POWER PLANTS – FGD
LIMESTONE SLURRY PROCESSES

NEW PROCESS TECHNOLOGY VS. TRADITIONAL

Pulverized Limestone w/ Vacucam® Ejector Mixers
vs.
Crushed Limestone & Wet Ball Mills

Presented at: EUEC-2011
Phoenix, AZ

Presented by: Charles S. Alack
Semi-Bulk Systems, Inc
TRADEDIONAL PROCESS [Crushed Limestone]
FOR
LIMESTONE UNLOADING, HANDLING, STORAGE & SLURRY PREP [Ball Mills]

- Limestone Supplier delivers crushed limestone to Power Plant
- Power Plant
  - Unload & mechanical convey to storage
  - Mechanical transfer to multiple day bins feeding Ball Mills
  - Operates Ball Mill processes
  - Slurry to storage tanks
  - Feed slurry to Scrubber
Limestone Supplier:
- Produces pulverized limestone w/ roller mills.
- Provide logistics for supplier storage and regional distribution
- Deliver and unload pulverized limestone to Power Plant silo.

Power Plant
- Supervision monitors automated slurry making process
VACUCAM® EJECTOR MIXER

Conditioned powder is vacuum conveyed into the system directly from a silo or a surge bin equipped with an Air-Cone® Hopper for conditioning of powder.

Powder, conditioned with air or inert gas, is conveyed into the mixer by the VACUCAM® system’s near-perfect vacuum.

At the mixpoint, the powder is propelled through a curtain of atomized liquid before proceeding through the discharge tube.

Liquid is introduced into the system from a separate stream or single pass or recycled.

Finished slurry is discharged.
VACUCAM® Ejector Mixer

- High Performance
- High Wetting/Dispersion Efficiency
- Operates under high vacuum for exposing maximum surface area of liquid to dry product
- No moving parts
- No maintenance
VACUCAM® Ejector Mixer

- Four main components:
  - powder tube
  - housing
  - orifice
  - discharge tube

- No moving parts
- No dynamic adjustment required
POWER PLANT
Process Options

1. Single Pass Process Direct Into Slurry Storage Tank
POWER PLANT-LIMESTONE SLURRY PROCESS
SINGLE PASS PROCESS DIRECT INTO SLURRY STORAGE
POWER PLANT-LIMESTONE SLURRY PROCESS
SINGLE PASS PROCESS DIRECT INTO SLURRY STORAGE
Dual Silo Feed to Dual Mixer System
POWER PLANT-LIMESTONE SLURRY PROCESS
SINGLE PASS PROCESS
Two Silos w/ Dual Outlets Direct to
Two Dual Mixer Processes
Pulverized Limestone Storage
Two silos w/ Dual Cone Outlets
VACUCAM® LIMESTONE SLURRY PROCESS
DUAL EJECTOR MIXER SINGLE PASS IN-LINE SLURRY
DIRECT TO SLURRY STORAGE

Limestone From Silo

Water Supply

30%+ Slurry to Storage Tank
POWER PLANT
Process Options

1. Single Pass Process Direct Into Slurry Storage Tank

2. Single Pass In-Line Process to Remote Slurry Storage Tanks
Single Pass In-Line Process to Remote Slurry Storage Tanks
Limestone Slurry Process
Dual Silos & Slurry Processes
DUAL DOME STORAGE
PULVERIZED LIMESTONE
Limestone Slurry Process
Dual Domes & Slurry Processes
Limestone Slurry System w/ Dome Storage Supply
Limestone Slurry Process in Dome Vault
Limestone Slurry Process
Dual Domes & Slurry Processes
WATER SUPPLY PUMP SKID

Water In

Water to Ejector Mixing Skid
LIMESTONE SLURRY PROCESS IN VAULT OF DOME
LIMESTONE SLURRY PROCESS IN VAULT OF DOME
1. Single Pass Process Direct Into Slurry Storage Tank
2. Single Pass In-Line Process to Remote Slurry Storage Tanks
3. Single Pass Process for Direct PH Control
POWER PLANT-LIMESTONE SLURRY PROCESS
SINGLE PASS PROCESS FOR DIRECT PH CONTROL TO SCRUBBER
-DIRECT INJECTION TO SCRUBBER
-ELIMINATE LIMESTONE SLURRY STORAGE
## ENERGY REQUIREMENTS
### TYPICAL MIXING PROCESSES

<table>
<thead>
<tr>
<th>TYPICAL SLURRY PROCESSES</th>
<th>KWH/TON CaCO3</th>
<th>$/TON CaCO3 @ $0.08/KW H</th>
</tr>
</thead>
<tbody>
<tr>
<td>SINGLE PASS VACUCAM EJETOR MIXER FROM SILO [12HP/100GPM@100PSI]—WATER SUPPLY PUMP ONLY</td>
<td>.97</td>
<td>$0.077</td>
</tr>
<tr>
<td>SINGLE PASS VACUCAM® EJM IN-LINE FROM SILO TO REMOTE SLURRY STORAGE—WATER SUPPLY +SLURRY DELIVERY PUMP TO STORAGE</td>
<td>1.94</td>
<td>$0.15</td>
</tr>
<tr>
<td>PNEUMATIC CONVEY [150HP/25TPH] NOTE: DOES NOT INCLUDE MAKING SLURRY</td>
<td>4.98</td>
<td>$0.40</td>
</tr>
<tr>
<td>SLURRY STORAGE MIXERS [4@30HP EACH] [AGITATOR MIXER IN A SLURRY TANK]</td>
<td>4.15</td>
<td>$0.33</td>
</tr>
<tr>
<td>BALL MILL SLAKER PROCESS [12.5HP/TON]</td>
<td>10.4</td>
<td>$0.83</td>
</tr>
</tbody>
</table>
# Typical Mix Processes vs. Costs for 24TPH CaCO3 Capacity [Example]

<table>
<thead>
<tr>
<th>Typical Slurry Processes</th>
<th>$/Ton CaCO3 @ $0.08/kWh</th>
<th>$/HR</th>
<th>$/Day</th>
<th>$/YR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Pass Vacucam Ejetor Mixer from Silo [12HP/100GPM@100PSI]—Water Supply Pump Only</td>
<td>$0.077</td>
<td>$1.85</td>
<td>$44.40</td>
<td>$16,206</td>
</tr>
<tr>
<td>Single Pass Vacucam® EJM In-Line from Silo to Remote Slurry Storage—Water Supply + Slurry Delivery Pump to Storage</td>
<td>$0.15</td>
<td>$3.6</td>
<td>$86.40</td>
<td>$31,536</td>
</tr>
<tr>
<td>Pneumatic Convey [150HP/25TPH] Note: Does not Include Making Slurry</td>
<td>$0.40</td>
<td>$9.6</td>
<td>$230.40</td>
<td>$84,096</td>
</tr>
<tr>
<td>Slurry Storage Mixers [4@30HP Each] [Agitator Mixer in a Slurry Tank]</td>
<td>$0.33</td>
<td>$7.92</td>
<td>$190.08</td>
<td>$69,379</td>
</tr>
<tr>
<td>Ball Mill Slaker Process [12.5HP/Ton]</td>
<td>$0.83</td>
<td>$19.92</td>
<td>$478.08</td>
<td>$174,499</td>
</tr>
</tbody>
</table>
## Limestone Mixer – Capacity Size Chart

### MIXER MODEL/SIZE -- SINGLE UNIT

<table>
<thead>
<tr>
<th></th>
<th>125B/C</th>
<th>150B/C</th>
<th>200C</th>
<th>250C</th>
<th>340C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Limestone</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[TPD]</td>
<td>322</td>
<td>386</td>
<td>515</td>
<td>644</td>
<td>876</td>
</tr>
<tr>
<td>[TPH]</td>
<td>13</td>
<td>16</td>
<td>22</td>
<td>28</td>
<td>38</td>
</tr>
<tr>
<td>[#/HR]</td>
<td>26,807</td>
<td>32,168</td>
<td>42,900</td>
<td>53,625</td>
<td>72,930</td>
</tr>
<tr>
<td>[#/MIN]</td>
<td>447</td>
<td>536</td>
<td>715</td>
<td>894</td>
<td>1,216</td>
</tr>
<tr>
<td><strong>WATER</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[#/HR]</td>
<td>62,550</td>
<td>75,060</td>
<td>100,080</td>
<td>125,100</td>
<td>170,136</td>
</tr>
<tr>
<td>[#/MIN]</td>
<td>1,042</td>
<td>1,250</td>
<td>1,668</td>
<td>2,085</td>
<td>2,836</td>
</tr>
<tr>
<td>[GPM]</td>
<td>125</td>
<td>150</td>
<td>200</td>
<td>250</td>
<td>340</td>
</tr>
<tr>
<td><strong>SLURRY [30% SOLIDS]</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[TPD]</td>
<td>1,072</td>
<td>1,286</td>
<td>1,715</td>
<td>2,144</td>
<td>2,916</td>
</tr>
<tr>
<td>[#/HR]</td>
<td>89,357</td>
<td>107,228</td>
<td>142,980</td>
<td>178,725</td>
<td>243,066</td>
</tr>
<tr>
<td>@ 9.97#/GAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[GPM]</td>
<td>149</td>
<td>179</td>
<td>239</td>
<td>299</td>
<td>407</td>
</tr>
<tr>
<td></td>
<td>Plant Requirements</td>
<td>Capacity @ 30% solids</td>
<td>Capacity @ 35% solids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>--------------------</td>
<td>-----------------------</td>
<td>-----------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>@ 30% slurry</td>
<td>1 X 250 Mixer</td>
<td>2 X 250 Dual Mixer</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>@ 35% solids</td>
<td>1 X 250 Mixer</td>
<td>2 X 250 Dual Mixer</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>DRY CaCO3</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TPH</td>
<td>34</td>
<td>27</td>
<td>54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TPD</td>
<td>816</td>
<td>643</td>
<td>1286</td>
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<tr>
<td>#:/HR</td>
<td>68,000</td>
<td>53,580</td>
<td>107,160</td>
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<tr>
<td>#:/MIN</td>
<td>1133</td>
<td>893</td>
<td>1786</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>WATER</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#:/MIN</td>
<td>2644</td>
<td>2085</td>
<td>4170</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GPM</td>
<td>317</td>
<td>250</td>
<td>500</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SLURRY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#:/min</td>
<td>3777</td>
<td>2978</td>
<td>5956</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TPH</td>
<td>113</td>
<td>89</td>
<td>178</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TPD</td>
<td>2719</td>
<td>2144</td>
<td>4288</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GPM (est. 10#/gal)</td>
<td>378</td>
<td>298</td>
<td>596</td>
<td></td>
<td></td>
</tr>
<tr>
<td>gpm (est. 10.5#/gal)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% CAPACITY</td>
<td>100</td>
<td>78.8</td>
<td>158</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OPERATING HOURS/DAY</td>
<td>15.2</td>
<td>12</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Use Requirements vs. Mix Capacity Options:

1. Plant CaCO3 requirements for a 24 hr. day would be 34TPH dry; requiring 317gpm water to produce 378 gpm of 30% slurry.

RECOMMENDATIONS:

OPTION 1: One option to produce this capacity would be to use a dual pair of Mixers @ 250gpm each for a total of 500gpm of water to produce 596gpm of 30% slurry. This process will produce 158% of required daily usage requiring 15.2 hours of operating time.

OPTION 2: A Second option to produce this capacity would be to use a dual pair of Mixers @ 250gpm each for a total of 500gpm of water to produce 612 gpm of 35% slurry. This process will produce 200% of required daily usage requiring 12 hours of operating time.
Semi-Bulk Systems has applied its technology and experience in Powder Handling & Powder/Liquid Mixing to provide the most efficient Limestone Handling/Slurry Processes for FGD. The Technology offers many benefits over conventional slurry processes.

- The VACUCAM® Mixing Systems incorporate no mechanical mixing devices and has no moving parts (other than liquid pumps).
- Lower Initial Capital Costs
- Lower Installation costs
- Less real estate required for installation.
- Lower Operating Cost in terms of manpower, maintenance and operating costs
- System never requires scheduled downtime for prolonged maintenance or preventative maintenance.
- Capacities to meet any requirements
- Energy—90%+ savings per ton of slurry
- Much greater Operation Flexibility
  - Instant start and stop of slurry process
  - Total System Automation
  - Simple wash down of slurry process
  - 100% Reliability
- Quality- efficient dispersion of dry powder to provide maximum surface area contact for scrubbing efficiency –no dry dust collection required.
- Lowest Cost of Ownership
Thank you