

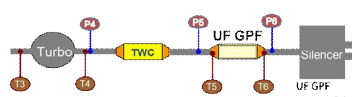
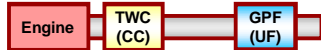
GPF durability study at two different exhaust locations for two identical vehicles: Effect of soot and ash accumulation over life time

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- Increasing tight PN emissions regulations affect Gasoline Direct Injection (GDI) engines in addition to Diesel. Gasoline Particle Filters are potential solutions to comply with the tight legislation requirement on PN. Even if some learnings from the development and application of particulate filters to Diesel engines can be transferred to gasoline engines, the particulate composition, the mass to number ratio and the temperature as well as the gas composition of gasoline engines are significant different to Diesel engines. Therefore, there is the need to study the application of gasoline particulate filters (GPF) in depth.
- The current work summarizes the performance of an uncoated GPF placed in 2 different locations à Close-coupled (CC) and under-floor (UF) in two identical vehicles (Opel Zafira) with a 1,6 litre GDI engine displacement. Both vehicles are running on road over a pre-defined cycle that reflects the “average customer behaviour” up to 200k km. Data on GPF PN filtration performance over lifetime are reported as well as ash accumulation vs. mileage and backpressure.

Evaluated Exhaust Layout 1:



CC : Close Coupled, UF : Under Floor

Evaluated Exhaust Layout 2:

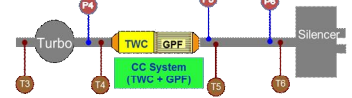


Figure 1: Vehicle set-up - Two Zafira Tourer with 1,6 I turbo GDI Opel engine and UF GPF (2,4 litre volume) and CC GPF (2 litre volume) – same NGK GPF material

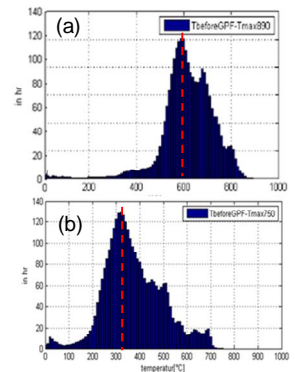
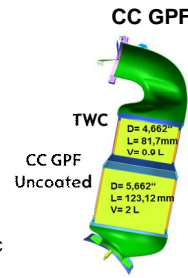
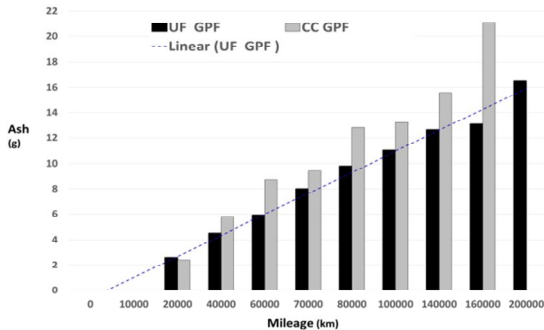


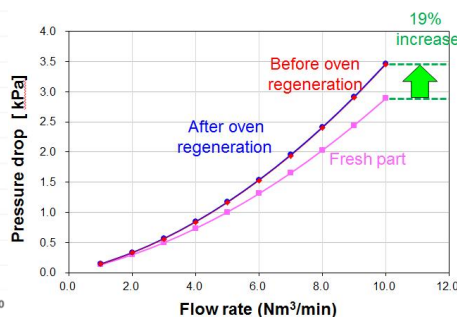
Figure 2: Temperature frequency distribution for the CC GPF (a) and UF GPF (b) on road.

- The two Zafira Tourer were driven over an “average customer cycle” on road, a combination of city (1500km), country and highway (1500km) mode.
- PN emissions measurements over WLTP were performed every 20k km together with GPF weighing and GPF CT scan to monitor GPF performance and evaluate ash accumulation vs mileage up to 200k km. The average fuel consumption over the “average customer cycle” was ~ 9.6 l/100 km (Super RON 95) and oil consumption in the range 0.02-0.03 l/1000 km.
- Uncoated NGK GPF medium porosity ~ 48% and mean pore size ~12µm.

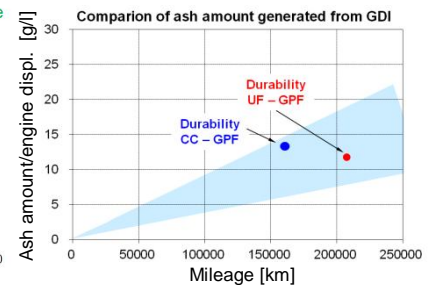
Ash accumulation vs mileage



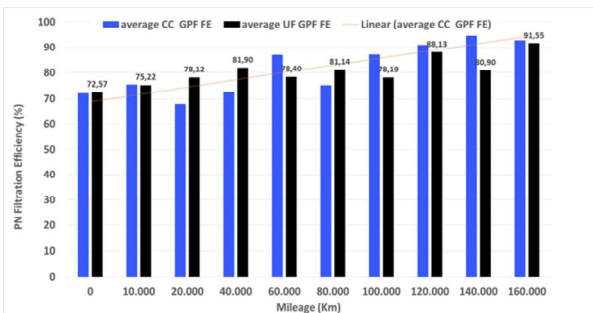
Backpressure UF GPF at 200k km



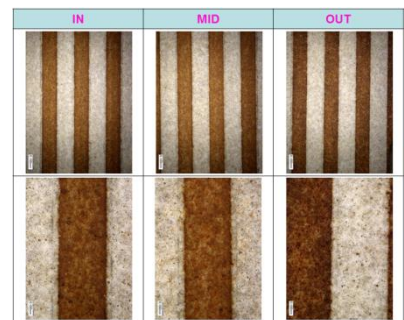
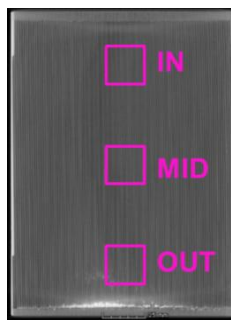
Ash accumulation experience



PN Filtration Efficiency vs mileage



Ash distribution UF GPF at 207k km



Summary & Conclusions

- Low ash accumulation over the lifetime was found for the two Zafira Tourer, having same engine and PN engine out emissions and same GPF material placed in different location (CC vs. UF) over the “average customer cycle” on road.
- Total ash (g) was ~17g total over 200k km for the UF GPF and ~ 21 g total over 160k km for the CC GPF case.
- Post Mortem Analysis of the UF GPF at 200k km showed a homogeneous ash distribution layer along the inlet channel on the whole length (inlet to outlet). The ash did not penetrate into the filter walls; ash was mainly found in front of the outlet plugs.
- Vehicle data analysis well match a more fundamental study of GPF ash accumulation over well-defined cycles (Artemis Urban & Motorway) (Rubino et al, 2017 SAE-Paper in progress). Further work and data analysis is in progress.