A NEW PROTOCOL TO ASSESS THE QUALITY OF TAILINGS FLOCCULATION/COAGULATION - A COLLABORATION TO IMPROVE TAILINGS TREATMENT AT SUNCOR ENERGY

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Current Chemical Screening Timeline

Potential New Chemical

Chemical Evaluation Program

Approximately 18 Months

Bench Top Batch Mixer

e.g. 350 ml paddle Mixer

Commercial Application

Field Scale

e.g. 1000 m³/hr pipe with static mixer
# Overall Chemical Evaluation Program

<table>
<thead>
<tr>
<th>Step</th>
<th>Program</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gate 1-Pre-Screening of available chemicals</td>
<td>Suncor Provides MFT information and minimum criteria for dewatering. Vendors conduct pre-screening of their products, and select up to 5 chemicals as the primary candidates.</td>
</tr>
<tr>
<td>2</td>
<td>Stage 2-Screening at NAIT</td>
<td>Suncor tests vendor’s primary chemical candidates using Suncor’s standardized lab techniques. This testing will be conducted by Suncor at NAIT research facilities in Edmonton, and are head-to-head comparison tests with Suncor’s current chemical. Vendor representatives are invited to participate. Chemicals which exceed the performance of Suncor’s current incumbent may be selected for continued testing at Suncor’s discretion.</td>
</tr>
<tr>
<td>3</td>
<td>Stage 3A-Testing on Coanda Rig</td>
<td>Suncor tests best chemical from Gate 2 for suitability in pipe reactor at the Coanda facility in Edmonton, AB. At this stage focus will be placed on the chemical’s suitability for field operations including effectiveness in pipe reactors, rheology and water release characteristics, beach flow parameters, and drying characteristics. Data from these tests will go towards the design of full scale field trials of select chemicals at Suncor’s discretion.</td>
</tr>
<tr>
<td>4</td>
<td>Stage 3B-Testing on TRO Test cell</td>
<td>Suncor tests successful chemical in a full scale field trial.</td>
</tr>
</tbody>
</table>
1. MFT characterization and Polymer concentration determination

2. Chemical reactivity test

3. Water release potential test

4. Mixing and conditioning parameter evaluation

5. Drying test
NWR Test

\[ CWR = \frac{\text{wt\% clay in solids \times wt\% solids in MFT}}{\text{wt\% water in MFT}} \]
Gate 3A In-line Pipe Reactor Flow Loop
Improvements to screening protocol

Automated Batch Flocculation:
  • Decrease operator sensitivity and low reliability

Current Lab-Scale dewatering test:
  • 24 hr dewatering + 12 hr Solids content measurement
  • The 18 mesh sieve works well only for large flocs

Potential alternative dewatering tests:
  • Capillary Suction Time (CST)
  • Specific Resistance to Filtration (SRF)
  • Modified NWR
  • Settling
Results Comparison

Normalized Results on Improvement of TRO Screening Protocol

Normalized Data vs. Clay Based Dosage (g/tonne)

- 24-hour CWR
- CST of released water
- CWR of SRF cake
- Calculated SRF
Conclusion

• Current chemical screening requires at least 18 months to examine a new product.

• There are a large number of chemicals proposed by various vendors for tailings treatment, and it would be advantageous to revamp the current process and create a more efficient and streamlined screening protocol.

• In 2019 Suncor hopes to introduce an improved more efficient chemical screening protocol to examine new chemicals for tailings treatment.
Example: Why dose on a clay basis and use CWR instead of total solids?

Polymer dosage sweep bench flocculation tests on 2 MFTs across CWRs from 0.25 to 0.35. All results plotted below show a dewatering metric on the y-axis and a polymer dosage metric on the x-axis.

<table>
<thead>
<tr>
<th>MFT</th>
<th>Wt% Solids</th>
<th>% Clay in Solids</th>
<th>Wt% fines in Solids</th>
<th>MFT CWR</th>
</tr>
</thead>
<tbody>
<tr>
<td>STP</td>
<td>31-27</td>
<td>74.5</td>
<td>94</td>
<td>0.35-0.25</td>
</tr>
<tr>
<td>Pond 8A</td>
<td>48-40</td>
<td>38</td>
<td>56</td>
<td>0.35-0.25</td>
</tr>
</tbody>
</table>

Dewatering and dosage metrics are similar across all MFTs and CWRs, and flocculation performance results can be accurately compared.
Chemical Reactivity Test

Flocculant addition

Tailings sample

Mixing

Released water

Sediment
Effect of mixing on Net Water Release

![Graph showing yield stress and net water release over mixing time.]

- **Yield Stress of tMFT Optimal Dose**
- **NWR of tMFT Optimal Dose**
Drying Test

- Flocculant addition
- Mixing at high speed until the polymer is dispersed, reduced to low speed for flocs to appear and water release
- Flocculant addition
- Tailings sample
- Water is setup to determine the water loss each day in the lab
- The sample is weighed every day
- Rheology is measured every day
- Sieve ((mesh size 18))
- Treated tailings
- Released water

Graph: Drying Test on 0.4 Feed CWR FFT

- Days of Drying
- w% Solids

10%
20%
30%
40%
50%
60%
70%
80%
90%
100%

- Polymer A
- Polymer B
- Polymer C
# Polymer Evaluation Criteria

## Table 3. The Criteria of 5-Point Scale for Polymer Evaluation

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Water Quality</th>
<th>Stage 3 24-hr CWR</th>
<th>Stage 4 24-hr CWR</th>
<th>Stage 4 24-hr Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Specification</td>
<td>Score</td>
<td>Specification</td>
<td>Score</td>
</tr>
<tr>
<td>Incumbent</td>
<td>Incumbent</td>
<td>1</td>
<td>Incumbent</td>
<td>1</td>
</tr>
<tr>
<td>Tested</td>
<td>Clarity is ≥ 1</td>
<td>CWR is incumbent +/- 0.02</td>
<td>CWR is incumbent +/- 0.02</td>
<td>dosage is incumbent +/- 100 ppm</td>
</tr>
<tr>
<td>Polymer</td>
<td>incumbent +/- 2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Clarity is &lt; incumbent-2</td>
<td>0.5</td>
<td>CWR &gt;0.5</td>
<td>CWR is &gt; incumbent +0.02</td>
</tr>
<tr>
<td></td>
<td>Clarity is &lt;4</td>
<td>CWR &lt;0.5</td>
<td>0</td>
<td>CWR &gt;0.55</td>
</tr>
<tr>
<td></td>
<td>CWR &lt;0.55</td>
<td>0</td>
<td>0.5</td>
<td>CWR &gt;0.55</td>
</tr>
</tbody>
</table>

*Note: The table entries represent criteria and scores for polymer evaluation. The scores indicate the evaluation based on the water quality and polymer performance.*
Gate 3A Results

Graph 1: 24h Final CWR vs. Polymer dosage (ppm clay)
- X: Sampled from 2.0m downstream
- ○: Sampled from 6.6m downstream
- □: Sampled from 12.7m downstream
- △: Sampled from 31.2m downstream

Graph 2: CST (s) vs. Polymer dosage (ppm clay)
- X: Sampled from 2.0m downstream
- ○: Sampled from 6.6m downstream
- □: Sampled from 12.7m downstream
- △: Sampled from 31.2m downstream

SUNCOR
Automated Batch Flocculation System