Filter Press vs. Settling Ponds

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Why do we need Water?

Average water use in the home:

- Toilet: 28%
- Shower: 21%
- Bath: 9%
- Faucets: 9%
- Dishwasher: 3%
- Washing machine: 22%
- Toilet leakage: 8%
Why do we need Water?

![Water Withdrawals Chart]

Total freshwater withdrawals in the United States, 2005

- Public supply: 3,830
- Domestic: 44,200
- Irrigation: 128,000
- Livestock: 2,140
- Aquaculture: 8,780
- Industrial: 17,000
- Mining: 2,310
- Thermoelectric: 143,000

Nothing Good Can Happen Without Water

![Images of water-related activities]
But Sometimes, It can be “not as much fun” as you hoped.
Reasons Water Management has come to the forefront

- Mine Planning (Don’t want to cover good reserves/Reclamation Plan)
- Water Constraints
  - At some point in the future the amount of water permitted to producers may be the single limiting factor that determines production capacities.
- Space issues
- Cost savings
- Permitting issues
- Environmental Concerns
- Safety Concerns

Typical Effluent or Tailings from a Wash Plant

- Slurry comprised of fine sand, silts and clays
- Water, obviously.
- Solids Concentrations of 3 to 10% solids by weight.
The Goal

Reclaim as much water as possible for reuse.
Get the solid fractions into a state that can be easily / safely stored or sold.

Recovering Fines

- Reduce Pond Maintenance Costs
- Extend pond life
- Potential Saleable product
- Permitting
- Environmental
Options Include...

Fines recovery device such as cyclones, screws or bucket wheels

- Effluent still needs further treatment to remove fine silts and clays

Thickeners

- Thickened mud (possibly 30 to 50% solids) still needs a home, aka pond, to allow further settling/dewatering

Filter Presses

- Ultimate answer to a pond free operation

Cyclone Systems to Recover +400 Mesh Sand
Thickeners

Application of Thickeners

- Useful in locations where water is in short supply or very expensive
- Ponds are located on mineable reserves
- More often mandatory when permitting / environmental issues arise
Benefits of Thickeners

- Immediate availability of clean water for reuse in the plant
- Approximately 85% of the water is recovered
- Drastically reduces the size requirements of slurry ponds
- Reduced Pumping Costs if using Water Tank
- Reduced evaporation / percolation losses

Thickeners - Three Basic Process Styles

High Rate Thickeners
- Generally sized on hindered settling velocity
- Lower Side Walls
- Lower Sludge Densities

High Density Thickeners
- Generally sized on Hindered Settling Velocity
- Higher Side Walls
- Denser Underflows (higher torque drives)

Deep Cone / Paste Thickeners
- Generally sized on Free Settling Velocity and Sludge Retention Time
- Tall Tanks. Aspect Ratios typically 2:1
- Dense Underflows with little to no further free water drainage
The Yield Stress Continuum

Underflow Solids Concentration

Yield Stress

Conventional

High Rate

Deep Bed

Deep Cone

Typical High Rate Thickener Underflow
To Totally Eliminate Slurry Ponds . . .

Recessed Plate Filter Presses
Recessed Plate Filter Presses

The Goal – Take Some Particulate Laden Slurry...
And separate it into this...

...and this
Pressed Cake is Removed by Front End Loader or Conveyors

Typical flow sheet
CASE STUDY: SCQ Wash Plant

Two Primary Goals

- Increase production of washed materials
- Decrease operating costs
More Production = more sales = more stockpile area = more pressure on the pond

Pond Maintenance

Required 6 to 8 days / month of lost production

Settled Sludge Mixed With Cement

On Average, $80,000 per Clean Out
Success would require elimination of the Pond

- No Permitting
- No Clean Outs
- Recovery of Area for Stockpiles
Effluent – Overflow from UFR System

Effluent Stream PSD

![Effluent Stream PSD Graph](image-url)
**Pond Elimination – 30,000 Foot View**

**Thickener**
- High Rate or Deep Cone

**Sludge Treatment**
- Belt Press
- Centrifuge
- Recessed Plate Press

**Solution Strategy**

**Cyclone & Dewatering Screen – In Place and Operating**
- recover solids down to 400 Mesh (38 microns)

**Deep Cone Thickener – 7m Diameter / 13m Tall**
- recycle water and produce a clay sludge of approx. 45% solids underflow

**Recessed Chamber Filter Press – 2m X 2m X 139 plates**
- recycle water and take 45% solids feed and dewater to 78% solids filter cake
Typical Picket Arrangement

Effect of Pickets in Paste Thickeners
Deep Cone Underflow Discharge

SCQ Deep Cone Thickener Underflow

- Typically 45 to 55% Solids
Cake Moisture = 20 – 23% w/w.
Cake Disposal / Backfill

Pond Area Soon Became...

New Stockpile Real Estate
Results

Cost of Adding Lime to Assist Cake Dewatering – $0.48 / net ton

Savings by elimination of pond – $1.12 / net ton

Conversion of pond to stockpile storage area essentially triples inventory capability

Avoided locating and permitting acreage for new pond.

Filter Press Operating Costs

98% of Press applications for Aggretate tailings require no additional chemicals

Operating Cost ~25 to 50 Cents per ton of Cake or ~$0.025 to $0.05 cents per ton/plant feed

Main costs are filter cloths and pump parts
Pond Operating Costs

Ponds often cost $100’s of thousand of dollars per year to maintain

Reclaiming a pond often costs in excess of $3-5/ton

A typical 300tph can require fifty to several hundred acres of pond space or more

Land Used with No Filter Press – 35% solids in Pond

<table>
<thead>
<tr>
<th>Gallons/Yr Slurry @ 2000 Hours/35% Solids</th>
<th>10 ft Depth</th>
<th>15 ft Depth</th>
<th>20 ft Depth</th>
<th>25 ft Depth</th>
<th>30 ft Depth</th>
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</thead>
<tbody>
<tr>
<td>15 tph</td>
<td>16,200,000</td>
<td>5.0 Acres/Yr</td>
<td>3.3 Acres/Yr</td>
<td>2.5 Acres/Yr</td>
<td>2.0 Acres/Yr</td>
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<tr>
<td>30 tph</td>
<td>32,400,000</td>
<td>9.9 Acres/Yr</td>
<td>6.6 Acres/Yr</td>
<td>5.0 Acres/Yr</td>
<td>4.0 Acres/Yr</td>
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<tr>
<td>45 tph</td>
<td>48,600,000</td>
<td>14.9 Acres/Yr</td>
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<td>7.5 Acres/Yr</td>
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<tr>
<td>60 tph</td>
<td>64,800,000</td>
<td>19.9 Acres/Yr</td>
<td>13.3 Acres/Yr</td>
<td>9.9 Acres/Yr</td>
<td>8.0 Acres/Yr</td>
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</table>

<table>
<thead>
<tr>
<th>Gallons/Yr Slurry @ 4000 Hours/35% Solids</th>
<th>10 ft Depth</th>
<th>15 ft Depth</th>
<th>20 ft Depth</th>
<th>25 ft Depth</th>
<th>30 ft Depth</th>
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<tr>
<td>15 tph</td>
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<td>9.9 Acres/Yr</td>
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<td>19.9 Acres/Yr</td>
<td>13.3 Acres/Yr</td>
<td>9.9 Acres/Yr</td>
<td>8.0 Acres/Yr</td>
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<tr>
<td>45 tph</td>
<td>97,200,000</td>
<td>29.8 Acres/Yr</td>
<td>19.9 Acres/Yr</td>
<td>14.9 Acres/Yr</td>
<td>11.9 Acres/Yr</td>
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<tr>
<td>60 tph</td>
<td>129,600,000</td>
<td>39.8 Acres/Yr</td>
<td>26.5 Acres/Yr</td>
<td>19.9 Acres/Yr</td>
<td>15.9 Acres/Yr</td>
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</tbody>
</table>
Land Used with No Filter Press – 50% solids in Pond

<table>
<thead>
<tr>
<th>Gallons/Yr</th>
<th>10 ft Depth</th>
<th>15 ft Depth</th>
<th>20 ft Depth</th>
<th>25 ft Depth</th>
<th>30 ft Depth</th>
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<tbody>
<tr>
<td>15 tph</td>
<td>9,900,000</td>
<td>3.0 Acres/Yr</td>
<td>2.0 Acres/Yr</td>
<td>1.5 Acres/Yr</td>
<td>1.2 Acres/Yr</td>
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<tr>
<td>30 tph</td>
<td>19,800,000</td>
<td>6.1 Acres/Yr</td>
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<td>3.0 Acres/Yr</td>
<td>2.4 Acres/Yr</td>
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<tr>
<td>45 tph</td>
<td>29,700,000</td>
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<td>6.1 Acres/Yr</td>
<td>4.6 Acres/Yr</td>
<td>3.6 Acres/Yr</td>
</tr>
<tr>
<td>60 tph</td>
<td>39,600,000</td>
<td>12.2 Acres/Yr</td>
<td>8.1 Acres/Yr</td>
<td>6.1 Acres/Yr</td>
<td>4.9 Acres/Yr</td>
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</tbody>
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Second Example of Pond vs Filter Press

- **Short Mountain Silica**
  - Started with 50 Acres of Pond space.
  - Pond space filled up and was costing $250,000 to $300,000 per year for pond maintenance
  - “Decided to go to a Filter Press because our Settling Ponds were full of material and we needed a permanent and environmentally safe solution to reclaim our waste material.”
Short Mountain Silica – Settling Ponds

Short Mountain Silica Filter Press Pictures
How does a Filter Press Work?

- A filter press is composed of a frame holding a series of plates lined with filter media. It is pumped full of solids which are dewatered into a drip-free cake.
  - For Recessed plate filter presses the dewatering is done using the hydraulic pressure created from the feed pump(s). Typically up to 225 psi
  - For Membrane plate design once the chambers are full the membranes located in each chamber are pressurized to squeeze the cake. Feed pressures up to 125 psi and squeeze pressures up to 225 psi
The Sludge Holding tank – Key to Marrying Continuous and Batch

Recessed Plate Filter Press

A series of plates that form a cavity lined with filter media. The cavities are filled with solids and dewatered into a drip-free cake.
Dry, Stackable Cakes

Recessed Plate Press Closing

Hydraulic piston push the plate pack closed. Chambers are formed between plates.
Throughout this stage of the process, water is pressed through filter cloths and collected in launders.

Cylinders pull back the moving plate, continuous carousel opens each plate.

Cakes drop for removal.

McLanahan
**Filter Plate Types – Plate and Frame, Recessed Chamber or Membrane Plate Filter Presses**

1. Mobile plate closes with pressure from the Hydraulic Power Unit
2. Hydraulic pressure builds up until it reaches sufficient force to hold the plate pack closed during filtration
3. Feed pump turns on and runs at a set fill speed until it reaches a programmed back pressure or fill time
4. Feed pump then speeds up over controlled ramp time until it reaches the max pressure
5. Feed pump maintains this pressure until the flow rate drops to the programmed rate or completes the programmed filtration time and then shuts off
6. Water followed by air evacuates the feed core (with core blow option)
7. Mobile plate opens creating space for the plates to open
8. Chain drive is turned on and pulls the plates open one-by-one discharging the cakes
9. Once the last plate is opened the press monitors the slurry level in the surge tank and then starts another cycle when enough slurry is present for a complete cycle.
Factors affecting cycle time

Key Filter Press selection factors affecting cycle time:
- Chamber Thickness
- Feed Pressure/Squeeze Pressure (100psi vs 225psi)
- Capacity of feed pump(s)
- Opening and Closing time of the filter press
- Filter media

Key process factors affecting cycle time:
- Slurry Feed Density (% solids of the slurry)
- Composition of solids in the slurry (Clay, Ash, Coal, Etc.)
- Size Gradation of the solids
- Chemicals used

Recessed Plate Press Capacity ...“It Depends...”

<table>
<thead>
<tr>
<th>Chamber Volume</th>
<th>Cycle Time</th>
<th>Final Cake S.G.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Press Capacity</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chamber</th>
<th>1.5m X 1.5m</th>
<th>2m X 2m</th>
</tr>
</thead>
<tbody>
<tr>
<td>25mm</td>
<td>200 cu. ft.</td>
<td>505 cu. ft.</td>
</tr>
<tr>
<td>40mm</td>
<td>286 cu. ft.</td>
<td>521 cu. ft.</td>
</tr>
</tbody>
</table>
What Influences Cycle Time?

Faster Cycles

- Faster Opening and Closing
- Higher Feed Solids Concentration
- Optimum Cake Moistures
- Higher Permeability
- Optimum Cake Thickness

Overhead Beam / Side Beam Filter Press
Multiple Cylinder vs. Single Cylinder

Overhead beam plate opening
Overhead beam plate opening

Open or Side filtrate discharge
Open or Side filtrate discharge

Side View with Dual Feed Inlets and Core Blow

- Dual Feed Inlets for lower inlet velocity and less wear
- Core Blow Valve option shown
Other Notable Options

Cake Blow

- On materials that can be dewatered quickly due to their high permeability it is possible to blow air through the filter cakes at the end of the cycle in order to remove additional amounts of moisture from the filter cake. In some tailings applications with limited amounts of clay this can be as much as 5 or more additional points (e.g., 80% solids vs. 75% solids.)

Automatic Filter Cloth Wash

- Most tailings applications only require filter cloth washing once every week to two weeks. When desired to reduce operator requirements it is possible to automate this function.

Drip-Tray or Bomb-bay Doors

- When an automated cloth wash is used it is typically necessary to use a Drip-Tray or Bomb-bay Doors underneath the filter press to capture the water coming from the cloth wash and prevent it from going onto the filter cakes.
Common tests performed on Tailings for selection of a filter press for include:

- Filtration tests. Tests are performed at varying feed solids, cake thickness, & pressures to determine filtration times and percent solids achievable.
- Size Gradation
- % solids
- Specific Gravity (SG). It is important to accurately determine two components of the Specific Gravity for accurate sizing:
  - Specific Gravity of the slurry & Specific Gravity of the Solids

**What is Considered in Filter Press Sizing**

- Desired Moisture Content
- Capacity
- Footprint of the press
- Filtration time
  - Testing is always recommended
- Safety Factor
- SG
- Compressibility
- Abrasiveness
- Cost
Typical Sizes

- 2m x 2m, 60-200 Plates
- 1.5m x 1.5m, 60-160 Plates
- 1.5m x 2m, 60-160 Plates
- 1.2m x 1.2m, 30-110 Plates
- 1m x 1m, 30-110 Plates
- 800mm x 800mm, 15-60 Plates
- 630mm x 630mm, 15-60 Plates
- 400mm x 400mm, 15-60 Plates

Questions?