OBJECTIVES DUTCH PTI DPF PROGRAM


  1. Definition of a relevant emission test
  2. Definition of a feasible PN limit value
  3. **Definition and specification of a low cost PN-tester**

- The PTI PN emission test, PN limit value and the new PN-tester are related and must be approached as a package.
PTI PN EMISSIONS OF 220 VEHICLES

161 vehicles (76%) have a PN emission of < 5000 #/cm³.
52 vehicles (24%) have an elevated PN emission of > 5000 #/cm³.
10% of the vehicles have a PN emission of > 250,000 #/cm³.

‘10% high emitters’

24% elevated PN-emission
Research of a new PTI DPF PN emission test

ISC-PN \textit{NEDC} VERSUS PTI-PN \textit{@ low idle speed}

\textit{PN (solid > 23 nm)} \textit{@ low idle speed seems to have a good correlation with PN in the ISC-NEDC test for these vehicles. Additional validation is needed.}
The PTI PN emission test, PN limit value and the new PN-tester are related and must be defined in one test procedure and validated with type approval emissions.
NPTI WORKGROUP: 2016 - 2018

- Informal open PTI workgroup.
- Goal: Development of PTI emission test procedures.
- Participants: Researchers, governments, type approval authorities, metrological institutes, test equipment manufacturers, EC-JRC.
- Exchange of reports and discussions.

- Chairman: Dr. A. Mayer.

- From 11/2016 to 06/2016 the NPTI group investigated in six meetings a PTI emission test for DPFs and the specifications of a PTI-PN-tester.
NPTI: PTI-PN RESEARCH ACTIVITIES

1. EC-JRC: Detailed PTI-PN emission research programs in 2017-2018
2. **Germany**: First PTI-PN investigation program was performed in 2018.
3. **Belgium**: First PTI-PN investigation program was performed in 2017, a second program will start in 2018.
5. **Netherlands**: Detailed PTI-Chassis dyno-PN emission research programs 2013-2019

The PTI PN test results of these five programs are very similar.

Several EU member states investigate the introduction of a PTI-PN-emission test.
2018 PRIORITY: PTI-PN-TESTERS

Potential suppliers of PTI PN testers:

- TSI
- Testo
- Naneos
- Sensors
- AVL
- Dekati
- TEN
- ........
DUTCH NMI: DRAFT SPECIFICATION OF NEW PTI PN TESTER

- Solid Particles, Psize: 70 nm.
- Measuring range: 0 – 5,000,000 #/cm³.

- 2018-Q2: Second draft is launched
- 2018-Q3: Your input is very welcome.

- Contact details: pkok@nmi.nl
DETAILS LOW IDLE SPEED PTI TEST

- Defined/repeatable engine conditions with the lowest engine PN emission:
  - Warm engine.
  - Without Exhaust Gas Recirculation (EGR-valve closed).
    - Note: EGR can increase the PN-emission 5-10 times!
    - EGR-systems are often deactivated after 60-180s low idle speed operation.

- Due to the high filtration efficiency (>99%) of most DPFs at low idle speed 70 to 80% of the vehicles even pass the PTI with an activated EGR-system within 15 seconds.

- The PN limit value is related to a certain loss of filtration efficiency of the DPF.
Pass/fail criteria of the PTI test must be related to the pass/fail criteria of the in-service conformity type-approval test but less stringent.
## PROPOSAL PTI PN LIMIT VALUES

<table>
<thead>
<tr>
<th>Euro class</th>
<th>Type Approval &amp; In Service Conformity (Manufacturer)</th>
<th>PTI (Vehicle Owner)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PM [mg/km]</td>
<td>PN [#/km]</td>
</tr>
<tr>
<td>3, 4, 5a</td>
<td>5.0</td>
<td>-</td>
</tr>
<tr>
<td>5b, 6</td>
<td>4.5</td>
<td>$6 \times 10^{11}$</td>
</tr>
</tbody>
</table>

Note: The engine out PN emission (without EGR) at low idle speed is approximately 2 to 4 E06 #/cm³.
THANK YOU VERY MUCH FOR YOUR ATTENTION

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# EMISSION LIMIT VALUES

<table>
<thead>
<tr>
<th>Emission class</th>
<th>PM limit value [mg/km]</th>
<th>PN limit value [#/km]</th>
<th>Smoke (Opacity) k [m⁻¹]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Euro 1 – 1993</td>
<td>140</td>
<td>-</td>
<td>3.0</td>
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<tr>
<td>Euro 2 – 1996</td>
<td>80</td>
<td>-</td>
<td>2.5</td>
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<tr>
<td>Euro 3 – 2000</td>
<td>50</td>
<td>-</td>
<td>1.5</td>
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<tr>
<td>Euro 4 – 2005</td>
<td>25</td>
<td>-</td>
<td>0.7</td>
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<tr>
<td>Euro 5a – 2009</td>
<td>5</td>
<td>-</td>
<td></td>
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<tr>
<td>Euro 5b – 2011</td>
<td>4.5</td>
<td>$6 \times 10^{11}$</td>
<td></td>
</tr>
<tr>
<td>Euro 6 – 2015</td>
<td>4.5</td>
<td>$6 \times 10^{11}$</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
EXAMPLE PN EMISSIONS PRE & POST DPF
FORD FIESTA EURO 6: ENGINE START & WARMING UP @ 800 RPM

DPF has a small failure
1 hour @ low idle speed.
At low idle speed the PN emission of the hot engine is
pre DPF $3,600,000 \text{#/cm}^3$
post DPF $300,000 \text{#/cm}^3$.

2014/45/EC
PTI smoke: \( k = 0.11 \text{ m}^{-1} \).
UNECE R83 Type I test
Chassis dyno NEDC*:
PM = 1.5 mg/km (CF = 0.3)
PN = $3.9 \times 10^{12} \text{#/km}$ (CF = 6.5)

A potential PTI test must be executed with a hot engine.

* Limit values PM=4.5 mg/km, PN $6 \times 10^{11} \text{#/km}$. 
IDLE SPEED TEST WITH 4 PN-COUNTERS

PEUGEOT 308 EURO 6 @ 104,755 KM

All PN-testers measure near zero #/cm³ with a ‘normal’ (= well functioning) DPF.
Ambient air is cleaned!

No solid & volatile particle emission at low idle speed.

Candidate 10 second PTI test @ low idle speed

Research of a new PTI DPF PN emission test