Control of Mercury, Dioxins/Furans, and Particulate Matter Emissions from Sewage Sludge Incinerators for Compliance with New US EPA Regulations

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Background

• 2011 Regulations, 40 CFR Part 60...
  • Subpart LLLL—Standards of Performance for New Sewage Sludge Incineration Units
  • Subpart MMMM—Emission Guidelines and Compliance Times for Existing Sewage Sludge Incineration Units

• New emission limits for...
  • Particulate matter, HCl, CO, dioxins/furans, mercury, NOX, SO2, cadmium, lead, and fugitive emissions from ash handling
  • >> Mercury was/is a common exceedance

• Compliance deadline March 2016
Background (cont’d)

• This paper/presentation presents 4 case studies of...
  • Air emission control systems installed on four SSIs
  • To control mercury, dioxins/furans, and particulate matter
  • Each of which commenced operation during 2016

• For each case study...
  • Discussion of key design considerations
  • Description of the emission control equipment installed at the sites
  • Compliance testing results
  • Summary of operating experience to date (~2 years of operation)
## Selected Process Data for the 4 SSIs

<table>
<thead>
<tr>
<th></th>
<th>FBI#1 (4)</th>
<th>FBI#2</th>
<th>FBI#3</th>
<th>FBI#4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FBI Sludge feed rate,</strong></td>
<td>1,180</td>
<td>4,990</td>
<td>950</td>
<td>1,020</td>
</tr>
<tr>
<td><strong>dry kg/hr (dry lbs/hr)</strong></td>
<td>(2,600)</td>
<td>(11,000)</td>
<td>(2,100)</td>
<td>(2,250)</td>
</tr>
<tr>
<td><strong>Gas exhaust volumetric flow</strong></td>
<td>13,780</td>
<td>48,740</td>
<td>10,080</td>
<td>11,430</td>
</tr>
<tr>
<td><strong>rate, Nm³/hr (SCFM)</strong></td>
<td>(8,200)</td>
<td>(29,000)</td>
<td>(6,000)</td>
<td>(6,800)</td>
</tr>
<tr>
<td><strong>Existing air emission control</strong></td>
<td>• Venturi</td>
<td>• Venturi</td>
<td>• Venturi</td>
<td>• Venturi</td>
</tr>
<tr>
<td><strong>equipment</strong></td>
<td>• scrubber</td>
<td>• scrubber</td>
<td>• scrubber</td>
<td>• scrubber</td>
</tr>
<tr>
<td>(prior to addition of advanced</td>
<td>• Tray</td>
<td>• Tray</td>
<td>• Tray</td>
<td>• Tray</td>
</tr>
<tr>
<td>emission controls) (3)</td>
<td>• WESP</td>
<td>• WESP</td>
<td>• WESP</td>
<td>• WESP</td>
</tr>
</tbody>
</table>

(1) Maximum level.
(2) Typical level.
(3) WESP = Wet electrostatic precipitator.
(4) FBI = Fluidized-bed incinerator.
Emission Limits and Emission Levels Prior to Installation of Advanced Emission Controls

<table>
<thead>
<tr>
<th>Emission Levels Prior to Installation of Advanced Emission Controls</th>
<th>Regulatory Limit- New SSIs</th>
<th>Regulatory Limit- Existing SSIs</th>
</tr>
</thead>
<tbody>
<tr>
<td>FBI#1</td>
<td>FBI#2</td>
<td>FBI#3</td>
</tr>
<tr>
<td>Mercury emissions, mg/dscm @ 7% O&lt;sub&gt;2&lt;/sub&gt;</td>
<td>0.750&lt;sup&gt;(1)&lt;/sup&gt;</td>
<td>0.178&lt;sup&gt;(1)&lt;/sup&gt;</td>
</tr>
<tr>
<td>Particulate matter emissions, mg/dscm @ 7% O&lt;sub&gt;2&lt;/sub&gt;</td>
<td>N/A</td>
<td>3.8&lt;sup&gt;(1)&lt;/sup&gt;</td>
</tr>
<tr>
<td>Dioxins/furans emissions, ng/dscm @ 7% O&lt;sub&gt;2&lt;/sub&gt;</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Cadmium emissions, mg/dscm @ 7% O&lt;sub&gt;2&lt;/sub&gt;</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Lead emissions, mg/dscm @ 7% O&lt;sub&gt;2&lt;/sub&gt;</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Key Design Considerations for Emission Controls

• 95.1% - 99.9% removal of mercury required
  >>>> Fixed carbon bed of sulfur-impregnated carbon required

• Fixed carbon bed in turn requires...
  1. Particulate-free exhaust gas
  2. Condensation prevention
  3. Provisions to avoid carbon bed hot spots and fires

• Once these pieces are place (for mercury control)...
  >>>> Particulate matter, cadmium, lead, and dioxins/furans will be controlled effectively at the same time.
Advanced Emission Control Equipment Installed

FBI #1
Exhaust from WESP → Coalescer-Demister → Ultra High-Efficiency Filter Unit → Tertiary Heat Exchanger → HEPA Filter → Activated Carbon Adsorber → Stack (Existing)

FBI #2
Exhaust from WESP → Addition of Hot Plume Suppression Air for Heating → Ultra High-Efficiency Filter Unit w/ Demister → Activated Carbon Adsorber → Stack (Existing)

FBI #3
Exhaust from WESP → Coalescer-Demister → Secondary Heat Exchanger → Ultra High-Efficiency Filter Unit → Activated Carbon Adsorber → Stack (Existing)

FBI #4
Exhaust from WESP → Coalescer-Demister → Secondary Heat Exchanger → Ultra High-Efficiency Filter Unit → Activated Carbon Adsorber → Stack (Existing)
## Compliance Test Results

<table>
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<tr>
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<th>Regulatory Limit- New SSIs</th>
<th>Regulatory Limit- Existing SSIs</th>
<th>FBI#1</th>
<th>FBI#2</th>
<th>FBI#3</th>
<th>FBI#4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mercury emissions, mg/dscm @ 7% O(_2)</strong> (removal efficiency)</td>
<td>0.0010</td>
<td>0.037</td>
<td>9.76E-06 (99.98%)</td>
<td>4.3E-05 (99.8%)</td>
<td>5.37E-04</td>
<td>2.7E-04</td>
</tr>
<tr>
<td><strong>Particulate matter emissions, mg/dscm @ 7% O(_2)</strong></td>
<td>9.6</td>
<td>18</td>
<td>0.872</td>
<td>N/A</td>
<td>2.26</td>
<td>6.04</td>
</tr>
<tr>
<td><strong>Dioxins/furans emissions, ng/dscm @ 7% O(_2)</strong>(1)</td>
<td>0.013 (TMB) 0.0044 (TEQ)</td>
<td>1.2 (TMB) 0.10 (TEQ) 0.00452 (TMB) 7.16E-05 (TEQ)</td>
<td>N/A</td>
<td>4.37E-03 (TEQ)</td>
<td>0.0017 (TEQ)</td>
<td></td>
</tr>
<tr>
<td><strong>Cadmium, emissions mg/dscm @ 7% O(_2)</strong></td>
<td>0.0011</td>
<td>0.0016</td>
<td>8.36E-05</td>
<td>N/A</td>
<td>1.16E-04</td>
<td>1.4E-04</td>
</tr>
<tr>
<td><strong>Lead emissions, mg/dscm @ 7% O(_2)</strong></td>
<td>6.2E-04</td>
<td>0.0074</td>
<td>7.98E-04</td>
<td>N/A</td>
<td>3.64E-04</td>
<td>1.99E-04</td>
</tr>
</tbody>
</table>

(1) TMB= Total mass basis; TEQ= Total equivalents basis. The regulation requires that one of the two standards be met.

(2) Percentages listed for mercury emissions are removal efficiencies.
Other Findings

• No carbon bed hot spots

• Experience regarding condensation and particulate

• Infrequent particulate filter change-out frequencies
Conclusions

• All four incinerators met the strictest standard for mercury

• All four incinerators met the standards for particulate matter, dioxins/furans, cadmium and lead.

• Three systems have had their one-year compliance test, again with all units passing

• No carbon bed hot spots

• Infrequent particulate filter change-out frequencies – costs as projected
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