Progress toward an operational DPF for retrofitting heavy duty engines

Joe Stachulak, Vale/Mirarco, Canada / Peter Werth, JM, Germany

THE LOW NO2 “MINING” CRT® SYSTEM

- Oxidation catalyst
  \[ \text{CO} + \frac{1}{2} \text{O}_2 \rightarrow \text{CO}_2 \]
  \[ \text{[HC]} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} \]
  \[ \text{NO} + \frac{1}{2} \text{O}_2 \rightarrow \text{NO}_2 \]

- NO2 Decomposition catalyst
  \[ \text{NO}_2 \rightarrow \text{NO} + \text{O}_2 \]

Similar system approved by CARB/EPA for bus/truck retrofit in US

Engine type

<table>
<thead>
<tr>
<th>Machine manufacturer</th>
<th>Machine type</th>
<th>Engine manufacturer</th>
<th>Engine type</th>
<th>Engine certification</th>
<th>Engine power</th>
<th>Engine speed</th>
<th>Engine displacement</th>
<th>Number of cylinders</th>
<th>Aspiration</th>
<th>Exhaust gas volume</th>
<th>Exhaust gas temperature</th>
<th>Fuel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caterpillar</td>
<td>Scoop tram R1700G</td>
<td>Caterpillar</td>
<td>C11</td>
<td>EPA TIER 3</td>
<td>263 kW</td>
<td>1800 RPM</td>
<td>11.1 Litres</td>
<td>6, in line</td>
<td>Turbo charged and aftercooler</td>
<td>3.143 m3/hour / 1500 kg/h</td>
<td>Diesel fuel, max. 15 ppm Sulphur</td>
<td></td>
</tr>
</tbody>
</table>

DPF Filter Type

<table>
<thead>
<tr>
<th>Filter type</th>
<th>Johnson Matthey Mining-CRT 2 x 2012SL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirements</td>
<td>ULSD Fuel, S&lt; 50ppm Exhast gas temperature &gt;250°C to &lt;50% of the operational time</td>
</tr>
<tr>
<td>Particulate reduction</td>
<td>&gt; 99% by particulate number</td>
</tr>
<tr>
<td>NOx, CO and HC reduction</td>
<td>Reduction</td>
</tr>
<tr>
<td>Filter body</td>
<td>Stainless Steel</td>
</tr>
</tbody>
</table>

Totten's Mine Test Cycles

LHD Operation on Surface (Remote Control)

- Load from ground stock pile (~ 200,000 tons to-date, 1200 hrs of operation)
- Haul on remote control some 100 to 1000 feet
- Dump material into old cave area on surface

Phase 2 – Results to Date

RESULTS & COMMENTS
- No operator involvement for DPF regeneration; normal operations
- Over-all the system operated very well with little maintenance & down time
- Operators need to minimize idle time to less than 20 minutes/hour due to > 250°C temperature which do not regenerate and cause accelerated plugging of filters
- DPF system was overhauled at 1200 hrs of operation

Phase 2 – Surface Operations Summary

- Mining CRT function successfully demonstrated
- Outstanding DPM reduction (smoke 99 reduced to 1)
- NOx tailpipe out is less than engine out emissions
- System is ready for Phase 3 (underground production testing)

Further information: Joe.Stachulak@vale.com