Presentation Outline

• AZ Biosolids Background
• Dewatering Technologies
• Considerations During Equipment Selection
• Optimization of Dewatering Systems
• Drying Overview
Biosolids Quality Produced at Wastewater Resource Recovery Facilities in Arizona

- Sample of 29 plants
- Most common: Class B
- Biosolids quality provides flexibility for end use/disposal
End Use/Disposal Methods for Biosolids From WRRFs in Arizona

- Landfill and land application account for 90%
- Dewatering directly affects transportation costs
  - Solids content: 2% to 20%
AZ Snapshot of Dewatering

• Survey of 9 plants (mostly Northern Arizona)
  – Plant capacity = 4 mgd (0.5 to 16 mgd)
  – Cake solids content = 17% (14% to 22%)
  – Hauling distance = 48 mi (15 to 100)

• Dewatering technologies most commonly used
  – Belt filter press
  – Centrifuge
  – Screw press
Trends and Drivers Impacting Biosolids Processing

Do More With Less
- Leverage existing facilities thru rehab
- Less O&M attention
- Adjust for upstream process changes
- Increased automation/optimization

Address Odors/Staff Safety and Public Perceptions
- Enclosed equipment
- Reduced housekeeping
- Producing acceptable final product (e.g. Class A/EQ)

Reducing Operating Costs
- Leverage improvements in technologies
- Find balance in operating costs
- Increased automation/optimization
- Offset costs by producing marketable resources
Dewatering Technologies
Suite of options has grown

Screw Presses

Centrifuges

Rotary Fan Presses

Electro-Dewatering

Hydraulic Piston Press

2- and 3-Belt Filter Presses

Source: Suez/Degremont

Source: Ovivo
What’s New in Belt Filter Presses?

• 2-Belt and 3-Belt Units
  – 2-Belt: Traditional
  – 3-Belt
    ▪ Horizontal or Vertical
    ▪ Independent gravity zone (separate belt/drive)
    ▪ Designed for thin feed (<1-1.5% solids)
    ▪ Potentially higher throughput and 1-2% increase in cake dryness
What’s New in Belt Filter Presses?

• Enclosed units
  – Better odor control and housekeeping
  – Costly (up to 25% more than open)
  – Makes maintenance more difficult

• Numbers of Rollers (8 or 12)

• Curved wedge zones for gradual increase in pressure
### Belt Filter Presses – Primary Advantages / Disadvantages

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Proven</td>
<td>• Odors and corrosion/housekeeping (open config)</td>
</tr>
<tr>
<td>• Low power consumption</td>
<td>• Lower cake dryness than centrifuges</td>
</tr>
<tr>
<td>• Low polymer consumption</td>
<td>• Capacity per footprint</td>
</tr>
<tr>
<td>• Low noise/vibration</td>
<td>• Less amenable to unstaffed operation</td>
</tr>
<tr>
<td>• Maintenance does not require specialized skills</td>
<td>• High wash water needs</td>
</tr>
<tr>
<td>• Relatively low cost for parts</td>
<td></td>
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</tbody>
</table>

- High wash water needs
Centrifuges

CF centrifuge components

- Bowl Motor
- Bowl
- Scroll
- Feed
- Scroll drive
- Gearbox
- Cake
- Centrate

GEA Mechanical Equipment / GEA Westfalia Separator
Operational Animation (Courtesy of Andritz)
Innovations in Centrifuges

• Energy Saving Features
  – Deep ponds (slim conveyors)
  – Centrate jets
  – VFD technology

• Controls/Automation
  – Simplified controls
  – PM Alerts
  – Integration of external sensors for automation
  – Automated centrate weir adjustments (manf specific)

Source: Alfa Laval
Innovations in Centrifuges

• Minimize disturbance at feed zone
  – Reduce polymer consumption

• Further increases in pond depth / clarification volume
  – Increased capacity
  – Better capture
  – Higher cake dryness
  – Reduced power

Source: Flottweg (Xelletor Series)
## Centrifuges – Primary Advantages / Disadvantages

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Proven</td>
<td>• High power and polymer consumption</td>
</tr>
<tr>
<td>• Capacity per footprint</td>
<td>• Noise/Vibration</td>
</tr>
<tr>
<td>• Highest cake dryness of common technologies</td>
<td>• STR/ELE Impacts</td>
</tr>
<tr>
<td>• Enclosed – low odors/corrosion</td>
<td>• Large bridge cranes</td>
</tr>
<tr>
<td>• Automated, easy start/stop</td>
<td>• Specialized maintenance and high cost spare parts</td>
</tr>
<tr>
<td>• Lower operational staff time required than BFPs</td>
<td>• Potential odors/pathogen regrowth in some cake</td>
</tr>
</tbody>
</table>
Typical Screw Presses

• Principle of Operation
  – Sludge conveyed through unit by a screw
  – Screw increases in size and applies pressure against cone to induce solids/liquids separation
  – Free water drains through perforated screen
  – Screen cleaned by wash system

• Inclined or Horizontal
Twist on the Screw Press

- Instead of perforated screen, free water drains between space created by moving and stationary rings
## Screw Presses – Primary Advantages / Disadvantages

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Designed for unstaffed, continuous operation</td>
<td>• Capacity per footprint</td>
</tr>
<tr>
<td>• Lowest power consumption</td>
<td>• Footprint</td>
</tr>
<tr>
<td>• Enclosed – low odors/corrosion</td>
<td>• High polymer consumption</td>
</tr>
<tr>
<td>• Automated, easy start/stop</td>
<td>• Lower cake dryness than centrifuges</td>
</tr>
<tr>
<td>• Low O&amp;M staffing needs</td>
<td>• Struvite buildup on screen, impacts of plug loss</td>
</tr>
<tr>
<td>• Simple maintenance</td>
<td>• Fewer installations</td>
</tr>
</tbody>
</table>
Rotary Fan Presses

- Principle of Operation
  - Solids rotated between two parallel revolving filter elements
  - Filtrate flows through these elements
  - Friction of plates and back pressure at outlet produces cake

Source: Fournier
Rotary Fan Presses

Source: Fournier
# Rotary Fan Presses – Primary Advantages / Disadvantages

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Enclosed – low odors/corrosion</td>
<td>• Capacity per footprint</td>
</tr>
<tr>
<td>• Expandable</td>
<td>• Higher polymer consumption than BFPs</td>
</tr>
<tr>
<td>• Low power consumption</td>
<td>• Lower cake dryness than centrifuges</td>
</tr>
<tr>
<td>• Low noise/vibration</td>
<td>• Best suited for high primary sludge applications</td>
</tr>
<tr>
<td>• Low O&amp;M staffing needs</td>
<td>• Fewer installations</td>
</tr>
<tr>
<td>• Simple maintenance</td>
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</table>
## General Comparison

<table>
<thead>
<tr>
<th></th>
<th>Screw Press</th>
<th>Belt Filter Press</th>
<th>Centrifuge</th>
<th>Rotary Fan Press</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cake Dryness</td>
<td>++</td>
<td>++</td>
<td>+++</td>
<td>+ to ++</td>
</tr>
<tr>
<td>Polymer Consumption</td>
<td>++</td>
<td>+++</td>
<td>++</td>
<td>++ to +++</td>
</tr>
<tr>
<td>Power Usage</td>
<td>+++</td>
<td>+</td>
<td>-</td>
<td>++</td>
</tr>
<tr>
<td>Solids Capture</td>
<td>+</td>
<td>+++</td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td>Unattended Operation</td>
<td>+++</td>
<td>-</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Enclosed/Odors</td>
<td>+++</td>
<td>-</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>Output Capacity</td>
<td>+</td>
<td>++</td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td>Relative to Footprint</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Washwater Requirement</td>
<td>++</td>
<td>-</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td>(gpd)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

More Favorable: +++  ++  +  -  Less Favorable: ++ to +++  +++  +++  ++ to +++

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*Filename: ppt/23*
Considerations During Equipment Selection
There is no silver bullet or one right answer for all situations

- Beware of “typical” performance values
  - Sludge is very different plant by plant
  - Sludge characteristics make a huge difference in dewatering performance, especially polymer consumption and cake dryness

- Get values from manufacturers specific to your application and plant
  - Send sludge samples to manfs for testing
  - Pilot if you can (side-by-side is best)

- Conduct site visits – seeing is believing
Key considerations that may impact which equipment is right for your plant

• Operating hours and staffing
  – Impacts # and size of units; feasibility of fit
  – Consider what’s happening downstream when you decide this parameter

• Retrofit of new equipment into existing bldg. or new facility? Consider impacts...
  – Structural (crane/maintenance, foundation, supports)
  – Electrical
  – Utilities (water, foul air/odor control, polymer system)

• Importance of odors/corrosion
Develop evaluation process carefully

• What governs? Capital or life cycle costs?
  – Life cycle costs will vary by plant and sludge
  – Assess whole costs of dewatering – driest material may not be the right answer for you
    ▪ Dryness (Hauling Costs)
    ▪ Polymer
    ▪ Power
    ▪ Capture

• Assign priorities/weights to all items to be considered, economic and non-economic
  – Include O&M staff in decisions
Consider various selection/procurement strategies and pros/cons

- Selection/Procurement Strategies
  - Open bid during construction
  - Pre-selection during design
  - Pre-procure before construction

- Performance guarantees are difficult to enforce
  - Consider use of 3rd parties to do initial dewaterability test to set design criteria
Optimization of Dewatering Systems
Dewatering costs a lot... (Case Study 1)

Average Monthly Dewatering Cost Breakdown - District-wide
(Hauling, Polymer, Power est.)

- Monthly Hauling Cost: 63%
- Monthly Polymer Cost: 32%
- Monthly Power Cost: 5%

Basis:
* $45.73/WT Hauling
* $1.24/lb Polymer
* $0.14/kW-hr and 100% of motor nameplate power consumption
* 7 day/wk; 8 hrs/day operation

Hauling:
4,275 wet tons/month
51,300 wet tons/yr

Average Monthly Costs:
* $194,000 Hauling
* $98,000 Polymer
* $17,000 Power
* $309,000 Total

Annual Dewatering Cost = $3.7M
Must consider whole costs of dewatering to find sweet spot (Case Study 2)

Driest cake not necessarily most cost-effective for plant – polymer consumption has major impacts on operating costs
Many parameters impact dewaterability and associated costs

- Sludge characteristics
  - PS:TWAS
  - VS, cations, temp
  - Upstream processes
- Polymer
  - Type
  - Dose, concentration, injection points
- Water quality
- Operations protocols, sampling, monitoring, tracking
- Equipment tweaks
Optimizing polymer can pay real dividends in polymer costs savings and improved dryness

- Polymer Types
- Range of Dilution
- Heated Dilution Water
- Accurate Measurements
- Multiple Feed Points
- In-Field Local Testing
- **Automated Control Systems**
Sludge pre-treatment may hold promise, but business models/costs/results differ

- **Orege**
  - Try and Buy Model ($300k for full system)
  - Dryness increases reported by Orege at 4 facilities; polymer improvement at two of those

<table>
<thead>
<tr>
<th>Location</th>
<th>Device Type</th>
<th>Cake Dryness Improvement</th>
<th>Polymer Improvement</th>
<th>Capture Rate</th>
<th>Throughput Increase</th>
<th>NET ROI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anne Arundel County, MD</td>
<td>Belt Filter Press</td>
<td>+2.7%</td>
<td>35% less polymer</td>
<td>99%</td>
<td>Unchanged</td>
<td>3 years</td>
</tr>
<tr>
<td>DeLand, FL</td>
<td>Belt Filter Press</td>
<td>+3%</td>
<td>Unchanged</td>
<td>98.5%</td>
<td>Unchanged</td>
<td>10 years</td>
</tr>
<tr>
<td>Gloucester County, NJ</td>
<td>Belt Filter Press</td>
<td>+3.5%</td>
<td>Unchanged</td>
<td>99%</td>
<td>+25%</td>
<td>4 years</td>
</tr>
<tr>
<td>Allentown, PA</td>
<td>Belt Filter Press</td>
<td>+3.3%</td>
<td>25% less polymer</td>
<td>99%</td>
<td>Unchanged</td>
<td>3 years</td>
</tr>
</tbody>
</table>

- **HydroFLOW** – potential reduction in polymer and struvite

- P-Removal upstream of dewatering
Case study of optimization proves that plants can save significant sums, even without changes in technology.
Continually optimize to address changes and maintain cost savings

- Implement optimization measures
- Sample and track performance data
- Develop monthly reports by facility and for District
- Analyze monthly reports and assess performance relative to goals
- Identify further changes to operations or goals
Drying Overview
Why practice sludge drying?

• Reduce quantity/volume of sludge/biosolids
• Produce Class A material
  – Avoid issues with Class B land application
  – Potential revenue if market exists
    ▪ Soil amendment
    ▪ Fuel
Common drying options vary in cost, complexity, and fit

- Least complex but footprint intensive
  - Drying beds
    - Lots of land but low O&M
  - Solar drying (greenhouses)
    - Need less land, more equipment and process control

- Fewer safety issues than mechanical drying systems

- Can take liquid sludge
Mechanical dryers require upstream dewatering; still vary in cost/complexity

- Low temperature direct (belt)
  - For smaller facilities (<25 mgd) but large footprint
  - Can use heat from cogen
  - Less complex than high temp; still need emissions control

- High temperature direct (drum for larger facilities)
  - Good product quality, operating experience
  - Safety considerations, complex, emissions controls
Mechanical dryers require upstream dewatering; still vary in cost/complexity

- High temperature indirect (paddle, screw)
  - Use heated oil or gas for indirect heating through conductive material
  - Good for smaller plants (<25 mgd)
  - Product quality not best for marketing
  - Less complex and fewer safety issues compared to drum dryers
Final thoughts on drying

• Decisions on drying often start with the end product
  – Is there a market?
  – Product quality required for that market may drive the decision on type of dryer needed

• If sufficient land available, consider leveraging AZ climate

• If mechanical drying is required, carefully consider safety requirements
  – Area classification
  – Purging and provisions to stop smoldering
Questions?

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Rashi: rgupta@carollo.com