

S2.6.1 GASOLINE PARTICLE FILTER DEVELOPMENT

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Direct injected gasoline (GDI) engines can create significant amounts of soot under certain operating conditions such as cold start and high load. California LEVIII and U.S. Tier 3 will require a tailpipe particulate matter (PM) maximum of 3 mg/mi, down from the current 10 mg/mi. Phase-in for the lower PM will occur in the 2017-2021 model years. Euro 6 particle number (PN) standards for DI vehicles are currently at 6×10^{12} particles/km (Stage 1) and become 90% lower at 6×10^{11} particles/km in September 2017 (Stage 2). New tests like real world driving emissions (RDE) will cover more driving conditions than on the older NEDC (New European Driving Cycle). Wall flow ceramic filters are one way to remove exhaust PM and PN. The filter may be used with or without a catalytic washcoat, and when applied to gasoline vehicles is called gasoline particle filter (GPF). In a relatively clean exhaust condition on GDI relative to diesel, a clean GPF can offer filtration efficiencies on the order of 60%. This can be improved to 70-80% with a small amount of soot and/or ash on the filter walls.

It is not trivial to fit a ceramic filter into a gasoline exhaust system that already contains one or more three-way catalysts (TWCs) to control hydrocarbons (HC), carbon monoxide (CO), and nitrogen oxides (NO_x). Often there is room underbody, downstream of the TWC(s), and the filter may be used without catalytic coating because it is not needed to meet emissions. On the other hand, some vehicles have very little ground clearance, and the filter must go in a location closer to the engine. If there are two existing TWCs, the filter may replace the second catalyst and would need to have catalytic coating itself to preserve emission control at higher speed/load conditions. Recent GPF development includes optimization of multiple, competing targets: low backpressure, high clean filtration, acceptable strength, high oxygen storage capacity, small size, and low cost. In addition, a GPF behaves differently than a DPF in terms of regeneration and ash loading behavior due to vastly different operating conditions.