DIESEL PARTICULATE FILTERS USED IN UNDERGROUND COAL MINES

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PARTICULATE FILTERATION THEORY
CHOICES FOR DPM REDUCTION

“THERE IS NO SILVER BULLET”

• Maintenance
• Diesel particulate filters (soot traps)
  – Passive
  – Active
• Disposable diesel particulate ‘paper’ filters
• Alternative approaches
• Ventilation

MAINTENANCE

• What is proper maintenance?
• 100% buy in from management
• Regular scheduled maintenance
• Proactive emission reduction program
• Never be satisfied with were you are
### HOW BIG OF DIFFERENCE CAN IT MAKE?

- In 1997 CFC’s fleet average concentrations of gases in raw exhaust were
  - 1597 ppm carbon monoxide
  - 997 ppm NO\(_x\)

- In 2003 CFC’s fleet average concentrations of gases in raw exhaust are
  - 158 ppm carbon monoxide
  - 458 ppm NO\(_x\)

### THE EFFECTS OF ENGINE TUNE ON THE EMISSIONS

<table>
<thead>
<tr>
<th></th>
<th>OEM</th>
<th>MSHA</th>
<th>MOD 1</th>
<th>MOD 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO ppm</td>
<td>1152</td>
<td>632</td>
<td>230</td>
<td>150</td>
</tr>
<tr>
<td>NO ppm</td>
<td>340</td>
<td>480</td>
<td>428</td>
<td>380</td>
</tr>
<tr>
<td>NO(_2) ppm</td>
<td>28</td>
<td>45</td>
<td>30</td>
<td>28</td>
</tr>
<tr>
<td>DPM G/HR</td>
<td>52</td>
<td>45</td>
<td>14</td>
<td>5.3</td>
</tr>
</tbody>
</table>
PASSIVE SOOT TRAP

- The trap should regenerate itself
- The systems needs to be monitored for back pressure
- NO$_2$ might be a problem
- Relatively low cost
PASSIVE SOOT TRAPS

• PIB 02-04 warning about NO₂ production from platinum catalyzed soot traps for both metal/non metal and coal mines

• PIB 02-07 notice for coal only! Traps shall not increase NO₂ emissions

ACTIVE SOOT TRAP

• No NO₂ production

• Require space where filters can be regenerated safely

• Need a power supply

• Designed to trap soot during one or more shifts

• Relatively high cost
ACTIVE SOOT TRAP
ON-BOARD SYSTEM

ACTIVE SOOT TRAP
OFF-BOARD SYSTEM
EVALUATION OF DPF SYSTEMS IN COAL MINES

• Passive systems
  – Cordierite coated with platinum catalyst
    • Excess of NO₂
  – Cordierite coated with base metal catalyst
    • So far more than 100 hours in operation

• Active systems
  – Silicon carbide on-board el. regeneration DPF system
    • Insulating filter caused failure of electrical components
    • Redesigned, works well
    • Trouble free 300 hours
EVALUATION OF DPF SYSTEMS IN COAL MINES

- Silicon carbide off-board el. regeneration DPF systems
  - DPF accumulate engine pm output during 12 hour shift
  - At the end of shift the unit is replaced with spare one and sent for regeneration
  - Regeneration station is located in maintenance shop
  - Regeneration takes 40 min. to two hours
  - Regeneration schedule should be religiously followed
  - The regeneration process should be supervised by trained personnel
  - This approach is labor intensive and require changing operator’s attitude

DISPOSABLE DIESEL PARTICULATE ‘PAPER’ FILTERS

- Heat exchanger
  - Wet (water scrubber and make-up tank)
  - Dry (air-to-water)
- Filter holder + ‘paper’ filter element
- Water separator (optional)
- Designed for in-by coal vehicles
  - Exhaust temp. Requirements (cooled exhaust)
  - Surface temp. Requirements (water jacketed exhaust manifold)
- High installation cost
DISPOSABLE DIESEL PARTICULATE ‘PAPER’ FILTERS - WET SYSTEM

Advantages
- Relative simple to replace filter

Disadvantages
- Complex and expensive
- Potential for fire
- Short filter life
- Wet system require maintaining water level in scrubber
- Dry system require frequent heat exchanger cleaning
EVALUATION OF DISPOSABLE FILTERS

• Not all media has adequate properties
  – Most of the filters available on market are designed as air intake filters
• Tests showed low efficiency of certain filter media
  – Confusion
  – Use only verified media
• Fire hazard
  – High temperature filters
    • For wet systems
    • For out-by vehicles

RETROFITING DIESEL ENGINES OPERATED ON HIGH ELEVATIONS WITH DPFs

• Naturally aspirated and turbocharged engines should be adjusted for altitude prior to retrofitting them with DPFs
  – DPM and gaseous emissions are significantly affected by altitude
  – DPF system will be overwhelmed by DPM
QUESTIONS?