"WESP Technology for Filterable and Condensable Control"

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Siemens Environmental Systems & Services
Outline of Presentation

1. New Regulations
2. What is PM2.5
3. WFGD PM2.5 Emissions
4. Why use a WESP
5. Conventional Wisdom = DSI + Fabric Filter
6. Possible Alternative = WFGD + Wet ESP
7. ICR Data
8. Advantages of WESP
9. Comparisons between FF and WESP
10. Summary
Future Regulations

- **Mercury Air Toxics Standards (MACT)**
  - PM – Filterable limits only
    - Existing Plants = 0.3 lb/MWh or 0.03 lb/MMBtu
    - New Plants = 0.07 lb/MWh (≈ 0.007 lb/MMBtu)
  - Condensable limits were in proposed rule but dropped in final

- **National Ambient Air Quality Standards for PM$_{2.5}$**
  - Proposed Rule to be issued June 2012
  - Final Rule to be issued June 2013
  - Previous releases included both filterable & condensable

- **Regional Haze (Visibility) Rule**
What is PM$_{2.5}$?

**Filterable Particulate**
- <2.5 microns in size
- Exists as solid particulate at temperatures of 250°F or higher
- Collected in “front-half” filter of PM test apparatus
- Represents @ 25% of PM$_{2.5}$ emitted by sources

**Condensable Particulate**
- <2.5 microns in size
- Vapors that condense at ambient temperatures
  - SO$_3$ – H$_2$SO$_4$ sulfuric acid mist (@ 0.5 micron)
  - Toxic metals – cadmium, chromium, lead, magnesium
- Collected in “back-half” impingers in PM test apparatus
- Represents @ 75% of PM$_{2.5}$ emitted by sources
- Has not been required to date to meet PM$_{10}$ standards
EPA Method 8 Sampling Method

Front-half Catch

Back-half Catch
Particle Size Distribution from a WFGD by Mass

Particle Size Distribution on Differential Mass Basis
Dry vs Wet Run comparison

Stokes Diameter, micrometers.

$dM/d\log D$, mg/dcm (Dry)

$dM/d\log D$, mg/dcm (Wet)

Dry
Wet

Courtesy of Clean Air Engineering
Particle Size Distribution from WFGD by Number

Courtesy of Clean Air Engineering
## # of Particles in 1 Cubic Inch (1 micron = 0.000039”) 

<table>
<thead>
<tr>
<th>Particle Size</th>
<th>Number of Particles = $\frac{1}{(4/3\pi r^3)}$</th>
<th>Compared to 10 microns</th>
<th>Surface Area of Particles = $P# \times 4\pi r^2$</th>
<th>Compared to 10 microns</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>128,850,993,811,609</td>
<td>8000x</td>
<td>153,846</td>
<td>20x</td>
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<tr>
<td>1</td>
<td>16,106,374,226,451</td>
<td>1000x</td>
<td>76,923</td>
<td>10x</td>
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<td>2.5</td>
<td>1,030,807,950,493</td>
<td>64x</td>
<td>30,769</td>
<td>4x</td>
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<tr>
<td>5</td>
<td>128,850,993,812</td>
<td>8x</td>
<td>15,385</td>
<td>2x</td>
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<tr>
<td>10</td>
<td>16,106,374,226</td>
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<td>7,692</td>
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</table>
Conventional Wisdom = PAC + Fabric Filter

Hydrated Lime Injection
Powdered Activated Carbon for Hg
Possible Alternative = WFGD + Wet ESP

Powdered Activated Carbon for Hg

Wet ESP alternative
Why Wet ESP?

Multi-Pollutant Control
- PM$_{2.5}$ - both filterable & condensable
- SO$_3$
- Metals
- Mercury (species dependent)

Opacity Reduction
- <10% visible plume

Operationally
- Low Pressure Drop
- No Moving Parts
- Self-Cleaning
- Small Footprint
- Flexible to Upset Conditions
- No impact on upstream equipment

Fuel Flexibility
- Switch to lower cost, higher S coal

A Final Polishing Device
WESP Controls SO₃ + PM₂.₅ + Hg
ICR DATA has 2 Plants with WESP
## Total PM Emissions ICR Data vs WESP Data

<table>
<thead>
<tr>
<th></th>
<th># of Units</th>
<th>Ave PM&lt;sub&gt;f&lt;/sub&gt; Lb/MMBtu</th>
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</thead>
<tbody>
<tr>
<td>PM&lt;sub&gt;f&lt;/sub&gt; Limit</td>
<td></td>
<td>0.0300</td>
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<tr>
<td>Top 12% mean</td>
<td>130</td>
<td>0.0022</td>
</tr>
<tr>
<td>Dallman Unit 3</td>
<td>1</td>
<td>0.0010</td>
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<tr>
<td>HL Spurlock Unit 1</td>
<td>1</td>
<td>0.0036</td>
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</tbody>
</table>

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FF / WFGD / WESP
# New Coal Plant WESPs not in ICR Data

<table>
<thead>
<tr>
<th>Facility</th>
<th>Unit Size (MW)</th>
<th>Fuel</th>
<th>APC Control Technology</th>
<th>Status</th>
</tr>
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<tbody>
<tr>
<td>Elm Road</td>
<td>2 x 615</td>
<td>Pittsburgh #8</td>
<td>FF / WFGD / WESP</td>
<td>Online</td>
</tr>
<tr>
<td>Trimble County</td>
<td>750</td>
<td>Blend of Bituminous &amp; Sub-bituminous</td>
<td>ESP / FF / WFGD / WESP</td>
<td>Online 2011</td>
</tr>
<tr>
<td>Prairie States</td>
<td>2 x 750</td>
<td>Southern IL Bituminous</td>
<td>ESP / WFGD / WESP</td>
<td>Summer 2012 &amp; Fall 2012</td>
</tr>
</tbody>
</table>
WESP installed after a WFGD
**Pressure Drop Comparison**

**Wet ESP + duct**
< 2” W.C. average pressure drop
Existing ID Fans may be acceptable.

**Fabric Filter**
= 7”- 10” W.C. pressure drop
May require replace ID fans?
Real Estate Comparison

Fabric Filter
Velocity = 4-6 fps
@ twice the size of a WESP
Is there room?

Wet ESP
Velocity = 7-10 fps
@ Half the size of a FF
Use area between WFGD & stack.
WESP  WFGD  DESP
Maintenance Comparison

**Fabric Filters**
- Bag Replacement every 3-5 years
- Hopper smoldering/fires
- Ash conveying
- A lot of moving parts & ash
- Constant maintenance

**Wet ESP**
- Alloy internals - no replacements
- Everything is saturated & wet
- No moving parts & no ash
- Drain to WFGD
- Outage inspection & maintenance
Process Comparison

Wet ESP
- Can handle WFGD upset conditions
- Can remove condensables w/o Lime

Fabric Filter
- Cannot handle WFGD upset conditions
- Needs Lime to remove condensables
Water Usage Comparison

Fabric Filter
- No water used

Wet ESP
- No additional burden
- First use of WFGD water
- Drain to WFGD
Capital Cost Comparison

Fabric Filter
$15- $25 /kw

WESP
$40-$70 /kw

Equipment Only
Summary

• Future Regulations may require condensable capture

• PM$_{2.5}$ includes both Filterable & Condensable PM

• Wet ESP after a WFGD offers
  • Removal of both filterable & condensable PM$_{2.5}$ including
  • SO$_3$ ($\text{H}_2\text{SO}_4$), metals, and some Hg

• Advantages of WESP are:
  • Low pressure drop    Low maintenance
  • Less real estate      No additional water burden
  • High Removal         Located after WFGD

• Analyze the economic benefits
  • Low operating costs vs High capital cost
THANK YOU

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