Hydrated Lime for HCl Mitigation

Benefits of High Reactivity Hydrate

July 18, 2013
Utility Focus - Support of Technical Advancement

- Support of key industry events
  - WPCA member
  - Sponsor of 2013 APC Conference in St. Louis
  - Dry Hydrate Users Group
- Continued funding of test programs
  - SO$_3$ & HCl mitigation
  - 2015 MACT/MATS requirements
- Technical Service and R&D organization
  - Equipment for field tests
  - Additional personnel
  - Focus on new product development
Hydrated Lime DSI (SO$_3$, HCl, SO$_2$)

**Known**
- Works well for acid gases
  - Good quality hydrate
- Works with hot or cold side injection
- On-site treatment unnecessary – ready to use as delivered
- Simple feed systems
- Ash-friendly

**Challenges, new and old**
- Tighter regulations for acid gases
- More in-flight capture
- Very marginal ESPs
Factors Affecting Removal Rate

- Hydrated lime quality
  - Purity & reactivity
- Injection system efficiency
  - Feed system
  - Flow splitting
  - Flue gas coverage
- Residence time
- Levels of HCl
Market Needs for Higher Reactivity Hydrate

- Lower emissions requirements at stack $SO_3$ & $HCl$
- Short residence time (<1.5 sec)
- In-flight capture of $SO_3$ due to co-injection with PAC
- Desire to use less hydrate
  - Freight savings & less truck traffic
- Marginal ESP limits particulate
Performance Improvement
Qualify High Reactive Hydrate

• Lab data
  – Internal reactivity test
    • HR Hydrate >> FGT Hydrate >> Industrial Hydrate
  – TGA

• Pilot Studies
  – Southern Research Institute
  – B&W

• Full Scale Field Results
  – HCl removal chart
  – Other testing
## General Properties – FGT Hydrate

<table>
<thead>
<tr>
<th>Property</th>
<th>Guaranteed</th>
<th>Comment</th>
</tr>
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<tbody>
<tr>
<td>Available Ca(OH)$_2$</td>
<td>≥ 94% wt</td>
<td>High purity improves utilization, minimizes byproduct.</td>
</tr>
<tr>
<td>- 325 mesh</td>
<td>≥ 92% wt</td>
<td>Fine power product</td>
</tr>
<tr>
<td>Moisture</td>
<td>≤ 1.0% wt</td>
<td>As shipped, good for handling</td>
</tr>
<tr>
<td>BET Surface Area</td>
<td>≥ 20.0 m$^2$/g</td>
<td>High surface area improves acid gas capture. Major hydrate DSI systems use material with &gt;20 BET material</td>
</tr>
<tr>
<td>SiO$_2$</td>
<td>≤ 2.0% wt</td>
<td>Low quantity of inert material</td>
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<td>Reduced wear on equipment</td>
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</tbody>
</table>
Identified potential laboratory screening method for hydrated lime reactivity

<table>
<thead>
<tr>
<th></th>
<th>Reactivity</th>
<th>Surface Area</th>
<th>Pore Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction Hydrate</td>
<td>50+ sec</td>
<td>15</td>
<td>0.050</td>
</tr>
<tr>
<td>High SA/PV Hydrate</td>
<td>42 sec</td>
<td>31.5</td>
<td>0.206</td>
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<tr>
<td>Hydrated Lime FGT</td>
<td>27 sec</td>
<td>21.5</td>
<td>0.089</td>
</tr>
<tr>
<td>High Reactivity Hydrate</td>
<td>4 sec</td>
<td>21.3</td>
<td>0.097</td>
</tr>
</tbody>
</table>

Determined that HR Hydrate was worthy of additional evaluation at pilot and full scale
Reactivity & Removal

Thermodynamic
• $\text{SO}_3 > \text{SO}_2 > \text{HF} > \text{HCl}$

Kinetic
• Maximize collisions
• Hydrate $D_{50} \sim 2-4 \ \mu m$
• Gas particles $\sim 0.0003 \ \mu m$

Benson, 2012 DHUG
Pilot Scale Testing Hydrate for HCl – In-flight

Hydrate Comparison In-flight HCl removal (before baghouse)

- **MLC-B&W Pilot Results**
  - Improved in-flight capture of HCl
- **HR Hydrate**
- **FGT Grade**
  - Native capture is not included in results
Pilot Scale Testing Hydrate for HCl – Baghouse Outlet

Overall (Baghouse outlet) HCl removal

MLC - B&W Pilot Results
HR Hydrate
FGT Grade

Improved sorbent activity results in higher removal
Native capture is not included in results
Test Site 1 - Results of Improved Distribution

4 lances/duct – MATS achieved

2015 HCl MATS

Beginning of trial – 2 lances/duct
*Good reduction but unable to meet 2015 MATS*

Additional lances allowed site to meet MATS requirements
Test Site 2 – HCl Reduction for MATS

- Smaller (<200 MW) Unit with Baghouse
- Higher SO$_2$ (~500 ppm) and HCl (~90 ppm) levels
- MATS achieved with >99% HCl reduction
- Also some SO$_2$ reduction (40-50%)
  - Relatively high Hydrate: Total Acid ratio (>3.0)
Test Site 3 – HCl and Hg Reduction for MATS

- Smaller (<200 MW) Unit with ESP
- Lower SO\textsubscript{2} (<400 ppm) and HCl (<10 ppm)
- MATS achieved for HCl
- Selenium emissions also reduced by \sim 80\% when injecting hydrate

- Issues:
  - Opacity increase, but below limits
  - pH increase in wet ash pond
Mississippi Lime – Confidential Information

Test Site 4 – CFB for HCl

HCl Removal with MLC Hydrate - CFB Application

Reduction required to meet 2015 MATS level

- PreBH injection
- PreAPH injection

Re-running in Aug ‘13 with slightly higher feed rates to see if that will meet MATS

Hydrate:Total Acid NSR

% HCl reduction

70% 75% 80% 85% 90% 95% 100%
Test Site 5 – Cement Plant for HCl

HCl - Cement Plant Reductions

% Reduction of HCl

Molar Ratio (Sorbent:HCl)

- Hydrate
- Bicarb
Highlights of Full Scale Testing for HCl Control

HCl Removal

• MATS Limits met in 6 out of 7 trials in 2012
  – Baghouse
  – ESP
  – Marginal ESP
  – Industrial Waste Incinerator
  – One trial not meeting MATS (dosage? Repeating test in Aug ‘13)
    • 96% HCl reduction

• Very marginal ESP and short residence time
  – HCl reduction of ~90% at 0.7 NSR (hydrate:total acid)
  – High chloride coal
Benefits of Using Less Hydrate

- Lower annual freight costs
- Fewer trucks ordered per year
  - Fewer transactions
  - Less local and plant traffic
  - Safety incident potential is reduced
    - Less hookups and disconnects
    - CO$_2$ reduction from reduced truck shipments
- Less tons of ash to landfill
  - Freight, traffic, transactional, and CO$_2$ benefits here also
  - Lower CaOH$_2$ levels in fly ash
Summary

• Mississippi Lime is an industry leader in Hydrated Lime DSI
• Hydrated Lime FGT is proven for SO$_3$ and HCl
• High Reactivity Hydrate presents a solution to improved in-flight capture of SO$_3$ and HCl
• Mississippi Lime has testing equipment and R&D personnel focused on conveying optimization and next generation products
Questions

Pat Mongoven
Business Development Manager – FGT
pgmongoven@mississippilime.com

Curt Biehn
Manager, Marketing and Technical Services
crbiehn@mississippilime.com

Mark DeGenova
Chief Chemist
mgdegenova@mississippilime.com

Eric Van Rens
Vice President, Sales & Marketing
ecvanrens@mississippilime.com

Mississippi Lime Company
3870 S. Lindbergh Blvd.
Suite 200
St. Louis, MO 63127
www.mississippilime.com