Assessment of the Flocculation Performance of Tailings Using Hyperspectral Imagery

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Motivation & Objectives

✓ Flocculation of tailings is widely used in the oil sands industry to dewater and remediate soft tailings.

✓ Flocculant dose and mixing condition (i.e. rate and time) play a crucial role in the flocculation process.

✓ Development of techniques that can monitor flocculation and provide feedback information to adjust flocculant dose and mixing conditions is of significant interest to the oil sands industry.

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Objectives

• Investigate the potential of hyperspectral sensing to assess the effectiveness of flocculation through hyperspectral measurements and spectral/image analysis.

• Develop spectral techniques for quick assessment of the flocculation performance to ensure consistent production of good flocculated materials, despite of varying feedstock.
Hyperspectral Imaging

- Measuring the *reflectance of light* from a target material as a *function of wavelength* within the *spatial context* of a digital image
  - Two forms of data:
    1. Digital image
    2. Reflectance spectra
Flocculation Experiments

- **Preparation of Flocculated Samples**
  - Small-scale lab-based tests
  - Different doses and mixing conditions
  - Polymer A3338
    - Concentration: 0.2% (w/w)
  - Sample description:
    - Initial solid content: 42 wt%
    - MBI: 3.75 meq/100g
    - Bitumen content: 2.57 wt%
    - Fines content: 40 wt%

- **Experiment 1**
  - Solid content: 30 wt%

- **Experiment 2**
  - Solid content: 10 wt%

- **Evaluation methods**
  - Visual assessment
  - CST measurement
Experiment 1

Solid content: 30 wt%
Optimum dose: 1200 ppm
Optimum mixing: 60s x 420 RPM
Experiment 1

SWIR False Color Image

R: 2150 nm
G: 2200 nm
B: 2350 nm
Band Ratio Analysis

Find a band ratio from the available band set revealing the most texture in the samples imagery and improving the contrast between the flocculated samples produced under different conditions.
Experiment 1

- Band ratio: 1678/1930 nm

- Spectral Profile

- 1000 ppm
- 1200 ppm
- 1400 ppm

- 60 x 550 RPM + 120 x 420 RPM
- 60 x 750 RPM
Experiment 1

- **Classified Band Ratio**

  Threshold-based segmentation
  - Red: 1.5-2.5
  - Blue: 2.5-3.5
  - Yellow: > 3.5
Solid content: 10 wt%
Experiment 2

60 s x 420 RPM 80 s x 420 RPM 120 s x 420 RPM

a
b
c
Experiments 1&2

- Experiment 1 (30 wt% solids)
- Experiment 2 (10 wt% solids)
Detecting under-dosed and/or over-sheared samples using spectral imagery looks promising.

No significant correlation was observed between CST and spectral results. The spectral metric developed in this research appeared to be sensitive to the variation in surface micro-topography and water content in the samples, which are not necessarily correlated with CST.

More flocculation tests need to be carried out to validate the results and calibrate the method.

It is required to investigate the relationship between hyperspectral observations and other flocculated tailings properties such as settling rate and flocs size.

Testing in-pipe spectral measurements using a point spectrometers is necessary to move towards developing methods for real-time flocculation monitoring.
Thank You!