Diesel Particulate Matter

Emission Reduction Methods
MSHA
Technical Support
Approval and Certification Center

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Methods to Reduce Diesel Particulate Matter Emissions

- New Engines Produce Lower DPM Emissions
- Diesel Particulate Filters Remove DPM
- Alternative Fuels Reduce DPM Emissions
- Maintenance Program Insures Methods Working Properly
§ 57.5067 (a) Engines

Any Diesel Engine Introduced Underground

– (a)(1) Have Affixed A Plate Evidencing Approval Under Subpart E of Part 7, Or Under Part 36

– (a)(2) Meet Or Exceed The Applicable PM Emission Requirements Of The U.S. EPA Listed In Table 57.5067-1
### EPA DPM Limits

#### MSHA Table 57.5067-1

<table>
<thead>
<tr>
<th>Hp Range</th>
<th>Emission Limit (g/bhp-hr)</th>
<th>Tier</th>
<th>Model Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hp &lt; 11</td>
<td>0.75</td>
<td>Tier 1</td>
<td>MY2000</td>
</tr>
<tr>
<td>11 ≤ HP &lt; 25</td>
<td>0.60</td>
<td>Tier 1</td>
<td>MY2000</td>
</tr>
<tr>
<td>25 ≤ HP &lt; 50</td>
<td>0.60</td>
<td>Tier 1</td>
<td>MY1999</td>
</tr>
<tr>
<td>50 ≤ HP &lt; 100</td>
<td>0.30</td>
<td>Tier 2</td>
<td>MY2004</td>
</tr>
<tr>
<td>100 ≤ HP &lt; 175</td>
<td>0.22</td>
<td>Tier 2</td>
<td>MY2003</td>
</tr>
<tr>
<td>175 ≤ HP &lt; 750</td>
<td>0.40</td>
<td>Tier 1</td>
<td>MY1996</td>
</tr>
<tr>
<td>Hp ≥ 750</td>
<td>0.40</td>
<td>Tier 1</td>
<td>MY2000</td>
</tr>
</tbody>
</table>

- On highway diesel vehicles such as pickup trucks from 1994 vehicle model year.
EPA Tier 3

- $50 \leq \text{HP} < 100$ Tier 3 MY2008
- $100 \leq \text{HP} < 175$ Tier 3 MY2007
- $175 \leq \text{HP} < 750$ Tier 3 MY2006

- NOX reductions only, no change in DPM
EPA Tier 4

- **Hp < 25** Tier 4 MY2008
- **25 ≤ HP < 75** Tier 4 MY2008 & 2013
- **75 ≤ HP < 175** Tier 4 MY2012 - 2014
- **175 ≤ HP < 750** Tier 4 MY2011 - 2014
- **Hp ≥ 750** Tier 4 MY2011 - 2015

- Substantial DPM reductions above 25 hp
- Substantial NOX reductions above 75 hp
Diesel Engines

- Upgrade Diesel Fleet by Replacing Older Engines

- “3 Strikes and You’re Out”
  - High horsepower (greater than 150),
  - High emissions (greater than 0.3 gm/hp-hr),
  - High use (greater than 6 hours per shift).

- Target Equipment:
  - Production Loaders and Trucks (primary),
  - Drills and Scalers (secondary)
  - PC engines (specialty mining equipment).

- One bad engine can spoil the entire fleet.
DPM Control Devices

Filters Filter

- Ceramic: Cordierite or Silicon Carbide
- Sintered Metal Fiber Filters
- Disposable filters: Paper and Synthetic
  - Permissible: Exhaust gas temperature below 302° F (185° F water scrubbers): 95% eff.
  - Nonpermissible: Exhaust gas temperature below 650° F: 80 – 83% eff.
- Fuel additives (supports regeneration)
Ceramic Wall Flow DPF

- 80 to 99% efficient.
Diesel Particulate Filter (DPF)

- High Elemental Carbon (EC) Reductions, 99%
- NIOSH and MSHA developed a DPF Selection Guide
  - [http://www.msha.gov/nioshmnmfilterselectionguide/dpmfilterguide.htm](http://www.msha.gov/nioshmnmfilterselectionguide/dpmfilterguide.htm)
- Provides information for choosing the correct DPF, Do’s and Don'ts
- Exhaust Temperature Profiles/Traces
- How to apply the information
Disposable Filter Media – Paper or Synthetic

- Very Efficient
- Temperature Limit – Synthetic: 650°F
- May require a heat exchanger prior to the filter media
- Filter Location
Sintered metal fibers can be designed to achieve any filter efficiency by changing fiber sizes, porosity, and thickness of filter medium.

Active Regeneration DPF where the Filter element is the Heating element

Automatic regeneration cycles

Pressure and temperature sensing can be used to initiate regeneration cycles
MANN+HUMMEL Diesel Particulate Filter SMF®-AR
New filter technology for diesel engines
Effectiveness of DPM Filters
Diesel Fuel

- MSHA §57.5065 requires diesel fuel with a sulfur content of less than 0.05 percent (500 ppm)
- EPA requirement for on-highway diesel fuel to be at 0.0015 percent (15 ppm) sulfur by mid – 2006
- EPA requirement for non-road diesel fuel to be at 0.0015 percent (15 ppm) sulfur by 2010
Biodiesel

- Fuel derived from vegetable oils or animal fats meeting ASTM D6751
- EPA registered diesel fuel
- 100% biodiesel, B100
- Biodiesel blend - biodiesel mixed with petrodiesel, called Bxx where xx is the volume % of biodiesel in the blend
  - B50 – 50% biodiesel, B20 – 20% biodiesel
Biodiesel
PIB P09-38

- Reduction in elemental carbon (EC) exposure using high biodiesel blends
- Increase in organic carbon (OC) compared to diesel fuel
- Significant reduction in total carbon (TC) exposure using high biodiesel blends with a diesel oxidation catalyst (DOC) / oxidation catalytic convertor (OCC)
Engine Maintenance Program

- Check DPF – cracks, backpressure, regeneration
- Check Engine – intake air
  - Engine emissions CO, NOx, CO2
  - Weekly repeatable engine load tests verify engine working properly


http://www.msha.gov/nioshmnmfiltselecti onguide/best%20practices/weeklyco1a.htm
QUESTIONS?
Thank You