Dewaterability of Tailings from a Hybrid Bitumen Extraction Process

Feng Lin, Yuming Xu, Tadeusz Dabros
Natural Resources Canada, CanmetENERGY in Devon
Richard Nelson
Alberta Innovates

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Hybrid Bitumen Extraction (HBE)

- Mined ore
- Slurry
- Flotation vessel
- Diluent recovery
- Froth treatment
- Tailings pond
- Product

- Makeup water
- Recycle water
- Tails

2/5 diluent
3/5 diluent

ambient temperature

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Background of HBE Research

- **Batch-scale**
  - Conducted at University of Alberta
  - Robust in obtaining high bitumen recovery
  - Adding ethyl cellulose improved froth quality
  - Amount of solvent added depended on ore grade
  - No need to heat water and no caustics
  - Reduce energy intensity and GHG emission

References:

- **Pilot-scale**
  - Currently underway at CanmetENERGY in Devon
Movie of Pilot Scale HBE Flotation
Objective of this Study

- To investigate the dewatering of tailings produced by ambient HBE, and compare to tailings produced from the current hot water extraction process.
## Composition (wt%) of Oil Sands Ore

<table>
<thead>
<tr>
<th>Ore</th>
<th>Bitumen</th>
<th>Solids</th>
<th>Water</th>
<th>Fines (of Solids)</th>
<th>Extractability</th>
</tr>
</thead>
<tbody>
<tr>
<td>OS1</td>
<td>9.68</td>
<td>83.87</td>
<td>6.24</td>
<td>20.58</td>
<td>Poor</td>
</tr>
<tr>
<td>OS2</td>
<td>11.68</td>
<td>84.75</td>
<td>3.16</td>
<td>24.38</td>
<td>Medium</td>
</tr>
<tr>
<td>OS3</td>
<td>11.35</td>
<td>85.60</td>
<td>3.02</td>
<td>16.31</td>
<td>Good</td>
</tr>
</tbody>
</table>

## Simulated Process Water (in ppm)

<table>
<thead>
<tr>
<th>pH</th>
<th>Na⁺</th>
<th>Ca²⁺</th>
<th>Cl⁻</th>
<th>SO₄²⁻</th>
<th>HCO₃⁻</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1</td>
<td>1012</td>
<td>20</td>
<td>922</td>
<td>128</td>
<td>915</td>
</tr>
<tr>
<td>9.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Solvent:** n-C6, n-C5 to n-C7, toluene
Tailings Sample Preparation: Batch Extraction Unit

- Oil Sands
- Solvent
- Soak
- 1st Water
- Conditioning
- 2nd Water
- Flotation
- Bitumen Froth
- Tailings
- Dewatering tests
Characterization of Tailings Dewatering
Experiments on Tailings Dewatering

- Sedimentation
  Sediment height vs. time
  (fixed $g = 355 \text{ m/s}^2$)

- Consolidation
  Equilibrium sediment height vs. acceleration ($g$)
  (various rpms)
Sedimentation
Calculation of Setting Rate

\[ R_{ave} = \frac{(1 - NH_{eq})}{t_{eq}} \]

Normalized Sediment height

\( NH_{eq} \)

\( t_{eq} \)

Time (h)
Effect of HBE on Settling Rate

Settling rate, $R_{ave}$ (h$^{-1}$)

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Consolidation
Initially

Centrifuge……..

$H_0$

$H_{eq1}$

$H_{eq2}$

$H_{eq3}$

$H_{eq4}$

$H_{eq5}$

$g_1$

$g_2$

$g_3$

$g_4$

$g_5$

Heq (mm)

$g$ (m/s$^2$)

Py(φ) (kPa)

ϕ (w/w)

Analysis


Green, M. D.; Eberl, M.; Landman, K. A. 1996. AIChE Journal, 42: 2308
Effect of HBE on Consolidation: OS1

- Compressive yield stress, $P_y(\phi)$ (kPa)
- Solid weight fraction, $\phi$ (w/w)

Data points:
- $0\%$ C6, $50^\circ$C, pH $9.0$
- $0\%$ C6, $50^\circ$C, pH $8.1$
- $20\%$ C6, $20^\circ$C, pH $8.1$
- $30\%$ C6, $20^\circ$C, pH $8.1$
Effect of HBE on Consolidation: OS2

Compressive yield stress, $Py(\phi)$ (kPa)

Solid weight fraction, $\phi$ (w/w)

- 0%C6, 50°C, pH9.0
- 0%C6, 50°C, pH8.1
- 10%C6, 20°C, pH8.1
- 15%C6, 20°C, pH8.1
- 20%C6, 20°C, pH8.1
Effect of HBE on Consolidation: OS3

Compressive yield stress, $P_y(\phi)$ (kPa)

Solid weight fraction, $\phi$ (w/w)

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Conclusions

- Tailings dewatering studied by single- and multi-speed centrifuge techniques
- Ambient HBE enhanced solid sedimentation rate
- Tailings from HBE were more compressible
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THANK-YOU!!!

Contact email: feng.lin@canada.ca