McIlvaine Hot Topic Hour:

Full-scale Plant Trials of Novinda’s non-carbon Mercury Capture Reagent

August 1, 2013
Product Overview

- Non-carbon, mineral based product
- Facilitates Chemical Reaction vs. Adsorption (PAC)
- Powerful Oxidizer
- Preserves Beneficial Use of Fly Ash and Gypsum
- > 90% Mercury Removal
- $\text{SO}_3$-Tolerant
- Non Flammable
- Pricing Equivalent to Brominated Carbon
- 20 Million lb/year production capacity now on-line
- Packaging – Rail, Pneumatic Truck, Super Sacks
SCR / CS-ESP / Wet FGD
Plant Layout (SCR / CS-ESP / WS)

- North
- Boiler
  - Train A
    - SCR
    - AH
    - ESP
    - ID Fan
    - Hydrated Lime Injection
    - AS-022 Injection Option 1
    - Method 30B
  - Train B
    - SCR
    - AH
    - ESP
    - ID Fan
    - AS-022 Injection Option 2
    - AS-022 Injection Option 3
  - CEM
  - CEM
  - CEM
  - CEM
  - Wet Scrubber
  - Stack
  - Method 30B + Method 5B

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Pre-Trial Characterization: Hg Speciation

![Graph showing Hg speciation at different stages: SCR Outlet, FGD Inlet, Stack, and HgT AVG. The graph compares Pre-Trial Characterization AVG Hg(2+) and Pre-Trial Characterization AVG Hg(0).]
Typical CEMS Data – FGD Outlet
Extended Test Conditions

• 100 hrs continuous injection
  o AS-022 @ 400 lb/hr
  o Hydrated Lime @ 500 lb/hr

• 31.5 hrs continuous injection
  o AS-022 @ 220 lb/hr
  o Hydrated Lime @ 500 lb/hr

• 17 hrs continuous injection
  o AS-022 @ 220 lb/hr
  o Hydrated Lime off
100 Hr Continuous Injection Results

AS-022 @ 400 lb/hr + Lime @ 500 lb/hr
Continuous Injection Comparisons

<table>
<thead>
<tr>
<th>Case</th>
<th>SCR Outlet</th>
<th>ESP Removal</th>
<th>WFGD Removal</th>
<th>Stack Emission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Trial Characterization (Method 30B)</td>
<td>9.42</td>
<td>0.56</td>
<td>8.31</td>
<td>0.55</td>
</tr>
<tr>
<td>Baseline: No Injection</td>
<td>8.21</td>
<td>3.30</td>
<td>3.66</td>
<td>1.26</td>
</tr>
<tr>
<td>AS-022 @ 400 lb/hr Hydrated Lime @ 500 lb/hr</td>
<td>8.70</td>
<td>7.13</td>
<td>1.08</td>
<td>0.49</td>
</tr>
<tr>
<td>AS-022 @ 220 lb/hr Hydrated Lime @ 500 lb/hr</td>
<td>8.99</td>
<td>6.75</td>
<td>1.29</td>
<td>0.95</td>
</tr>
<tr>
<td>AS-022 @ 220 lb/hr Hydrated Lime Off</td>
<td>9.04</td>
<td>5.79</td>
<td>2.51</td>
<td>0.74</td>
</tr>
</tbody>
</table>

Note: All Hg Concentrations in lb/TBtu
**Green** Indicates Hg level below MATS limit of 1.2 lb/TBtu
Summary

- Air Heater Inlet Injection Location proved most efficient in parametric testing.
- Lime provided performance enhancement.
- Configuration for extended trial
  - AS-022 Injection at Air Heater Inlet @ 400 lb/hr
  - Hydrated Lime @ 500 lb/hr
- MATS compliance for Hg capture satisfied during extended trial.
- Gypsum quality maintained during trial
- Majority of Hg capture moved from WFGD to ESP.
- Equilibrium in a WFGD requires several days to be established.
Typical Operation: Daily Load Cycling
Injection Ratio: 0.6 lb/mmacf (average)
Wygen 2 Results - Cumulative Average

Injection Ratio 2.2 lb/mmacf
Injection Ratio 1.3 lb/mmacf

HgT (lb/TBtu)

Start AS Injection

MATS Limit

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Neil Simpson 2 Test with AS-022

Material required ~0.9 lb/mmacf for similar removal.
## Cost Analysis – Pulse Jet Unit with AS-HgX

<table>
<thead>
<tr>
<th>Material Flow Rate</th>
<th>Material</th>
<th>CaCl2 Injection Rate</th>
<th>Reduction</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 lbs/hr</td>
<td>BrPAC with CaCl2</td>
<td>400 ppm</td>
<td>83%</td>
<td>$62.70/hr</td>
</tr>
<tr>
<td>100 lbs/hr</td>
<td>BrPAC</td>
<td>0</td>
<td>83%</td>
<td>$75.00/hr</td>
</tr>
<tr>
<td>30 lbs/hr</td>
<td>Amended Silicates</td>
<td>0</td>
<td>90%</td>
<td>$30.00/hr</td>
</tr>
</tbody>
</table>

**AS @ $1.00/lb**  
**Brominated PAC @ $0.75/lb**  
**CaCl$_2$ @ $1.50/gallon**

**Annual Savings Over:**  
**BrPAC + CaCl$_2$ - $286,452 (52%)**  
**BrPAC - $394,200 (60%)**
Advantages of AS-HgX

• Innovative, non-carbon mercury control technology
• Available now in commercial quantities for full-scale plant trials or long-term supply contracts
• SO$_3$ tolerant up to 20 ppm
• Compatible with continued sale of Fly Ash and Gypsum
• Non-flammable
• Powerful, stand-alone oxidizer
• Improves capture of high-resistivity fly ash in a CS-ESP
• Significantly reduced feed versus Brominated PAC in dry-scrubbed configurations
• Cost competitive with Brominated PAC
• Reduced carbon footprint versus PAC and/or Brominated PAC
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