Particulate and Condensable Removal with a Membrane

Mcllvaine Co.  Hot Topic Hour
April 26, 2013
• Technical expertise
  • Proven 30 years ePTFE manufacturing experience

• Superior customer service
  • Committed to satisfying customer needs

• Global presence
  • Worldwide sales and manufacturing capabilities

• Local support
  • Offices around the world
Condensables

By definition – They are vapors that pass through the bag house then at some point transition to the solid phase – PM

Problem: Condensables can be 3x – 4x PM

CSAPR
CSAPR Regulations

CSAPR (Cross State Air Pollution Rule)

Defined states reduce SO$_2$ emissions by 73% and NO$_x$ by 54% from levels in 2005 (in CSAPR region)

Unknown when effective; Court of Appeals temporary stay- hearing in June 2012
<table>
<thead>
<tr>
<th>LB/MWh</th>
<th>Filterable Particulate</th>
<th>Acid Gasses (Hydrogen Chloride)</th>
<th>Mercury</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Existing</td>
<td>New</td>
<td>Existing</td>
</tr>
<tr>
<td>Not Low Rank Virgin Coal</td>
<td>0.3</td>
<td>0.007</td>
<td>0.02</td>
</tr>
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<td>0.3</td>
<td>0.007</td>
<td>0.02</td>
</tr>
</tbody>
</table>

*Lb/MWHR
*10 MMBTU
Perspective

Reduced By:

PM = 97.7%
Acid Gas = 98.0%
Mercury = 98.5%
**Coal**

**Not Low Ranked Virgin Coal**

<table>
<thead>
<tr>
<th>Type</th>
<th>Fixed Carbon</th>
<th>Volatile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthracite or anthracitic</td>
<td>&gt;86%</td>
<td>&lt;14%</td>
</tr>
<tr>
<td>Bituminous coal</td>
<td>&lt;86%</td>
<td>&gt;14%</td>
</tr>
<tr>
<td>Sub bituminous</td>
<td>&gt;8300</td>
<td>&lt;11500</td>
</tr>
</tbody>
</table>

**Low Ranked Virgin Coal**

<table>
<thead>
<tr>
<th>Type</th>
<th>Fixed Carbon</th>
<th>Volatile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lignite A</td>
<td>&gt;6300</td>
<td>&lt;8300</td>
</tr>
<tr>
<td>Lignite B</td>
<td>-</td>
<td>&lt;6300</td>
</tr>
</tbody>
</table>

Planning Model

Retrofit pollution control installations on coal-fired capacity (by technology) with the base case and with the proposed Toxics Rule, 2015 (measured in GW capacity). Source: Integrated Planning Model run by EPA, 2011.

- FGD: flue gas desulfurization (scrubber)
- DSI: dry sorbent injection
- SCR: selective catalytic reduction
- ACI: activated carbon injection
- FF: fabric filter
BENEFITS OF MEMBRANE
Sorbent/Activated Carbon Injection

Increases Filter Bag Inlet Grain Loading

Lime/Milled Lime/Hydrated Lime 2-45 microns PSD range
Sodium/Milled Sodium/Trona 7-30 microns PSD range

PAC Injection:

90-99% minus 325 mesh 5-20 microns PSD range
ePTFE Membrane

**ePTFE = Expanded Polytetraflouroethylene**

- Membrane: Porous film made from PTFE
- Manufactured from 100% PTFE Polymer resin
- Thermally bonded onto a range of substrates
- A surface filtration membrane
- Acts as a primary dust cake*
- No pre-coat required *
- Inhibits fine particulate penetration
- Helps to preserve integrity of the substrate
- Helps to optimize filter performance

* Precoat for fuel oil at start-up.
Depth Filtration - Surface Filtration
Depth Filtration

- Efficiency relies on cake formation
- Dust cake restricts airflow
- Requires high cleaning energy which imparts mechanical stresses
- Fine particles migrate into media causing abrasion damage
- Leads to blinding - High pressure drop
Surface Filtration - Tetratex®

- Acts as primary dust cake, no pre-coat required*
- Inhibits particle migration
- Low cake formation allows for reduced cleaning therefore less mechanical stresses
- Higher cleaning efficiency gives higher constant airflow
- Excellent cake release - Low pressure drop

* Precoat for fuel oil at start-up.
Membrane at 500x
Microscopic View of Utility ePTFE Membranes

- **Tetratex EXTREME**
  - 10-20 cfm @ 0.5"

- **Tetratex High Efficiency**
  - 3-8 cfm @ 0.5"

- **Tetratex**
  - 7-12 cfm @ 0.5"
Efficiency Comparison: 16oz PPS

Conventional Media

Tetratex Laminate (8162)

* Independent test results conducted by LMS Technologies Inc. May 2012
## Efficiency Comparison: 16oz PPS

### Conventional Media

<table>
<thead>
<tr>
<th>Size Range (mm)</th>
<th>Status</th>
<th>Initial</th>
<th>after loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>DP (”H₂O)</td>
<td></td>
<td>0.185</td>
<td>0.385</td>
</tr>
<tr>
<td>0.3-0.4</td>
<td></td>
<td>12.5</td>
<td>85.7</td>
</tr>
<tr>
<td>0.4-0.55</td>
<td></td>
<td>15.0</td>
<td>87.6</td>
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<tr>
<td>0.55-0.7</td>
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<td>22.3</td>
<td>88.6</td>
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<tr>
<td>0.7-1.0</td>
<td></td>
<td>33.1</td>
<td>90.1</td>
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<tr>
<td>1.0-1.3</td>
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<td>39.7</td>
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<td>1.3-1.6</td>
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<td>1.6-2.2</td>
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<td>4.0-5.5</td>
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<td>88.4</td>
<td>96.0</td>
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<td>5.5-7.0</td>
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<td>97.5</td>
<td>98.3</td>
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<td>7.0-10.0</td>
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<td>0.956</td>
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<td>98.1</td>
<td>99.6</td>
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Observations and Concerns

1. Utility Bag Houses being built with Membrane bags
2. Is current instrumentation capable of measuring accurately and repeat ably to the new standard
3. CSPARR?
4. Outlet particulate emissions leaving the system shall not exceed -- X mg/m$^3$
5. The box – the bag – fused seams – stitched seam - taped seams (vertical & horizontal) – sewing on rings
Thank You
References:

Changes from the Proposed Rule – Utility MACT-
http://www.dep.state.pa.us/dep/subject/advcoun/aqtac/2012/01-12-12/Utility_MACT-Final_Rule-AQTAC_with_TAP_addition(3).pdf

GEOLOGICAL SURVEY CIRCULAR 891
URL: http://pubs.usgs.gov/circ/c891/guidelines.htm

EPA’s Final Mercury and Air Toxics Standards and NSPS for Power Plants
Air Quality Technical Advisory Committee Meeting January 12, 2011 Harrisburg, PA 17105

Technology Transfer Network Air Toxics Web Site
http://www.epa.gov/tnn/atw/utility/utilitypg.html