Activated Carbon Injection for Mercury Control on Industrial Coal-Fired Boilers

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ADA develops and commercializes innovative technologies to sustain the viability of coal as a critical national resource. (NASDAQ: ADES)
Currently building one of the largest U.S. located AC plant to date
First line will produce approx. 150+ MPY
Permitted for two lines or 350 MPY
Under construction and on schedule
Red River, LA plant initial startup target: mid-2010
Currently processing and shipping carbons (up to 60 MPY) from interim facility in LA.
MERCURY CONTROL FOR COAL-FIRED STATIONARY SOURCES
Three (3) New Drivers for Mercury Control

- **Power Generation:**
  - EPA Section 112 MACT or legislation (3-P) by congress, Min. 90% Hg control expected

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

- **Industrial Boilers:**
  - Draft bill being introduced April 15, 2010
  - Promulgation scheduled for December 2010
  - 70 to 80% control expected by end of 2013
Federal Rule Update:
- Draft Industrial Boiler MACT rule to be proposed April 15th, 2010
- Expected decision December 16, 2010
- Compliance date – 2013

Industry Market:
- 1549 Facilities 13,100 Boilers
- Focus: Coal Fired Boilers: ~ 680
- Potential for other fuels as well

<table>
<thead>
<tr>
<th>Industry Sector</th>
<th>Number of Facilities</th>
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<tbody>
<tr>
<td>Utilities</td>
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</tr>
<tr>
<td>Food Manuf.</td>
<td>107</td>
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<tr>
<td>Wood Product Manuf.</td>
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</tr>
<tr>
<td>Paper Manuf.</td>
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<td>Petroleum Manuf.</td>
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</tr>
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<td>Plastics &amp; Rubber Products Manuf.</td>
<td>82</td>
</tr>
<tr>
<td>Primary Metals &amp; Metals Product Manuf.</td>
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<tr>
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<tr>
<td>Furniture Manuf.</td>
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<tr>
<td>Educational Services</td>
<td>77</td>
</tr>
<tr>
<td>National Security</td>
<td>22</td>
</tr>
</tbody>
</table>
Federal Rule Update:
- EPA released Draft rule in April 2009 to reduce mercury emissions from Portland cement kilns
- Final rule expected Spring 2010
- Compliance date – 2013
- ADA testing AC for mercury and organics (THC’s) for cement companies

Cement Market:
- 118 new or planned cement kilns in US
- Fourth-largest source of mercury air emissions

Meeting the Cement Market Needs
- Utility or Smaller Industrial scale ACI equipment is appropriate depending upon flue gas flow rates and injection rates
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

- Acid gases (HCl, SO$_2$)
  - Scrubbers (wet or dry)
  - Dry injection for SO$_3$ mitigation
    - Trona
    - 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, SO$_2$, SO$_3$)
  - Gas Temperature

- **Emission Control Equipment**

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

Similar factors affect native Hg removal.
Challenges:
- > 350ºF
- > 5 ppm SO₃

Activated Carbon Effectiveness

Hg Removal (%) vs. Injection Concentration (lb/MMacf)

Temperature vs. Acid Gases (SO₃)
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

Sorbent Screening Device

Transportable Silo for Long-Term Full-Scale Tests

Portable Feeder for Short-Term Full-Scale Tests
Activated Carbon Injection (ACI) Systems

Large Utility Size ACI System

Smaller Industrial Boiler Size ACI System
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
Hg Control Demonstration Program
Cornell University

Case Study
Cornell University Utilities Boiler #8

- Mass Overfeed Stoker
- Riley 1949
- 175,000 pph steam
- Pulse jet fabric filter installed 1998
- Flue gas 375°F
- Bags: woven fiberglass with 10% Teflon® B finish
- Historically operated October to May
Background

- Plant fires low sulfur bituminous coal
- Mercury (3 year avg) 5.9 lb/tBTU (range 3.6 to 9.5)
- High (> ~10 ppm) SO$_3$ in flue gas
  - Coal sulfur < 1%, but boiler design and operation resulted in high conversion to SO$_3$
- Unburned carbon in ash > 20%
- Results from 2007 test show
  - low native mercury removal and
  - low mercury removal with ACI
- New York State Energy Research and Development Authority (NYSERDA) awarded grant for mercury control project in 2008
Baseline Removal

Characterize effectiveness of PAC, no SO$_3$ mitigation
- Standard PAC
- PAC treated with bromine

Characterize effectiveness of PAC, with SO$_3$ mitigation
- Trona (sodium sesquicarbonate) injection
  - Goal: capture SO$_3$
- Ammonia injection
  - Goal: form ammonium sulfate
Additional testing and optimization is required to assess balance-of-plant impacts and assure long-term mercury capture.
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 systems.
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THANK YOU

QUESTIONS?