Cost and Performance of Mercury Control for Coal-Fired Boilers

STAPPA/ALAPCO Workshop

October 27, 2004
Coeur d’Alene, ID

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Outline

• Sorbent Injection for Controlling Hg Emissions
• Status of Technology
• Costs for Mercury Control
• Regulatory Parameters from a Control Device Perspective
• Conclusions
Coal-Fired Boiler with Sorbent Injection

Sorbent Injection

90% have ESPs
10% have FFs

Ash and Sorbent

Hg CEM
Sorbent Injection System
Activated Carbon Storage and Feed System
Powdered Activated Carbon Injection System
ADA-ES Full-Scale Evaluation of Sorbent Injection on PRB Unit with an SDA/FF
Addition of Sorbent Injection for Mercury Control
Simplicity of Hg Removal with PAC
Issues to be Resolved with Sorbent Injection Technology

Sorbent Injection

Impact on ESP & FF??

Impact on Ash??

Hg Removal??

Ash and Sorbent

Hg CEM

ESP or FF
ADA-ES Hg Control Program: Phase I

• Full-scale field testing of sorbent-based mercury control on coal-fired boilers.

• Primary funding from DOE National Energy Technology Laboratory (NETL).

• Cofunding provided by:
  – Southern Company;
  – We Energies;
  – PG&E NEG;
  – EPRI;
  – Ontario Power Generation;
  – TVA;
  – FirstEnergy;
  – Kennecott Energy; and
  – Arch Coal.
PAC Installations on Various Coal-Burning Power Plants

- Eastern Bituminous
- ND Lignite
- PRB
- PRB
- Eastern Bituminous

(Images of PAC installations at various locations)
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<th>Site</th>
<th>Coal</th>
<th>Equipment</th>
<th>Company</th>
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Full-Scale Tests of Sorbent Injection
On-Going and Scheduled: 2004-2005

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Effect of Flue Gas Characteristics

• The capacity of sorbents to capture mercury decreases at higher temperatures.

• Chlorine and other trace acid gases play a significant role in the performance of PAC.
Hg Capture vs. Temperature (w/ACI)

Mercury Removal (%) vs. Sorbent Injection Rate (lb/Macf)

- ESP Bitum 300F
- ESP - Bitum 350F
Enhancing Mercury Removal for Western Coals

Cl, Br, F, I

Sorbent Injection

Cl, Br, F, I

ESP or FF

Ash and Sorbent

Hg CEM

Cl, Br, F, I

Cl, Br, F, I
Enhanced Hg Removal with Halogenated Sorbents for Western Coals

![Graph showing Hg Removal vs. Injection Concentration for different coal samples.]

- DARCO FGD Holcomb
- FGD-E3 Holcomb
- Long Term FGD-E3 Holcomb
- DARCO FGD Stanton U10
- FGD E3 Stanton U10
- BPAC Stanton 10
- KNX + FGD Holcomb

Injection Concentration (lb/MMacf at ~ 29°F)

Hg Removal (%)
Ash Issues

- The mercury captured by PAC, LOI, and ash appears to be very stable and unlikely to reenter the environment.
- The presence of PAC will most likely prevent the sale of ash for use in concrete.
- Several developing technologies to address the problem:
  - Separation
  - Combustion
  - Chemical treatment
  - Non-carbon sorbents
  - Configuration solutions such as EPRI TOXECON™
TOXCON™ Configuration

Coal → Electrostatic Precipitator → Fly Ash (99%) → Sorbent Injection → Fly Ash (1%) + PAC → PJFF
Long-Term Testing of TOXECION™

Overall Hg Removal > 85%
EPRI TOXECO® Configuration

10% of Fly Ash + Sorbent
Sorbent recycle
Sorbent regeneration or disposal

90% of Fly Ash
Sell for use in concrete

Coal

Hg Sorbent

Ash Sales
Full-Scale Performance of TOXECON 2™

Mercury Removal (%) vs. Sorbent Injection Rate (lb/Macf)

- Mid-ESP Injection @ Coal Creek
- Upstream ESP Injection @ P4
Costs for Mercury Control

• EPA Study: Srivastava et al., 2004
  – 80-90% Control for all plants: 0.003-3.096 mills/kWh
  – 80-90% Control for majority of plants: 0.003 to 1.9 mills/kWh

• DOE Study: Hoffmann and Brown, 2003
  – 70-90% Control for Bituminous Coals: 1.27 to 2.15 mills/kWh
  – 60-90% Control for Subbituminous Coals: 1.91 to 2.36 mills/kWh
Costs of Mercury Control Depend on Plant Size Not on Amount Removed

- Costs of mercury control are unrelated to the amount of mercury captured
  - Sorbent Injection Technology
  - SCR/FGD
  - Catalytic Oxidation
  - Other Developing Technologies
Regulatory Parameters from a Control Device Perspective

1. Long Term Averaging
2. Dual Limit
   • Removal Efficiency
   • Emission Limit
3. Flexibility in Achieving Mercury Removal
   • Accounts for site by site variation in performance
   • Enhances cost effectiveness
   • Reduces risks associated with guarantees
4. Mechanism to Encourage Early Adoption
   • Offset risks with new technology
   • Provide increased experience base
   • Reduce potential impacts on generation
   • Soft landing reduces cost impacts on consumers
   • Banking
Conclusions on ACI Performance

- AC injection can effectively capture elemental and oxidized mercury from subbituminous and bituminous coals.
- There will be differences in site to site performance of ACI due to differences in coal, equipment, and flue gas characteristics.
- Fabric filters provide better contact between the sorbent and mercury than ESPs, resulting in higher removal levels at lower sorbent costs.
- Long-term results are promising showing consistent Hg removal greater than 85%.
- Flexibility in a regulation provides the best framework to take advantage of a rapidly developing technology.