Mercury Emission Control
Using
The Chem-Mod™ Solution

MEC & Minamata Convention on Mercury Implementation Conference

Beijing, China
December 9, 2015
Outline

• Chem-Mod Company Overview
• Commercial Applications
  – Refined Coal: US IRS Code Section 45
  – Regulatory Compliance: US Mercury and Air Toxics Standard (MATS)
• Emissions Data
• Benefits
  – Mercury/Metals captured and locked in ash
Chem-Mod Company Overview

• Chem-Mod International LLC is an advanced clean coal company which has developed a sorbent-based, multi-pollutant control technology called The Chem-Mod™ Solution

• Chem-Mod International is a privately held corporation
Chem-Mod Company Overview

- Chem-Mod International was founded in 2004 to promote the use of the Chem-Mod technology internationally.
- The technology is jointly owned with Chem-Mod LLC, which provides emission control in the United States and Canada.
Chem-Mod Company Overview

• Chem-Mod technology substantially reduces emissions at coal-fired power plants
  – Mercury and other Metals
  – Nitrogen Oxides
  – Sulfur Oxides
  – Chlorides
Chem-Mod LLC Technology

• Dual-Reagent System
  – MerSorb® for Oxidation of Mercury and Other Heavy Metals
  – S-Sorb® III for Capture of Oxidized Metals and Reducing NO$_x$ Emissions

• TriSorb™ Reagent System (New)
  – MerSorb, S-Sorb III and B&W Mitagent™ (Enhances MerSorb effectiveness)

• Chemicals Applied to Coal
### Chem-Mod Intellectual Property

- **Multiple US and International Patents Issued**
- **Four Patent Families Applied for in China**

<table>
<thead>
<tr>
<th>Case No.</th>
<th>International Application</th>
<th>Chinese Application, Date</th>
<th>Claims</th>
<th>Status</th>
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<tr>
<td>2a</td>
<td>WO2006/101499</td>
<td>2014100452884, 2/7/2014</td>
<td>Mercury Sorbents</td>
<td>Under prosecution</td>
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<td>11</td>
<td>WO2007/092504</td>
<td>2014101054526, 3/202014</td>
<td>Cementitious ash; Non-leaching ash; Use of combustion byproducts</td>
<td>Under prosecution</td>
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</table>
Refined Coal

• Commercial Facilities
  – 44 Operating Sites
  – All Coal Firing Configurations
    • PC (Wall, Tangential & Riley Turbo), Cyclone, Fluidized-bed, Stoker

• Production
  – 2015 Annual (est.): 125,000,000 US tons
  – To Date: >380,000,000 US tons

• Coal Types
  – All Major US Steam Coal Producing Basins
    • Appalachian, Illinois, Powder River, Colorado Plateau, North Dakota Lignite, Gulf Coast Lignite
History of Chem-Mod Refined Coal Production

Total production to date >380 mmtons

- 2010
- 2011
- 2012
- 2013
- 2014
- 2015

- First Quarter
- Second Quarter
- Third Quarter
- Fourth Quarter
Chem-Mod Refined Coal Plant
- 3000 tph -
Refined Coal Emission Data

• Commercial Plants
  – Tangential-fired PC Boiler: Midwestern US
    • ESP+WFGD
    • PRB Coal
  – Cyclone-fired Boiler: Midwestern US
    • ESP
    • PRB Coal
  – Wall-fired PC Boiler: Southeastern US
    • ESP+WFGD
    • CAPP (Central Appalachian) Coal
Tangentially-fired PC Boiler Hg Emissions:

ESP+WFGD, PRB Coal and Dual-reagent Additives
Cyclone-fired Boiler Hg Emissions:
ESP only, PRB Coal and Dual-reagent Additives

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<th>Hg, lb/TBtu</th>
<th>Base Coal</th>
<th>5.533</th>
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<td>Refined Coal</td>
<td>2.171</td>
</tr>
<tr>
<td>Difference</td>
<td></td>
<td>3.362</td>
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<tr>
<td>Reduction</td>
<td></td>
<td>60.8%</td>
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Test Day
Wall-fired PC Boiler Hg Emissions:
ESP+WFGD, CAPP Coal, and TriSorb™ Additive Package

<table>
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<tr>
<th>Test Day</th>
<th>Coal Hg, lb/TBtu</th>
<th>Flue Gas Hg, lb/TBtu (% Reduction)</th>
<th>Scrubber Inlet M30b</th>
<th>Stack M30b</th>
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<tr>
<td></td>
<td></td>
<td>Oxidized</td>
<td>Total</td>
<td>Total</td>
</tr>
<tr>
<td>1</td>
<td>9.38</td>
<td>2.20</td>
<td>2.27 (76)</td>
<td>1.04 (88)</td>
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<tr>
<td>2</td>
<td>7.30</td>
<td>1.41</td>
<td>1.46 (80)</td>
<td>1.02 (86)</td>
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</table>
MATS Mercury Emission Limits

- Bituminous and Sub-bituminous Coals
  - 1.2 lb Hg/ TBtu ($10^{12}$ Btu)
- Lignite Coals
  - 4.0 lb Hg/ TBtu
- Acid Gases and Other Metals
MATS Emission Test Data

• Commerical Plants
  – Tangentially-fired PC Boiler: Midwestern US
    • ESP
    • PRB Coal
  – Wall-fired PC Boiler: Midwestern US
    • SCR+CDS+FF
    • PRB Coal
Tangentially-fired PC Boiler Hg Emissions:
ESP only, PRB Coal and TriSorb™ Additive Package

Period of TriSorb Coal Additives
Wall-fired PC Boiler Hg Emissions:
SCR+CDS+FF, PRB Coal and TriSorb™ Additive Package

Baseline Test
Chem-Mod/B&W TriSorb Additive Package

INTERNATIONAL
Making Power Cleaner.
## Other Metals

Wall-fired Boiler, ESP/WFGD, CAPP Coal and TriSorb™ Additive Package

<table>
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<tr>
<th>Additive rates</th>
<th>Se (lb/TBtu)</th>
<th>P (lb/TBtu)</th>
<th>As (lb/TBtu)</th>
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<tr>
<td>Baseline</td>
<td>3.95</td>
<td>308</td>
<td>2.32</td>
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<tr>
<td>Bromine only</td>
<td>4.91</td>
<td>298</td>
<td>2.20</td>
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<tr>
<td>TriSorb additives</td>
<td>3.69</td>
<td>225</td>
<td>1.76</td>
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Refined Coal Fly Ash Properties

• Improved ESP performance
  – Lower Resistivity
• Meets US RCRA limits and in most all cases Drinking Water limits
  – Lower leachability by TCLP, particularly for As, Cr, Pb, Hg and Se
• Readily saleable as Cement additive
  – Higher pozzolanic activity
## Commercial Benefits

### Multi-pollutant Control
- Hg, NO\textsubscript{x}, and Other Metals
- Removes Elemental Hg
- Hg and Other Metals Locked in Ash

### Low-cost Solution
- Low Capital and O&M Costs
- Small Footprint for Equipment
- Minimum Tie-in Downtime

### Environmentally Stable
- Readily-available Chemicals With No Special Handling Requirements
- Fly Ash is Saleable
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