The CoLD® Crystallization Process

HPD® Evaporation and Crystallization

McIlvaine Hot Topic Hour
August 15, 2013
Clean Technologies Innovation

Veolia Water Solutions & Technologies is Committed to Supporting our Customers to Achieve Their Sustainable Visions

Our integrated solutions include resource-efficient technologies to:

- Improve operations
- Reduce costs
- Achieve sustainability goals
- Decrease dependency on limited resources
- Comply with current and anticipated regulations
Contents

- What is the CoLD Process?
- What are the advantages of CoLD Process?
- How is the CoLD Process applicable to FGD ZLD?
- Comparison of conventional FGD ZLD to CoLD ZLD.
  - Flowsheet
  - CAPEX
  - OPEX
What is the CoLD Process?
Crystallization of high solubility salts at Low Temperature and Deep Vacuum

U.S. Patent 8,052,763
Conventional ZLD Process

- Pretreatment
- Evaporation/Crystallization
- Separation
- Drying

Waste Water → Pretreatment → Evaporation/Crystallization → Separation → Drying

Chemicals → Pretreatment

Waste Water → Pretreatment

Sludge → Pretreatment

Solids → Drying
CoLD® Process

- Pretreatment
- CoLD® Crystallization
- Separation
- Drying

- Chemicals
- Water
- Sludge
- Solids

- No Chemicals
- No Water
- No Sludge
- No Drying
Result of CoLD® Process ZLD

FGD Scrubber Blowdown

Clean Water for Recycle and Stable Solid for Landfill Disposal
What are the advantages of CoLD Process?
Advantages of CoLD Process

- No Chemicals
- Much Less Solids to Dispose
- Simpler System with Fewer Unit Operations
- Robust System
- Similar Energy Requirement to Conventional Process
- Similar CAPEX
- Much lower OPEX
How is the CoLD Process applicable to FGD ZLD?
CoLD® Process

Crystallization of high solubility salts at Low Temperature and Deep Vacuum

U.S. Patent 8,052,763
High Solubility Salts Predominate in FGD Purge

- Chlorides
  - Calcium
  - Magnesium

- Nitrates

- Organic Acids
  - Formic acid
  - DBA
Comparison of conventional FGD ZLD to CoLD ZLD

Flowsheet
CAPEX
OPEX
Conventional ZLD for FGD

Monfalcone Power Plant, Italy
- 336 MW Coal-Fired
- LSFO Scrubber (MHI)
- ZLD Operational Summer 2008
- Dry Cake for Landfill Disposal

Pretreatment: Lime-Soda Ash Softening
CoLD® Process eliminates chemicals, reduces solids disposal and equipment footprint.

Basic Flowsheet for FGD ZLD

Chemicals → Softening → Evaporation/Crystallization → Separation → Drying

Sludge → Water

CoLD™ Flowsheet for FGD ZLD

Chemicals → Softening → Evaporation/CoLD® Cryst. → Separation → Drying

Sludge → Water → Solids
CoLD™ Process

Crystallization of high solubility salts at Low Temperature and Deep Vacuum

U.S. Patent 8,052,763
At atmospheric pressure, the boiling point curve chases the solubility curve.
Under vacuum, the boiling point is lower and a solid phase can form at a lower concentration.
## Economic Comparison of FGD ZLD Options

### Facility Comparison
- **Conventional ZLD**: 350 gpm capacity, Softening, Evaporator, Crystallizer
- **CoLD ZLD**: 350 gpm capacity, Evaporator, CoLD® Crystallizer

### Economic Comparison Table

<table>
<thead>
<tr>
<th></th>
<th>Conventional</th>
<th>CoLD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cap - Amor</td>
<td>$5.4MM</td>
<td>$5.4MM</td>
</tr>
<tr>
<td>O&amp;M</td>
<td>$2.8MM</td>
<td>$2.8MM</td>
</tr>
<tr>
<td>Chemicals</td>
<td>$6.3MM</td>
<td>$250k</td>
</tr>
<tr>
<td>Disposal</td>
<td>$4.5MM</td>
<td>$1.0MM</td>
</tr>
<tr>
<td>Energy</td>
<td>$1.8MM</td>
<td>$2.3MM</td>
</tr>
<tr>
<td><strong>Total Opex</strong></td>
<td><strong>$15.4MM</strong></td>
<td><strong>$6.4MM</strong></td>
</tr>
<tr>
<td><strong>Net Annual Cost</strong></td>
<td><strong>$20.8MM</strong></td>
<td><strong>$11.8MM</strong></td>
</tr>
<tr>
<td><strong>$/gal</strong></td>
<td><strong>$0.125</strong></td>
<td><strong>$0.071</strong></td>
</tr>
</tbody>
</table>
Summary of Conventional and CoLD Processes

**Conventional:**

FGD wastewater is pretreated using lime and soda ash softening to replace calcium and magnesium, which form highly soluble chloride salts, and which are very difficult to crystallize.

**CoLD:**

Low operating temperature lowers the solubility of the high solubility dissolved salts, so they crystallize at a much lower concentration. Softening equipment, chemicals and resulting sludge disposal costs are eliminated.
Thank You

Bill Shaw
T  815-609-2241
M  414-418-4948
E  bill.shaw@veoliawater.com