Holistic Impacts of NOx Control Technologies on Boiler Equipment and Hg/SO$_3$ Emissions

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McIlvaine Hot Topic Hour
NOx Control – Low NOx Technology Update
February 23, 2012
Background
Holistic Emissions Impacts

- NOx reduction approach must be made in context of coal burned, potential impacts on other pollutants, and overall unit performance
- Need to quantify tradeoffs
  - Goal of minimizing costs while complying with regulatory framework
  - Cannot operate combustion system in isolation of post combustion pollution control devices
- Research being conducted to evaluate potential impacts from combustion operation on post combustion systems

Combustion modifications can affect post combustion systems
Boiler / SCR Optimization

- Boiler
- SCR Bypass Damper
- ID Fan
- FD Fan
- Air Heater
- Staging vs Waterwall Wastage
- Furnace Exit NOx & SO₃
- Fly Ash Mineral Vaporization
- Economizer
- CO & UBC
- SCR Bypass Damper
- Outlet Dampers
- Hg & SO₂ Oxidation
- Possible Future Layer
- NH₃ Injection
- Inlet Dampers
- Catalyst Poisons
- Air
- Flue Gas to PCD & Scrubbers
- Coal Selection (FeS Content)
- ABS Formation
- Staging vs Waterwall Wastage
- Coal Selection (FeS Content)
**Boiler / SCR Optimization Example**

- Two different coals
- Two boiler stoichiometric ratios (different NOx levels)

<table>
<thead>
<tr>
<th>Coal Properties</th>
<th>Low Sulfur Bituminous</th>
<th>High Sulfur Bituminous</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Proximate Analysis (%wt, dry)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moisture</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Volatiles</td>
<td>36.04</td>
<td>39.04</td>
</tr>
<tr>
<td>Fixed Carbon</td>
<td>52.38</td>
<td>50.98</td>
</tr>
<tr>
<td>Ash</td>
<td>10.45</td>
<td>9.98</td>
</tr>
<tr>
<td>Sulfur</td>
<td>1.13</td>
<td>3.25</td>
</tr>
<tr>
<td>Btu/lb</td>
<td>13430</td>
<td>11645</td>
</tr>
<tr>
<td><strong>Ultimate Analysis (% wt, dry)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon</td>
<td>76.35</td>
<td>74.84</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>5.04</td>
<td>4.52</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>1.54</td>
<td>1.55</td>
</tr>
<tr>
<td>Chlorine</td>
<td>0.01</td>
<td>0.27</td>
</tr>
<tr>
<td>Oxygen</td>
<td>5.48</td>
<td>5.6</td>
</tr>
</tbody>
</table>
Simple Corrosion Predictor Model
Predicted Fireside Wastage Rates

Predicted corrosion rate of higher sulfur coal increases by factor of 3
Predicted Mercury Oxidation Results

<table>
<thead>
<tr>
<th>Case</th>
<th>Case 1</th>
<th>Case 2</th>
<th>Case 3</th>
<th>Case 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel</td>
<td>Low Sulfur Bit</td>
<td>Low Sulfur Bit</td>
<td>High Sulfur Bit</td>
<td>High Sulfur Bit</td>
</tr>
<tr>
<td>Staging</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>SCR inlet</td>
<td>0.32 lb/MBtu</td>
<td>0.40 lb/MBtu</td>
<td>0.27 lb/MBtu</td>
<td>0.34 lb/MBtu</td>
</tr>
<tr>
<td>Requierd deNOx</td>
<td>70%</td>
<td>75%</td>
<td>65%</td>
<td>72%</td>
</tr>
<tr>
<td>SCR Hg Oxidation</td>
<td>82%</td>
<td>81%</td>
<td>94%</td>
<td>93.50%</td>
</tr>
</tbody>
</table>
Summary

• Pollutant emission regulations require multi-pollutant considerations
  – Trade-offs can exist in system performance and cost impacts with different operating scenarios
  – Additional information required to enable optimization

• EPRI working to quantify impacts and potential costs associated with different operating scenarios
  – Conducting field tests to quantify trade-offs
    • Program 71 – Boiler Performance and NOx Control
    • Program 73 – Post Combustion NOx Control
  – Seeking/evaluating potential host sites

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