Filter Press Modification to Assess Dewatering Performance of Fluid Fine Tailings

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Objective

• Reclamation of fine tailings deposits to a dry landscape requires high undrained shear strength for trafficability.

• Graymont was interested in the potential of lime application to filtration on fluid fine tailings treatment.
  • Lime Treatment may be potential to get reclamation faster due to the combination of coagulation and pozzolanic reactions.
Original SRF Setup

- Measure filtrate volume with pressing time and solids% in compressed cake.
- Calculate Specific Resistance to Filtration (SRF) value.

Shrinkage cracking → restriction on further desaturation.
NAIT-COSS Modified SRF Setup

- Avoid compressed cake cracking to allow for measuring true dewatering potential of lime treated tailings.
- Dewater through a single drainage path.
- Potential for use as a rapid indicator of long-term consolidation behavior?
Original SRF setup:
- The compressed cake cracked, stopping the test less than one hour into pressing.
- The higher dosage of lime in the treated FFT, the more quickly the cake cracked.

Modified SRF setup:
- Not observe cake cracking on lime-treated FFT.
- Produce higher solids% and more consistent results.
- Determine the optimal dosage of lime to treat FFT.
SRF Test on 150 g of Lime-Treated FFT

Filtrate volume vs. compressing time
- 0, 2000, and 3000: approximately linearly increase for 60 min compressing
- 4000 and 5000 ppm: linearly increase until 30 min compressing

How do we calculate SRF?

\[
SRF = \frac{2 \cdot \Delta P \cdot A^2}{\mu_f \cdot c} \cdot b
\]

b = slope of t/V against V plot = t/V^2
SRF Test on 150 g of Lime-Treated FFT

- Two trends are similar.
- 4000 ppm is the optimal dosage of lime for the filtration test.
SRF Test on 300 g of Lime-Treated FFT

Materials for treatment:

- Lime dosage: 4000 ppm
- Gypsum dosage: equivalent Ca\(^{2+}\) dosage to 4000 ppm of lime
- Polymer A3338: optimal dosage

Compressing: 60 minutes

Lime-treated FFT generated a much denser filter cake indicating a potential benefit of lime addition in filtration applications.

- A3338-treated FFT: consistent with Jelly-donut behavior seen in the field and long consolidation times predicted from LSC and SICT.
  - Water release observed from the middle of cake once removed from sample holder.
- Gypsum treatment and raw FFT: similar behaviors observed in the field – crusting and long consolidation times.
- Lime treatment: only treatment to produce a filter cake with a consistency closer to the plastic limit.
SRF Test on 300 g of Lime-Treated FFT

Reference:
Long-time SRF Tests

- Conduct SRF tests on 300 g of samples for a long time duration until no filtrates were collected.
- Indicative of long term consolidation behavior?

Filter compress on Lime-treated FFT for 20 hours: 91.2 wt% solids.
- Lime treatment may be an option for reducing the consolidation time of FFT.
- Lime treatment may be suitable for pressure filtration.
Conclusions

• The modified SRF setup can effectively press the sample and avoid cracking the compressed cake.

• SRF could determine the impact of dosage on filtration resistance, and therefore the optimal lime dosage.

• Lime-treated FFT provided better filtration performance and formed a more compact cake compared to gypsum- and polymer-treated FFT.

• SRF results directionally consistent with published LSC, SICT and field trial information – may have potential to be used as a consolidation performance indicator test.

• The tests indicate that Lime treated FFT may consolidate significantly faster than other treatments being used to date.
Acknowledgement

NAIT COSS

Graymont Western Canada Inc.
- Nikolas Romaniuk
- Mike Tate
SRF Study on Lime-Treated FFT using Modified Setup

Characterization of fluid fine tailings (FFT).

<table>
<thead>
<tr>
<th>Bitumen (wt%)</th>
<th>Mineral (wt%)</th>
<th>Water (wt%)</th>
<th>MBI (meq/100 g solids)</th>
<th>Clay% in solids (wt%)</th>
<th>Clay to water ratio (CWR)</th>
<th>Fines (wt%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2</td>
<td>24.7</td>
<td>73.6</td>
<td>14.1</td>
<td>101%</td>
<td>0.34</td>
<td>84.2</td>
</tr>
</tbody>
</table>

Testing samples for SRF – test the capability of the bench-scale equipment: 150 g and 300 g
SRF Calculation

Theoretical filtration model derived from Darcy’s equation:

\[
\frac{dV}{dt} = \frac{A \cdot P}{\mu_f \cdot SRF \cdot c \cdot \frac{V}{A} + \mu_f \cdot R}
\]

Therefore, SRF can be calculated from the slope (b) of the t/V versus V plot:

\[
SRF = \frac{2 \cdot \Delta P \cdot A^2}{\mu_f \cdot c \cdot b}
\]

Where

- \(\Delta P\) = Pressure drop = 100 psi = 689476 Pa
- \(A\) = Area of filter = 50.27 \times 10^{-4} m^2
- \(\mu_f\) = viscosity of filtrate = 1 \times 10^{-3} Pa\cdot s
- \(c\) = concentration of solid in suspension (kg/m^3)
- Density of water = 1000 kg/m^3
- Density of solids = 2650 kg/m^3
- \(b\) = slope of t/V against V plot = t/V^2
- \(V\) = volume of filtrate after time t (m^3)

(...assumed viscosity of filtrate equal to water)
**SRF Test on 150 g of Lime-Treated FFT**

<table>
<thead>
<tr>
<th>Dosage of lime (ppm)</th>
<th>60 Minutes SRF Test Data</th>
<th>30 Minutes SRF Test Data</th>
<th>✓</th>
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<tbody>
<tr>
<td></td>
<td>b value</td>
<td>R² value</td>
<td>SRF</td>
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<tr>
<td>0</td>
<td>2.39E+12</td>
<td>0.999</td>
<td>3.85E+14</td>
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<td>2000</td>
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<td>3000</td>
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<tr>
<td>5000</td>
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<td>0.809</td>
<td>4.83E+13</td>
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