were elevated under both passive and active regeneration conditions:
NEDC: Short periods during regenerations showed nucleation mode levels many times higher than non-regenerating tests. Across the loading and regeneration cycle this still has minimal impact on average emissions. Solid particles did increase but by a small factor relative to the cold start NEDC, and the increase is a few percent when averaged over the entire loading and regeneration cycle of 98 NEDCs. On this basis there is no necessity to require specific regulatory tests to quantify solid particles during regeneration.





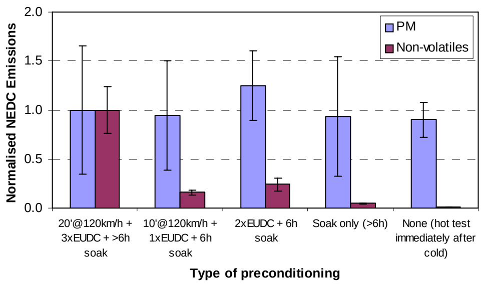
Stabilisation distance (Figure 3)

After regeneration, 300 km to 400 km (approximately 30% of the distance between regenerations) is required to stabilise the DPF to give repeatable particle number results. For future work comparing DPF particle number emissions, stabilised loading should be achieved.



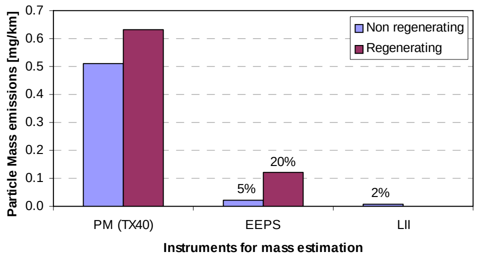
Preconditioning (Figure 4)

More severe engine operation preceding a cold start NEDC led to higher particle number emissions during the initial 5 minutes of that test. It is believed that the walls of the DPF are 'charged' with solid carbon particles during the preconditioning. These are released during subsequent cold start tests possibly due to temperature expanding the substrate and pressure effects 'blowing-out' stored particles. Preconditioning must be considered for repeatable and representative post-DPF particle number measurements. The mass method was not sensitive enough to distinguish effects of pre-conditionings.



Mass method (Figure 5)

Filter measured PM emissions levels from efficient wall-flow DPF equipped Diesels were much higher than carbon (LII) and particle (EEPS) derived masses: gas-phase volatiles retained by the filter matrix mask the true mass emission and there is no mass vs. number correlation for these vehicles. The filter mass method is inaccurate, insensitive compared with the number method and inappropriate for measuring particle emissions from DPF equipped Diesel vehicles.



[2]Barouch Giechaskiel, P. Dilara
European Commission • DG Joint Research Centre
Institute for Environemnt and Sustainability
Tel. +39 0332 786161 • Fax +39 0332 789259
E-mail: barouch.giechaskiel@jrc.it

[1]Jon Andersson
Ricardo Consulting Engineers
Chemistry Department
Tel. +44 1273 794477• Fax +44 1273 794118
E-mail: Jon.Andersson@ricardo.com

European Commission
Directorate-General
Joint Research Centre