

Non-volatile particle number emissions from light- and heavy-duty vehicles and marine engines

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Introduction

Exhaust gas particle emissions are well known of being harmful to human health. In Europe, solid particle number (sPN) emission legislation has been adopted for light- and heavy-duty vehicles and will be adopted in 2020 for marine sector (inland waterway vessels).

We compared sPN emissions from different road and marine applications using diesel, gasoline, ethanol blend (E85), natural gas (NG), heavy fuel oil (HFO) and marine diesel oil (MDO) fuels.

Methods

The sPN measurement method in European legislation is based on hot primary dilution and removal of volatile compounds with evaporation chamber or catalytic stripper. Furthermore, the sample gas is diluted on second stage before it enters to particle counter. In the legislation the D50% cut point for particle counter is set to 23 nm.

Vehicle emissions were measured on light- and heavy-duty chassis dynamometers using NEDC (light-duty) and WHVC (heavy-duty) cycles. Marine engine emissions were measured at laboratory and on-board using engine loads above 50%. A Dekati DEED and Airmodus A23 CPC were used for sPN measurement and sample gas was taken from a constant volume sampling system (CVS) in the vehicle measurements and from a partial flow dilution system (AVL Smart Sampler) in marine engine measurements.

Results

Results show the clear differences between fuels and technologies. Diesel engines without diesel particulate filter (DPF) had the highest sPN emissions. The order of magnitude is the same regardless of the application and used fuel (road diesel, marine fuels) (Figure 1).

The Euro 6 gasoline cars and E85 fueled FFV had 1-2 order of magnitudes lower emissions compared to diesel engines without DPF. The NG and DPF equipped diesel engines had the lowest sPN emissions, diesel with DPF being the lowest. Particulate filter for gasoline and E85 fueled cars would reduce their sPN emissions remarkably.

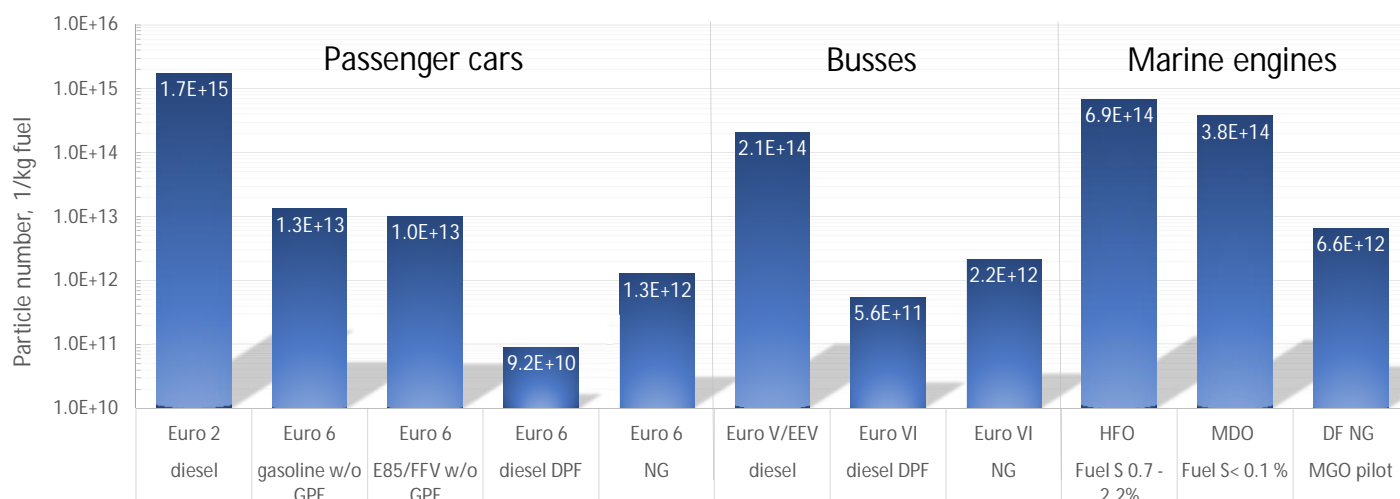


Figure 1. Solid particle number emissions from different sources, results from measurement campaigns.

Conclusions

- § The order of magnitude of sPN emission from diesel engine w/o DPF is not sensitive to fuel or engine technology
- § Natural gas engines have low sPN emission even without particulate filter
- § Spark ignited engines using gasoline or ethanol would need particulate filter to reduce sPN emissions
- § Diesel particulate filter is very efficient way to reduce sPN emissions

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