Effects of Mixing Parameters on Water Settling in Bitumen Froth

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Background:

- Ore extracted from typical commercial oil sands are composed of 9-13% bitumen, 3-7% water, and 80-85% solids. [1]
- Bitumen froth is taken off the top layer in a gravity-separated vessel [Figure 1], and is typically 10% fine solids and 30% water. Low quality froth is more difficult to purify as it is about 13% solids and 37% water
- These solids, emulsified water droplets and fine clays settle slowly due to their small diameters. The polymers, clays and asphaltene over move to water droplet surfaces and make them more stable, thus slowing down the settling [2]

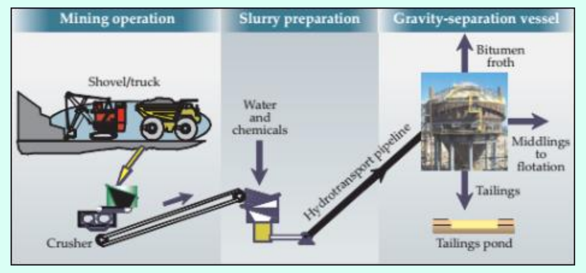


Figure 1 Production of bitumen froth [1]

Purpose:

The focus this summer has been on the settling of lower quality froth. Through microscopy and the Karl Fischer (water content analyzer), we hope to gain a greater understanding of what the behaviour of the water droplets looks like when acted upon by demulsifier. As well as the optimal conditions for bitumen upgrading.

Methods:

Figure 2 Froth and naphtha in ethylene glycol heating bath

- Needles and microscope slides are silanized to increase their hydrophobicity (ability to repel water), this allows for a more accurate picture of the settling process
- Froth and naphtha are heated in a ethylene glycol bath to 70 and 82°C respectively [Figure 2]
- Demulsifier is prepared at 12 wt% (X_{IC}= -1), 16.5 wt% (X_{IC}= 0) or 21 wt% (X_{IC}= 1) concentration
- Premixing of the froth occurs for 15 minutes at 1000rpm with the pitch blade turbine (PBT) impeller, sample P is taken at the end
- The froth and naphtha are poured into the confined impeller stir tank (CIST), where it is mixed by either the Rushton or Intermig impellers

Manipulated Variables	Responding Variables
- Injection Concentration (IC) - Bulk concentration (BC) - Mixing energy (J)	-Settling time -Water and solid content

- The froth is blended with naphtha (a hydrocarbon mixture commonly used as a solvent) to decrease its viscosity, sample A is taken at the end of naphtha blending
- The demulsifier is injected using the syringe pump, injection volume varies, sample B is taken during demulsifier dispersion
- Once the impeller stops, the timing for settling begins. Samples are taken at Z1, Z2, Z3, and Z4 [Figure 3] at 5, 10, 15, 20, 25, 30, 45 and 60 minutes. Z1 and Z2 have additional samples taken at 90 and 120 minutes.
- Larger final samples are taken at the very end with insertion depths of 58,150 and 242mm , these are sent to Syncrude for further testing

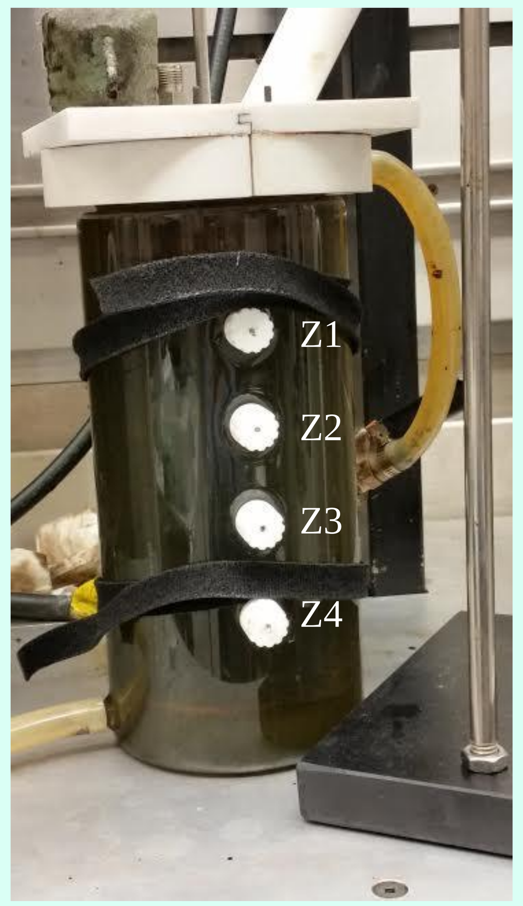
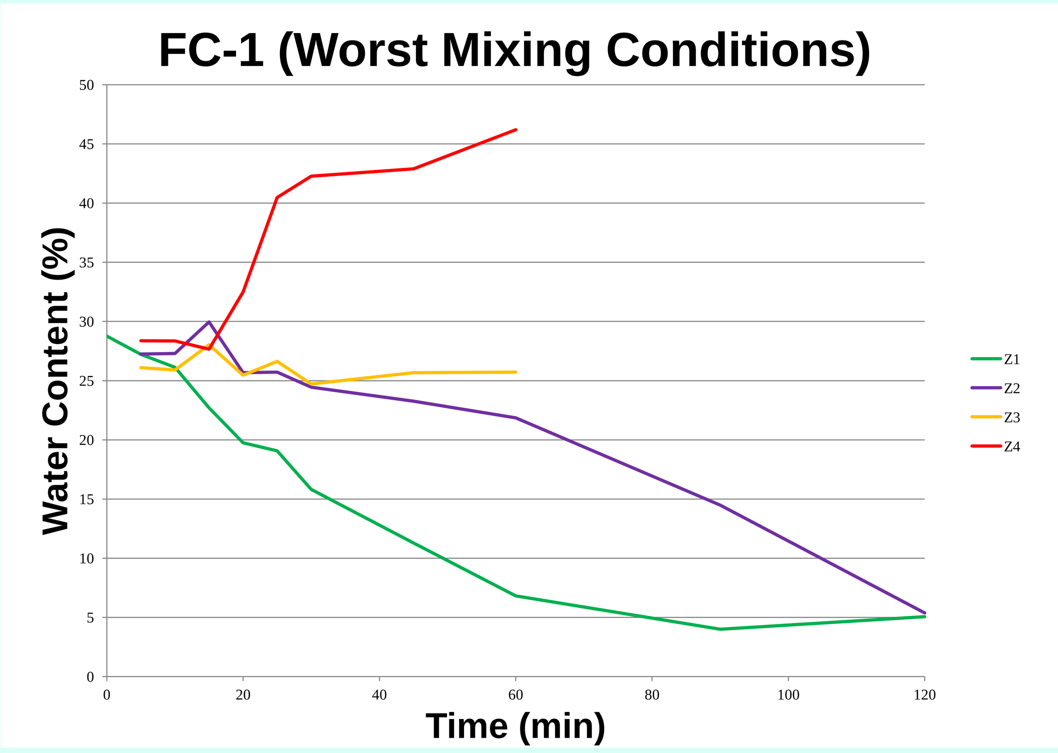


Figure 3 CIST with four levels labelled

Results:



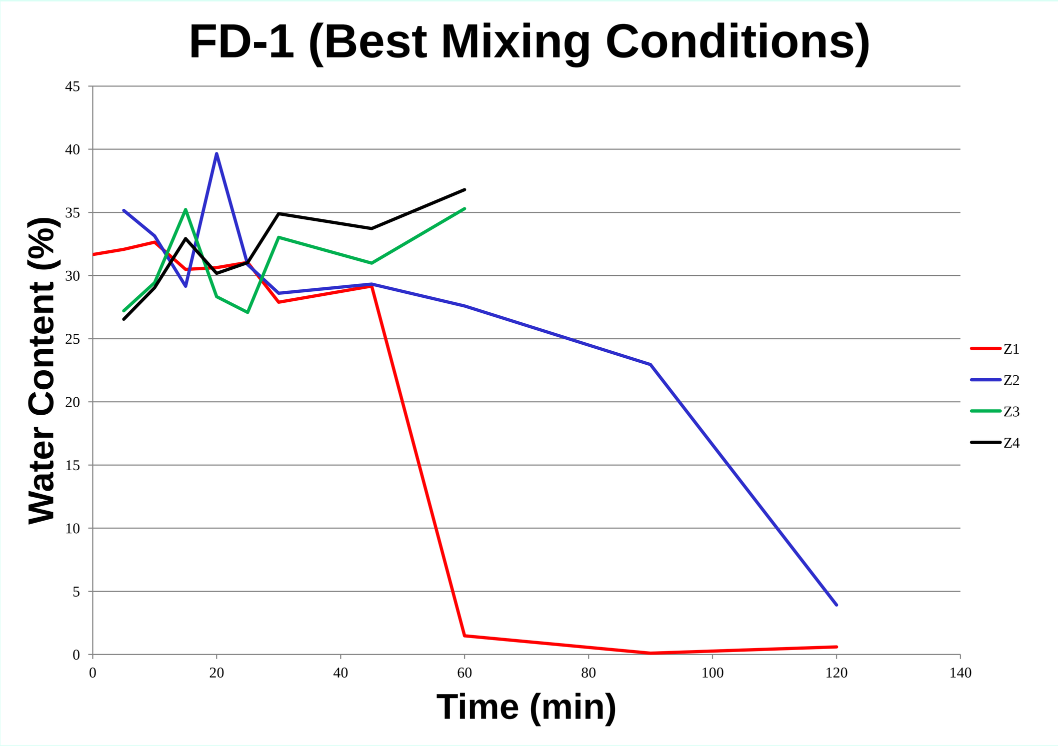
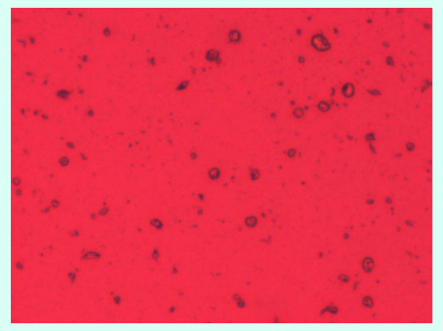


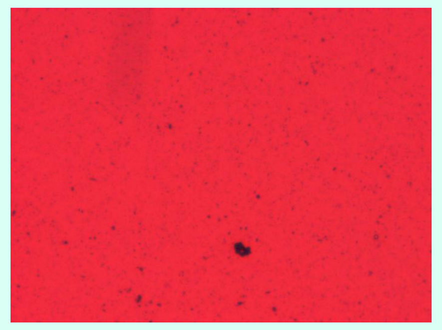
Figure 4- Factorial C, first replicate
Low mixing energy, high injection concentration

Figure 5- Factorial D, first replicate
High mixing energy, low injection concentration

10x

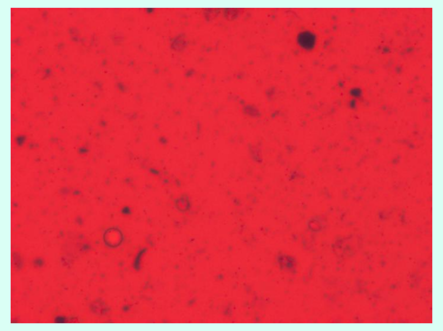


FC-1 60-Z1

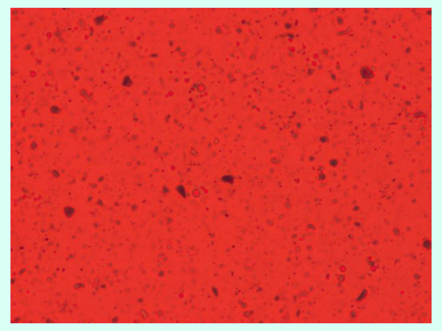


FD-1 60-Z1

40x



FC-1 60-Z1



FD-1 60-Z1

Conclusions:

- From all the factorials of IC and J, low mixing energy and high injection concentration is the best case scenario, while the reverse are the worst conditions
- Decreasing BC leads to increase in water content
- 200ppm is a good concentration to study mixing in low quality froth
- Settling tends to happen later for good mixing conditions. Water content level is steady until a sudden drop at approximately 40 - 60 minutes. The drops occurs later when compared to the relative linear descent of the water content in Z1 of FC-1
- In the microscope slides of FD-1 60-Z1 [Figure 6, Figure 7], the image is less crowded with free water.

Future Direction:

- Instead of only focusing on the different combinations of high and low mixing energy and injection concentrations, we are now running center point experiments to see if mid levels of the variables will affect the water content. We will also be collecting size data in the vessel during settling using the focused beam reflectance measurement (FBRM).

Acknowledgements:

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Literature Cited:
[1] Murray Gray, Zhenghe Xu, and Jacob Masliyah. Physics in the Oil Sands of Alberta.
[2] Alexandre Goldszal and Maurice Bourrel. Demulsification of Crude Oil Emulsions: Correlation to Microemulsion Phase Behaviour