ETH Conference on Combustion Generated Nanoparticles

Current and future European regulations on particle emissions

Nikolaus Steininger
Automotive Industry Unit
Enterprise and Industry Directorate-General
European Commission
nikolaus.steininger@ec.europa.eu
Agenda

• Drivers of emissions legislation
• Light duty (Euro 5/6)
• Heavy duty (Euro VI)
• Retrofit systems
• Conclusion
Drivers of emissions legislation

Why is legislation needed?

- Set high standards in the interest of human health and environmental protection
- Principal-Agent situation: immediate actors (VMs, clients) are not direct beneficiaries of health and environmental standards

Why do we harmonise?

- Ensure a single market for vehicles across the EU
- Ensure implementation of EU’s Thematic Strategy on Air Pollution
Emissions problem not yet solved

- With no further changes (i.e. without Euro 5 and 6 and Euro VI), road transport is forecast to contribute in 2020:
  - 31% of total NOx emissions
  - 12% of VOC emissions
  - 7% of primary PM
Emissions problem not yet solved

- The **health impacts of air pollution remain a problem**
  - No safe level for human exposure to particulate matter
  - Average EU life expectancy is currently reduced by 9 months, by 2020 forecast to be reduced by 5 months
Tighter emissions standards are needed

- EU’s Thematic Strategy on Air Pollution seeks **further reductions in emissions from all sectors**
- **Required reductions (from 2000 to 2020)**
  - 59% reduction in PM$_{2.5}$
  - 60% reduction in NOx
  - 51% reduction in VOCs
Overview of EU Emissions Legislation

• ‘Euro’ emissions standards - introduced progressively since the 1990’s:


Light duty vehicles - Euro 5 and 6

- Adoption of the ‘split-level’ approach, i.e. needs implementing legislation
- Implementing Regulation (692/7008) published on 28 July 2008
- A Regulation with direct applicability
- Extensive references to UNECE regulations wherever possible
Euro 5: Focus on Particulate Emissions

- Euro 5: applicable as from 1 September 2009 / 1 January 2011
- 80% reduction PM from CI diesel (from 25 to 5 mg/km)
- 90% reduction in PM from large diesel vans (from 60 to 5 mg/km)
- New PM standard for direct injection petrol engines (5 mg/km)
- Introduction of particle number limit (PN ≤ 6 x 10^{11} / km) for diesel vehicles by 1 September 2011 / 1 January 2013
- Revised measurement PM procedure
- PM OBD threshold limit: 50 mg/km
Evolution of PM emission limits

- **Euro 1** (1993-1994): 140 mg/km
- **Euro 2** (1997-1998): 80 mg/km
- **Euro 3** (2000-2002): 50 mg/km
- **Euro 4** (2005-2007): 25 mg/km
- **Euro 5** (2009-2012): 5 mg/km
- **Euro 6** (2014-2016): 5 mg/km
Euro 6: What will change?

- Euro 6: applicable as from 1 September 2014 / 1 September 2015
- Focus on diesel NOx: 80 mg/km limit
- Particle number (PN) limit for petrol vehicles:
  - Study to be launched (by JRC)
  - Analyse existing PN emissions: numbers, chemical composition, ...
  - Health benefits: PN limit should be same for petrol & diesel (?)
  - Technical feasibility for reduction
- Intended OBD threshold limit for PM (PN): 9 mg/km (1.2 x 10^{11} / km) => monitoring for total/partial DPF failures?
HD Euro VI emission limits

- Applicable from 2013 – 2014
- Key issues
  - PM/PN limits
  - NOx reduction
  - technologies
  - CO₂ impacts
  - global harmonisation
Heavy duty vehicles - Evolution of emission limits

% reduction


NOx PM

(ETC test cycle)

Euro I Euro II Euro III Euro IV Euro V
### HD Euro VI emission limits

<table>
<thead>
<tr>
<th></th>
<th>CO (mg/kWh)</th>
<th>THC (mg/kWh)</th>
<th>NMHC (mg/kWh)</th>
<th>CH4 (mg/kWh)</th>
<th>NOX (mg/kWh)</th>
<th>NH3 (ppm)</th>
<th>PM mass (mg/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESC (CI) -&gt; WHSC</td>
<td>1500</td>
<td>130</td>
<td></td>
<td>400</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>ETC (PI) -&gt; WHTC</td>
<td>4000</td>
<td>160</td>
<td></td>
<td>400</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>ETC (CI) -&gt; WHTC</td>
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ESC: European stationary cycle; ETC: European transient cycle; WHTC: World-harmonised transient cycle; WHSC: World-harmonised stationary cycle
HD Euro VI – total PM emissions

Year: 2010, 2015, 2020, 2025, 2030

PM emissions:
- Basecase
- G5
HD Euro VI – state of play

Split-level approach:

- **Co-decision regulation** – adopted by European Parliament & Council

- **Technical implementing regulation** – to be adopted by Commission with Committee in early 2010
HD Euro VI – PN limit

• Co-decision Regulation mandates Commission to establish PN limit in implementing legislation with reference to technology used for meeting PM limit

• Issues at stake:
  - Technical basis for definition of PN limit value, ”best available technology”, …
  - Implications on future technology implemented for Euro VI (closed wall flow filter, open filters, …)
  - Same/different PN limit values for WHTC and WHSC?
  - Interpretation of test data supplied by industry and JRC
  - Influence of active regeneration (Ki-factors)
Member States seem to support a PN limit oriented at today’s “main stream” technology for Euro VI, i.e. wall flow filters

Values « proposed » (for:
- $5 \times 10^{11} / \text{kWh}$ (wall flow filter manufacturer)
- $10^{12} / \text{kWh}$ (Member State)
- $3 \times 10^{13} / \text{kWh}$ (vehicle manufacturer not using wall flow filters)

NB: these values have been proposed by individual stakeholders and do not represent any consensus!

WHSC: high loads & high passive regeneration => more porous wall flow filters have higher PN and difficulties to meet demanding PN limit

WHTC PN limit value -> wall flow filter yes/no

WHSC PN limit value -> “maximum” porosity of wall flow filter
HD Euro VI – Retrofit systems

• Co-decision Regulation mandates Commission to establish rules for financial incentives for retrofitting existing vehicles to Euro VI emission limits in implementing legislation

• Working group chaired by the JRC has studied “harmonisation” of retrofit systems reducing particle emissions -> first draft on a “system” approach based on minimum filtration efficiency of the retrofit system (similar to the Swiss VERT)

• Key Member States support “vehicle oriented” approach (similar to German Anlage 27), i.e. approval of individual combinations of retrofit systems/vehicles to Euro VI limit values

• Issues: off cycle emission performance, installation requirements, integration of retrofit system (regeneration, safety, other pollutants,…), conformity assessment

• UNECE Regulation: “twin approach”, which leaves choice between “system” and “vehicle oriented” approach to retrofit system manufacturer???
Conclusion

• Continued air quality issues require further action on vehicle emissions
• Euro 5 and 6 Regulations for LDVs adopted
• Euro VI for HDVs: implementing Regulation being prepared
• More details: http://ec.europa.eu/enterprise/automotive/index_en.htm

The End
THANK YOU for your attention

Dr. Nikolaus Steininger
Automotive Industry Unit
Enterprise and Industry Directorate-General
European Commission