“Strategy to Improve Air Preheater Performance via $SO_3$ Control”

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McIlvaine Hot Topic
January 9, 2014
Outline

• SO$_3$ Impacts
• APH Fouling Mechanisms
• APH Performance Strategy
• Pilot Demonstration Results
• Economic Analysis
• Other Co-Benefits
SO$_3$ Adversely Impacts ...

- Equipment Corrosion
- Air Heater Reliability
- Mercury Capture
- Heat Rate
- NO$_x$ Removal
- CO$_2$ Emissions
Air Heater Fouling Agents

- Ash
- Sulfuric Acid
- Ammonium Bisulfate

Source: Alstom Airpreheater Company
Sulfuric Acid Formation

1) Fuel S converted to SO₂

2) SO₂ oxidized to SO₃ (~1%)

3) SO₂ oxidized to SO₃ (~1%)

4) SO₃ + H₂O => H₂SO₄

Condensed sulfuric acid forms sticky, corrosive deposits in “cold-end” of APH
Ammonium Bisulfate (ABS)

1) $\text{NH}_3$ Injected for NOx Control

2) $\text{NH}_3 + \text{SO}_3 + \text{H}_2\text{O} \Rightarrow (\text{NH}_4)\text{HSO}_4$

Condensed Ammonium Bisulfate forms sticky, corrosive deposits in “middle” of APH
Strategy: APH Performance

1) *Inject Sorbent to Remove SO$_3$ Prior to Air Heater*

\[
\text{NH}_3 + \text{SO}_2 + \text{H}_2\text{O} \rightarrow (\text{NH}_4)\text{HSO}_4
\]

\[
\text{SO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4
\]

2) *Reduce Exit Gas Temp from Air Heater*
Strategy: Step 1

Result: No Fouling of Air Heater
Strategy: Step 2

The diagram illustrates the relationship between SO$_3$ concentration (ppmv) and Sulfuric Acid Dewpoint (Deg F). Different curves represent varying H$_2$O concentrations: 14%, 12%, 10%, 8%, and 6%. The dewpoint values are marked at 300, 260, and 240 Deg F.
Air Heater Fouling Impact

No Fouling

Gradual Fouling

Goal: Control SO$_3$ to 5 ppm or less at AH inlet
Alstom Pilot APH Test Facility

- Gas Inlet Ducting: SO₃, H₂O, Flyash Injection
- Preheat Burner System
- Instrumentation Panel
- PLC Based Control System & Data Acquisition
- Tower #1
- Tower #2
Alstom Low-T AH Pilot Testing

- Sodium in Ash
- 5 ppm SO$_3$
- Operated 24/7
- 220 F gas out
- Typ. Soot-blowing
- 1500 hrs total
- No dP rise

Full-scale implementation planned at SBS site in 2014
Simulated SBS Injection (220°F)

No Significant Deposit Thickness Was Found
Strategy: Heat Rate Benefit

Annual Fuel Savings ($M/Yr)

<table>
<thead>
<tr>
<th>APH Exit Temperature (F)</th>
<th>Fuel Savings</th>
</tr>
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<tbody>
<tr>
<td>340</td>
<td>$0.7</td>
</tr>
<tr>
<td>305</td>
<td>$1.4</td>
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500 MW Gross
9500 Btu/kW-hr
85% Cap Factor
$2.00/MMBtu
Strategy: Other Co-Benefits

- Reduced CO₂ Emissions
  - higher unit energy efficiency
- Enhanced Mercury Capture
  - greater carbon absorption capacity
  - less SO₃ interference
- Enhanced ESP Performance
  - lower gas volumetric flow (higher SCA)
  - lower ash resistivity (temp and SO₃ effect)
- Reduced Gas Path Pressure Drop
Questions?

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