Nanoparticles Emissions of Gasoline Cars with Port Injection (MPI) and Potentials of Particle Filter (GPF)

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Abstract

Further efforts to reduce the air pollution from traffic are undertaken worldwide and the filtration of exhaust gas will also be increasingly applied on gasoline cars (GPF* – gasoline particle filter).

In the present paper, some results of investigations of nanoparticles from four MPI gasoline cars are represented. The measurements were performed at vehicle tailpipe and in CVS-tunnel. Moreover, two variants of GPF were investigated on a high-emitting modern vehicle, including attempts of soot loading in road application.

The modern MPI vehicles can emit a considerable amount of PN, which in some cases attains the level of Diesel exhaust gas without DPF and can pass over the actual European limit value for GDI (6.0 x 10¹¹#/km).

The GPF-technology offers in this respect further potentials to reduce the PN-emissions of traffic. With GPF, in the investigated steady state operation, there is no significant visible nuclei mode and the ultrafine particles concentrations below 10 nm size are insignificant.

Results

Driving Cycles

- Transient driving cycles WLTC, RTS 95 and ADAC 130
- Instantaneous filtration efficiency and exhaust temperature before GPF in the high-speed driving cycle ADAC 130
- Appearance of PM-material collected on TGA quartz filters from the lowest & highest emitting vehicles in different transient cycles.

Conclusions

The most important statements of this work can be summarized as follows:

- The present work demonstrated that the modern SI-vehicles as follows:
  - With coated cGPF added after 3WC some gaseous emission components are further reduced: CO, HC, NH₃, HCHO and MeCHO.
  - There is a positive influence of tested GPF’s on the PAH-emissions.
  - For the investigated vehicles with gasoline MPI, there is no increase of PC’s in nuclei mode (below 10 nm) at the measured constant speeds, the particle counts below 10 nm are negligible.
  - In the real road trial of uncoated GPF no increase of weight or backpressure could be observed up to 4100 km.

The present research on MPI vehicles, showed some tendencies of significantly increased PN-emissions. With this knowledge and taking into consideration the immense multiplication factor of MPI vehicles worldwide the legal PN-limitations for MPI should be quickly progressed and GPF offers excellent potentials of emission reduction.

Tested MPI vehicles

<table>
<thead>
<tr>
<th>Vehicles</th>
<th>Displacement cm³</th>
<th>Torque Nm</th>
<th>Injection type</th>
<th>Supercharging</th>
<th>Curb weight kg</th>
<th>Gross vehicle weight kg</th>
<th>Drive wheel</th>
<th>Gearbox</th>
<th>First registra-tion</th>
<th>Model year</th>
<th>km at the beginning</th>
<th>Emission standard</th>
<th>Exh. after-treatment</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opel Adam</td>
<td>1386</td>
<td>875</td>
<td>MPI</td>
<td>no turbo</td>
<td>1195</td>
<td>1465</td>
<td>Front-wheel drive</td>
<td>m5</td>
<td>5.3.13</td>
<td>2013</td>
<td>5113</td>
<td>EURO</td>
<td>TWC</td>
<td></td>
</tr>
<tr>
<td>Fiat Panda 4x4 Twin Air</td>
<td>85 @ 5500 rpm</td>
<td>550 @ 1900 rpm</td>
<td>MPI</td>
<td>no turbo</td>
<td>1170</td>
<td>989</td>
<td>Front-wheel drive</td>
<td>m5</td>
<td>2.12.15</td>
<td>2015</td>
<td>5113</td>
<td>EURO</td>
<td>TWC</td>
<td></td>
</tr>
<tr>
<td>Ford KA 1.2i</td>
<td>120 @ 4400 rpm</td>
<td>100 @ 2000 rpm</td>
<td>MPI</td>
<td>no turbo</td>
<td>120 @ 4000 rpm</td>
<td>1320</td>
<td>Front-wheel drive</td>
<td>m5</td>
<td>30.5.16</td>
<td>2016</td>
<td>5736</td>
<td>EURO</td>
<td>TWC</td>
<td></td>
</tr>
<tr>
<td>Suzuki Baleno 1.2 Hybrid</td>
<td>66 @ 6000 rpm</td>
<td>62 @ 6000 rpm</td>
<td>MPI</td>
<td>no turbo</td>
<td>1010</td>
<td>1405</td>
<td>Front-wheel drive</td>
<td>m5</td>
<td>29.4.16</td>
<td>2015</td>
<td>5113</td>
<td>EURO</td>
<td>TWC</td>
<td></td>
</tr>
</tbody>
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