Improvements in Screen-Bowl Centrifuge Performance

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Solid-Liquid Separations

- All modern coal preparation plants use water for sizing and cleaning.
- Solid-liquid separations are needed downstream to remove moisture.
  - Vibrating Screens
  - Centrifugal Dryers
  - Screen-Bowl Centrifuges
  - Disc & Belt Filters
- Residual moisture:
  - Reduces heating value
  - Increases transport costs
  - Makes handling difficult
Solid-Liquid Separations

Particle Diameter (mm)

- Screens
- High Frequency Screen
- Vibratory Centrifuge
- Screen-Scroll Centrifuge
- Fine Screen-Scroll
- Screen-Bowl Centrifuge
- Horizontal Belt Filter
- Disc Vacuum Filter

0.01 0.1 1 10 100
Screen-Bowl Centrifuge

**Characteristics**

- High capacity centrifugal device used to efficiently dewater fine coal
- Variation on the counter-current solid-bowl design
- Bowl - provides initial dewatering (to achieve clarity)
- Screen - provides final dewatering (to reduce cake moisture)
- Main effluent is discarded
- Screen effluent recycled back to feed
- High capacity and good product moisture (10-30%) – depends on fineness
Screen-Bowl Centrifuge
SBC Components

- Liquid Headwall
- Solid Headwall
- Bowl & Screen
- Inside Screen
Components

Scroll Assembly
SBC Performance

- **Product Moisture**
  - Reduces moisture by rejecting high-surface-area solids
  - Final moistures are 4-6 percentage points lower than vacuum filters

- **Solids Recovery**
  - Screen-bowls recover less solids (80-90%) than filters (95-99%)
  - Ultafines are too small to settle during the short residence time

- **Dilemma**
  - Trade-off between solids recovery and product moisture!
SBC Performance

Spiral (1x0.15 mm) and Flotation (0.15 mm x 0) Clean Coal

<table>
<thead>
<tr>
<th>Size Class (mm)</th>
<th>Feed Mass (%)</th>
<th>Feed Ash (%)</th>
<th>Product Ash (%)</th>
<th>Effluent Ash (%)</th>
<th>Product Yield (%)</th>
<th>Product Moisture (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plus 0.045</td>
<td>74.4</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>99.6</td>
<td>---</td>
</tr>
<tr>
<td>Minus 0.045</td>
<td>25.6</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>50.4</td>
<td>---</td>
</tr>
<tr>
<td>Totals</td>
<td>100.0</td>
<td>9.60</td>
<td>7.20</td>
<td>25.0</td>
<td>87.0</td>
<td>16.2</td>
</tr>
</tbody>
</table>
Moisture in a Typical 28 Mesh x 0 Feed

(28 Mesh = 595 Microns)
(325 Mesh = 44 Microns)
R&D Project

- Project objectives include:
  - to formulate engineering criteria for optimizing the performance of industrial screen-bowl centrifuges
  - to develop design enhancements that improve moisture reduction and increase fine coal recovery

- Work has focused on testing of injection tubes for adding:
  - polymer to the low-solids pool
  - surfactants to the dewatered screen solids
Solids Recovery

- Traditional flocculants cannot withstand high shear forces
- Solids content (15-35%) is too high for flocculants to be effective

Solution

-Inject reagent into the “dilute” pool after solids have been captured
-Use a shear-resistant polymer specially designed for this application
Polymer Injection
Polymer Injection

Initial Field Tests (Plant A)

<table>
<thead>
<tr>
<th>Condition</th>
<th>Effluent Solids (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Addition</td>
<td>6</td>
</tr>
<tr>
<td>Polymer A Injected</td>
<td>1.5</td>
</tr>
<tr>
<td>Polymer B Injected</td>
<td>1.5</td>
</tr>
</tbody>
</table>
Addition Point Tests (Plant B)

**Effluent Solids (%)**
- No Addition
- Floc in Feed
- Polymer A Injected
- Polymer B Injected

**Cake Moisture (%)**
- No Addition
- Floc in Feed
- Polymer A Injected
- Polymer B Injected
Addition Point Tests (Plant B)

- **Effluent Ash (%):**
  - No Addition: 9.5
  - Floc in Feed: 9.2
  - Polymer A Injected: 8.8
  - Polymer B Injected: 8.5

- **Cake Ash (%):**
  - No Addition: 7.2
  - Floc in Feed: 7.5
  - Polymer A Injected: 7.8
  - Polymer B Injected: 8.0
Polymer Injection

Extended Field Tests (Plant C)

- **Effluent Solids (%):**
  - Day 1: No Addition, 4.0%
  - Day 1: Polymer Injected, 0.5%
  - Day 8: No Addition, 1.0%
  - Day 8: Polymer Injected, 1.5%

- **Cake Moisture (%):**
  - Day 1: No Addition, 12.0%
  - Day 1: Polymer Injected, 16.0%
  - Day 8: No Addition, 6.0%
  - Day 8: Polymer Injected, 18.0%
Polymer Injection

Extended Field Tests (Plant C)

- Effluent Ash (%)
  - Day 1: No Addition
  - Day 1: Polymer Injected
  - Day 8: No Addition
  - Day 8: Polymer Injected

- Cake Ash (%)
  - Day 1: No Addition
  - Day 1: Polymer Injected
  - Day 8: No Addition
  - Day 8: Polymer Injected
Polymer Injection

- **Plant Impact**
  - Additional moisture acceptable within contract
  - Five 36 x 72 units (350 gpm feed, 225 gpm effluent @ 4% solids)

- **Coal Gain:**
  - 2.02 tph x $35/ton = $70.70/hr

- **Polymer Cost:**
  - 10 lb/hr x $1.30/lb = $13.00/hr

- **Net Gain:**
  - $57.70/hr x 6,000 hr/yr x 5 units = $1,730,000/yr
  - 45 hr payback on $1,100 injection tube and $1,500 pump cost
Product Moisture
- Moisture can be reduced by adding “surface tension” modifiers
- Dosage too high to be practical in industrial applications

Solution
- Inject reagent directly onto “cake” after bulk water rejected
- High concentration (low surface tension) possible at low dosage
Surfactant Injection

- Preliminary tests conducted using a rebuilt Sharples SB centrifuge
- 15 cm diameter – extended bowl
  - long slurry residence time
  - >80% recovery -325 Mesh Solids
Surfactant Injection

Pilot-Scale SBC Tests

Cake Moisture (%)

- No Addition (Base)
- Injected Low Dose Reagent X
- Injected High Dose Reagent X
- Injected Low Dose Reagent Z
SBCs are one of the most effective methods for dewatering fine coal.

Reagent injection methods have been examined to further enhance performance.

**Polymer Injection**
- Injection of polymer into low-solids pool can substantially improve solids recovery.
- Shear-resistant polymers very important.
- Slight increase in product moisture and ash.
- Tremendous payback if inerts can be tolerated.

**Surfactant Injection**
- Injection of surfactant onto screen has the potential to reduce cake moistures.
- Addition point ensures high concentration.
- Retrofit of industrial machine has been completed and installation is underway.
CAST Initiative
Nalco Company
Decanter Machine
Coal Producers