Activated Carbon Injection for Mercury Control on Combustion Applications

Richard Miller
Vice President Business Development
ADA Environmental Solutions
Co-Chairman ICAC Mercury Committee
ADA: Innovate, Develop, Commercialize

- Mercury Control
- \( \text{SO}_3, \text{SO}_2 \) and HCl Mitigation via DSI
- ESP Flue Gas Conditioning for Particulate Control
- Coal Enhancements
- Developing CO_2 Capture Technologies

- Red River Parish, LA: One of the largest activated carbon plants in North America
- ADA-ES joint venture with Energy Capital Partners, LP

www.adaes.com  NASDAQ: ADES
MERCURY CONTROL FOR COAL-FIRED STATIONARY SOURCES
Three (3) New Drivers for Mercury Control

- **Power Generation:**
  - EPA Section 112 MACT
    - Proposed ~91% Hg reduction control on existing units

- **Cement Kilns:**
  - New rule proposed by EPA
    - Reduction target of 11,600 lbs (81%)
  - Also need for organics (THC) reduction

- **Industrial Boilers:**
  - Draft bill introduced April 15, 2010
  - Promulgation occurred in January 2011
    - ~40-50% Hg control
Combustion Sources Discussed

- **Industrial, Commercial, and Institutional (ICI) Boilers**
  - More than 175,000 ICI boilers
  - Natural gas is the fuel fired at most ICI boilers
  - Natural gas- and oil-fired boilers fire < 20 MMBtu/hr
  - Boilers fired with coal, wood, or process byproducts typically >100 MMBtu/hr

- **Portland Cement Kilns**
  - 170 kilns in the US (147 that burn non-hazardous waste)

- **Electric Generating Unit (EGU) Boilers**
  - ~1,100 boilers in operation in the US
  - 50-60% likely candidate for ACI Injection for Hg Control
  - More possible as a final trim with FGD systems
2011 and 2012 will be when boiler and kiln operators identify and select vendors and equipment for federal MACT compliance
- One-year extension possible for MACT compliance period

- In states:
  - Compliance timelines vary
ICI Boiler Major Source Limits

- Final Rule: 2/21/2011 => 3 year compliance
- Coal and biomass treated the same
- Hg emission limits the same for all solid fuel boilers
  - Limits for other HAPs vary with combustion system design

<table>
<thead>
<tr>
<th>HAP/Fuel (Pulverized Coal Units)</th>
<th>Existing Boilers</th>
<th>New Boilers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hg (Proposed existing was 3.0 lb/TBtu)</td>
<td>4.6</td>
<td>3.5 lb/TBtu</td>
</tr>
<tr>
<td>PM (surrogate for non Hg metals)</td>
<td>0.039</td>
<td>0.0011 lb/ MMBtu</td>
</tr>
<tr>
<td>HCl (surrogate for acid gases)</td>
<td>0.035</td>
<td>0.0022 lb/ MMBtu</td>
</tr>
<tr>
<td>CO (surrogate for non D/F organics)</td>
<td>160</td>
<td>12 ppm at 3%O₂</td>
</tr>
<tr>
<td>Dioxin/Furans</td>
<td>0.004</td>
<td>0.003 ng/dscm at 7%O₂</td>
</tr>
</tbody>
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Utility Air Toxics MACT (Existing Boilers)

- Final rule expected in November 2011
- 3 Year Compliance Window
- Existing bituminous and subbituminous units will need ~80-90% Hg control
- Lignites: ~50-60%

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Assumed Properties</th>
<th>Emission at Proposed Existing Boiler Limit</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Coal S, wt% AR</td>
<td>Coal Cl, µg/g dry</td>
</tr>
<tr>
<td>Bituminous</td>
<td>3.60%</td>
<td>1000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subbituminous</td>
<td>0.23%</td>
<td>25</td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lignite</td>
<td>0.38%</td>
<td>50</td>
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¹Concentrations at 3% O₂
Differences between EGU and ICI Boilers

- EGU boilers produce steam to generate power, but ICI boilers primarily generate steam for industrial processes in addition to small levels (<25MW) of electric generation.

- Large, base-loaded EGUs operate mainly near maximum capacity (steam production), but ICI boilers typically do not run at maximum capacity, but this varies from one industry to another.

- Type of manufacturing is often more important in determining duty cycle (load vs. time) than manufacturing demand in general.

- All coal-fired EGUs have PM emission control and many have controls for SO₂ and NOx emissions, but ICI boilers are less likely to control SO₂ and NOx emissions.
Mercury Control Technology Strategies

- Remove Hg before combustion
  - Remove pyrite (bituminous coals)
  - Thermal processing (subbituminous and lignites)

- Increase natural Hg capture
  - Combustion modifications
  - Burn coal blends
  - Use additives or catalysts to increase oxidized Hg
  - Addition of scrubber to removed oxidized Hg

- Use of sorbents
  - Activated carbon
  - Advanced sorbents, oxidizing agents or additives – low rank coals

- Wet scrubbers
  - Catalyst or additive to maximize oxidation

- Multipollutant control methods
  - Reduce SO$_3$ using DSI with alkaline agents
ADA Alkali (DSI) Injection System
Factors Affecting Native Mercury Removal

- Coal Type
  - Halogen content (Cl, Br, other)
  - Sulfur content
- Flue Gas
  - Acid Gases (HCl, SO$_2$, SO$_3$)
  - Flue Gas Temperature
  - Unburned carbon (LOI)
- Emission Control Equipment Present
Typical Emission Controls Present

- **Particulate Matter**
  - Fabric filters, ESP’s

- **Acid gases (HCl, SO$_2$)**
  - Scrubbers (wet or semi-dry)
  - CDS (Circulating Dry Scrubbers)
  - Dry injection for SO$_3$ mitigation
    - Sodium Compounds (Trona, Soda Ash, Sodium bicarbonate)
    - Hydrated Lime

- **NOx**
  - LNB, SCR, SNCR
Activated Carbon Injection Technology for Controlling Mercury Emissions

Sorbent Injection

AH Inlet location may be more effective for ESP’s for Hg capture

ESP or FF

Ash and Sorbent

CEM - Hg Measure.
Powdered Activated Carbon Specifications

- Particle size: 15-25 µm
- Surface Area: Typical > 500 m²/g
- Treated sorbents (brominated) more effective for low-halogen flue gas applications such as PRB-fired units with ESPs or SDA/FFs or for higher temp applications
- Emerging activated carbon sorbents for higher SO₃ flue gas
Factors Affecting ACI Performance

- **Coal Type**
  - Halogen content (Cl, Br, other)
  - Sulfur content

- **Flue Gas**
  - Acid Gases (HCl, SO₂, SO₃)
  - Gas Temperature

- **Emission Control Equipment**

- **ACI System Design**
  - Distribution
  - Residence time
  - Sorbent characteristics

Similar factors affect native Hg removal.
Potential Mercury Control Issues Facing Industrial Boilers

- Coal types fired in boilers
- Flue gas operating temperatures
- $\text{SO}_3$ levels in the flue gas exiting boilers and entering particulate control systems
- Existing APC configuration and particulate control systems in-place. (ESP, FF, Cyclones, Scrubbers)
- Possible ammonia slip from NOx systems
- May need to replace existing ESP’s with Fabric Filters
Tools for Evaluating ACI Performance

ADA Owns 11 Hg CEMS Used for Test Programs

Portable Hg CEMS and Calibration Units

• Mercury Control
• Dioxin/Furan Control
• THC control

Sorbent Screening Device

Transportable Silo for Long-Term Full-Scale Tests

Portable Feeder for Short-Term Full-Scale Tests

Fabric Filter Screening Device
Typical ADA ACI System

- Sorbent delivered in pneumatic trucks or rail cars
- Silo(s) with up to three product take-offs
  - 1 x 100%, 2 x 100% or 3 x 50% feed trains
- Worry-free PAC flow from silo
- Custom fluidizing system designed for PAC
- Modular approach
  - PAC storage
  - Electrical room
  - Feeder room
  - Blower room
- Dilute-phase pneumatic conveying
- Custom engineered distribution manifolds
- Custom injection lances
- Site-specific control schemes
- Use of 1,000 lb Super-Sac discharge systems for smaller industrial boiler installations
Typical Commercial ACI Systems
Summary

- Many lessons learned from the utility power sector can be applied to industrial boilers.

- Industrial boilers have unique concerns:
  - Full-scale demonstration testing is recommended to better characterize performance.

- Commercial AC injection equipment and activated carbon is available but experienced suppliers key to success.

- Carbon can be delivered to process via many types of systems, including:
  - Portable (900 to 1,000 lb. Super Sacs) injection systems.
  - Shop welded and assembled steel silos.
  - Hybrid smaller silo designed systems.

- Combination of DSI and ACI may be required due to high $\text{SO}_3$ Levels in flue gas.
Where to Find More Information

**Regulations in the U.S.:**
US EPA's Utility Air Toxics page:
http://www.epa.gov/airquality/powerplanttoxics/

US EPA's Industrial Boiler MACT page:
http://www.epa.gov/airquality/combustion/actions.html#feb11

Final Portland Cement Rule:

The National Association of Clean Air Agencies (a good place to find information on state regulations):
http://www.4cleanair.org

**International:**
The U.N. Mercury homepage:
http://www.chem.unep.ch/mercury/
ADA Contact Information

Mercury Control Systems:
Rich Miller – ADA-Environmental Solutions
Vice President Business Development
richm@adaes.com
610-760-1555

Activated Carbon Supply:
Thomas Stocker – ADA Carbon Solutions
North Eastern Regional Sales Manager
tstocker@ada-cs.com
267-795-8486
THANK YOU
QUESTIONS?