



EOR Produced Emulsion Separation

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April 2011

Produced Brine Composition (SP)

- 1 wt.% NaCl
- 500 ppm Ca⁺⁺
- 1200 ppm SNF Polymer FLOPAAM™ 3330S
- 0.15 wt% Neodol ® 67-7PO sulfate
- 0.05 wt% IOS 15-18 sulfonate
- 0.4 wt% *I*so-butyl acohol
- Deionized water

70/30 vol. ratio of produced brine and W.Texas crude oil

Produced Brine composition well below optimum salinity

Produced oil as o/w emulsion found most difficult to demulsify

Preliminary Demulsification Studies



1

2

3

4

5

6

7

8

9

10

1 – 200ppm Demulsifier A

2 – 200ppm AQAH

3 – 1000ppm AQAH

4 – 2000ppm AQAH

5 – 200ppm Demulsifier V

6 – 200ppm Demulsifier P

7 – 200ppm Neodol 25-3

8 – 2000ppm Neodol 25-3

9 – No additives

10 – No additives, heated to 50C

All added chemicals diluted to 1 wt% in water except Demulsifier A diluted in Heavy Aromatic Naphtha

Effect of Combinations of Demulsifier A with Cationic or Amphoteric Surfactants



1

2

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5

1 – No added chemicals

4 – 50ppm Demulsifier A + 50ppm Cocobetaine

2 – 50ppm Demulsifier A + 50ppm AQAH

5 – 50ppm Demulsifier A + 50ppm Octyl betaine

3 – 50ppm Demulsifier A + 50ppm Capryl/capramidopropyl betaine

AQAH diluted to 2.5wt% in water, Amphoterics diluted to 5wt.% in water, and Demulsifier A diluted to 5 wt.% in Heavy Aromatic Naphtha.

Conclusions

- Heating 70/30 produced brine/crude oil emulsion to 50° C produces clear separation of aqueous and oil phases < two hours
- Cationic surfactant, AQAH, at 200 & 300ppm, found effective in reducing water in oil to 0.2 vol.% and reducing oil in aqueous phase significantly
- Synergism between AQAH and ethoxylated resin demulsifier A when added simultaneously produces clearer produced brine, requires significantly lower total dosage for demulsification
- Addition of 50ppm AQAH and 50ppm Demulsifier A appears close to optimum dosage
- Further details in Energy & Fuels paper 2010, Petrophase poster



Diluted Bitumen Emulsions

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April 2011

Oil Sands

- 170 billion barrels crude bitumen in Alberta
- 3.9% bitumen reserves produced since 1967
- 1 billion barrels/year by 2019
- Suncor, Syncrude, Shell and CNRL are operators involved in bitumen mining projects.
- After open pit mining, bitumen treated with warm water to separate from sand, resulting mixture called “froth”



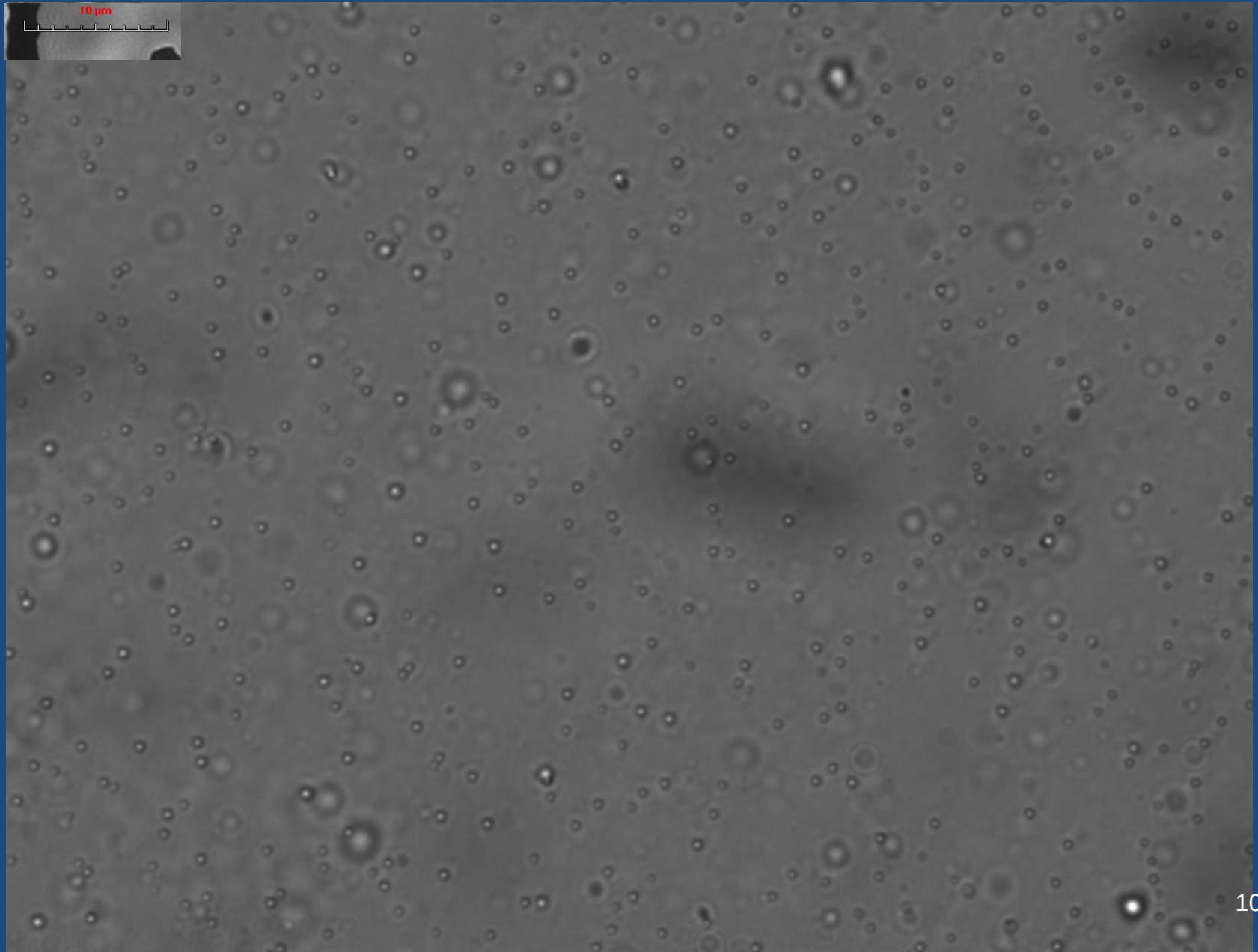
Energy Resources Conservation Board (ERCB) of Alberta

Bitumen Processing

- Bitumen API 8° to 12° ; RT viscosity >50,000 cp
- Bitumen froth containing 30% water and 10% solids
- Froth treated with naphtha to obtain diluted bitumen
- Current process results in about 1% water remaining in diluted bitumen.
- Project goal to reduce bitumen water content < 0.5% to meet improved coker feed specifications

Microscopy of Diluted Bitumen allowed to gravity separate for one year after demulsifier addition, sample provided by Syncrude 100X magnification

Using hydrophobic slide and cover slip

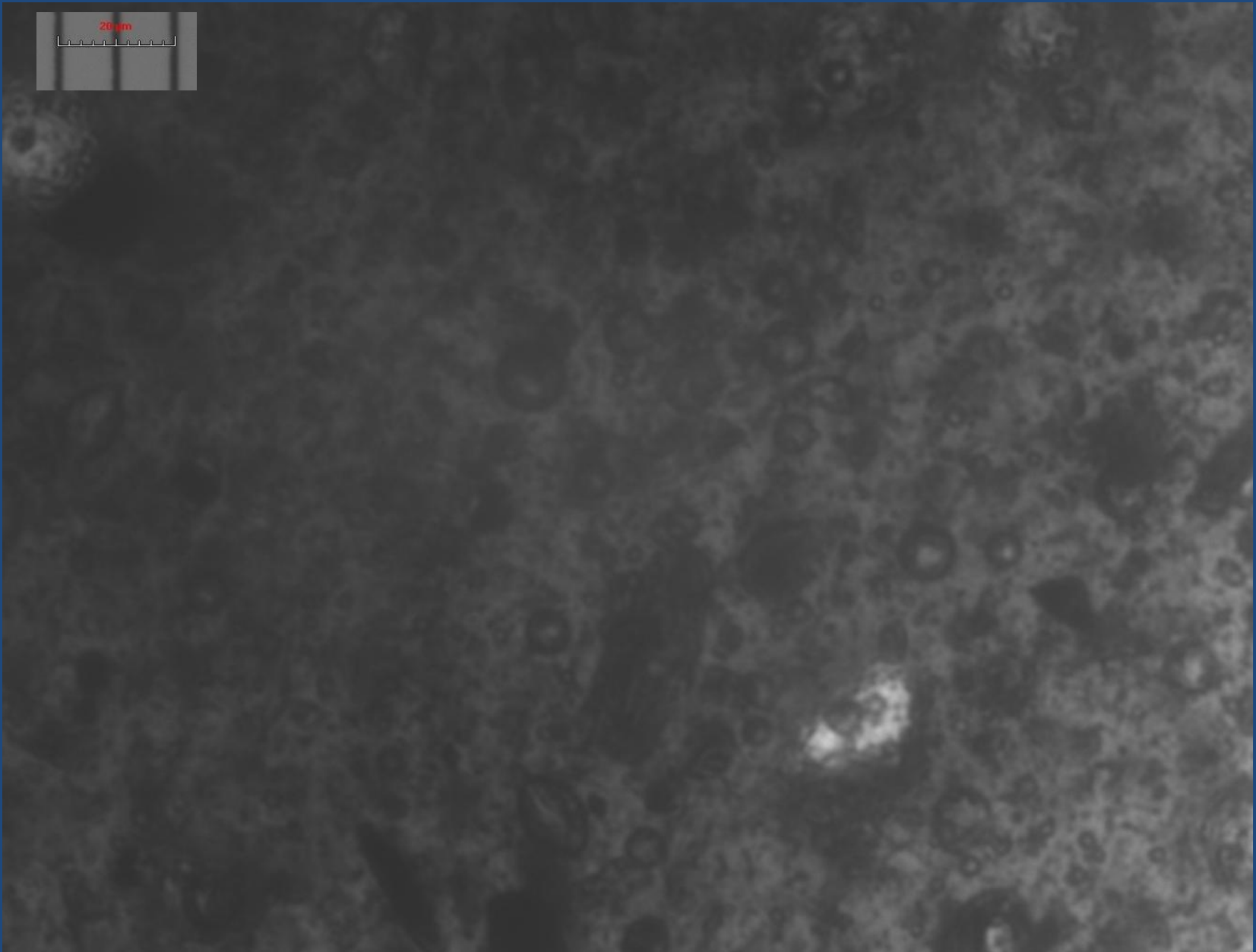


Karl-Fischer water analysis on Diluted Bitumen supplied by Syncrude

Demulsifier added, then one year gravity separation

- 0.62 – 0.66% water in diluted bitumen – Rice
- 0.55 wt% water in diluted bitumen - Syncrude

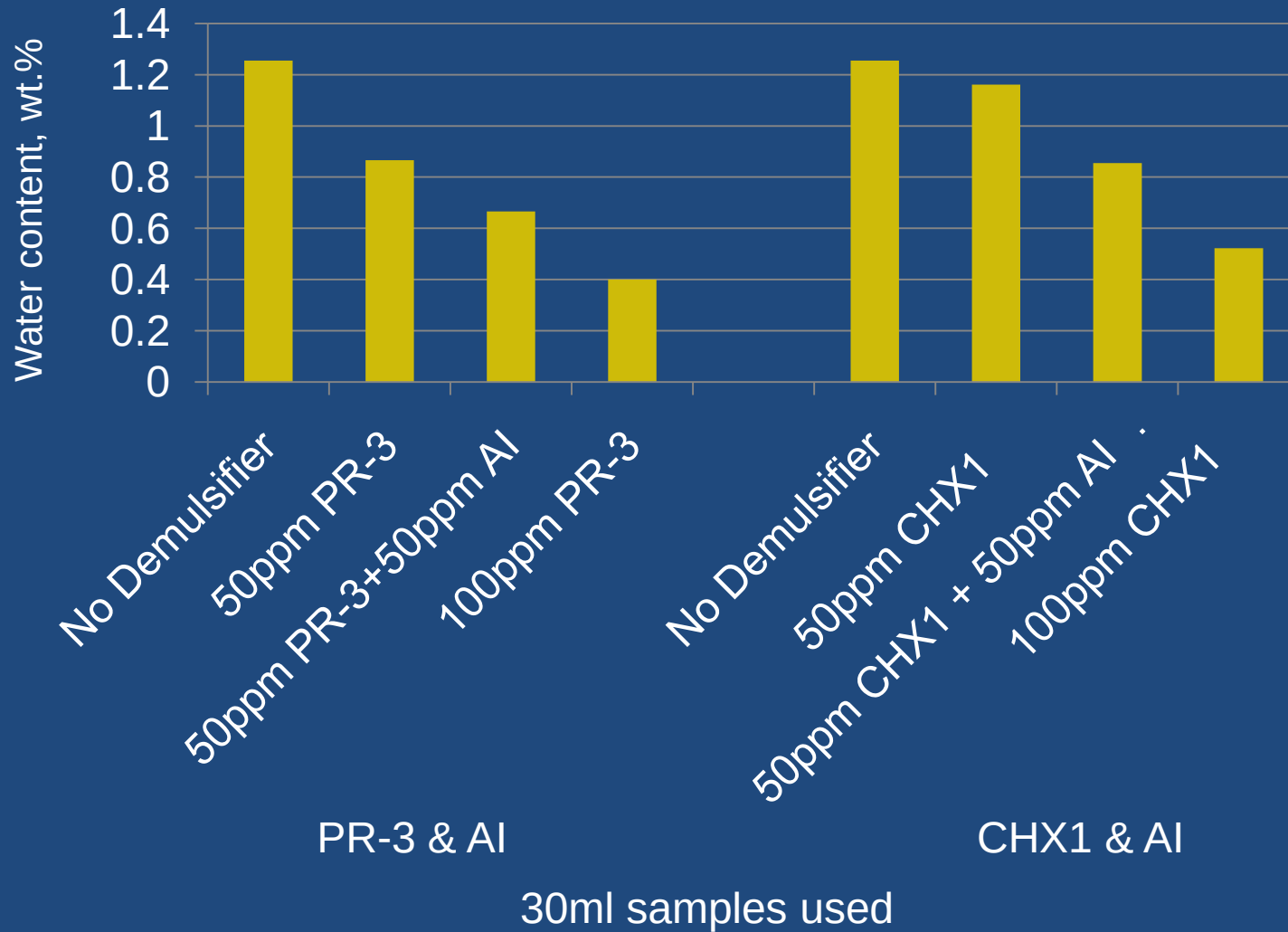
Bitumen Froth – 40x



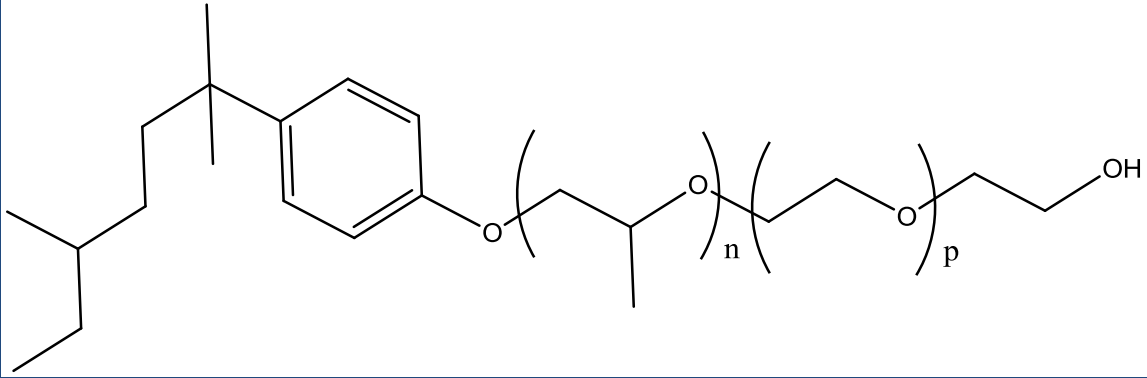
Materials & Methods

- Diluted Bitumen froth and Naphtha supplied by Syncrude
- Bitumen diluted with Naphtha to $N/B=0.7$
- Demulsifiers CHX1, CR 421X series, Asphaltene Inhibitor (AI) supplied by Champion Technologies
- Karl Fischer Titrino 701 titrator used for water content analyses
- Eberbach Shaker used for mixing bitumen and naphtha and after demulsifier addition.

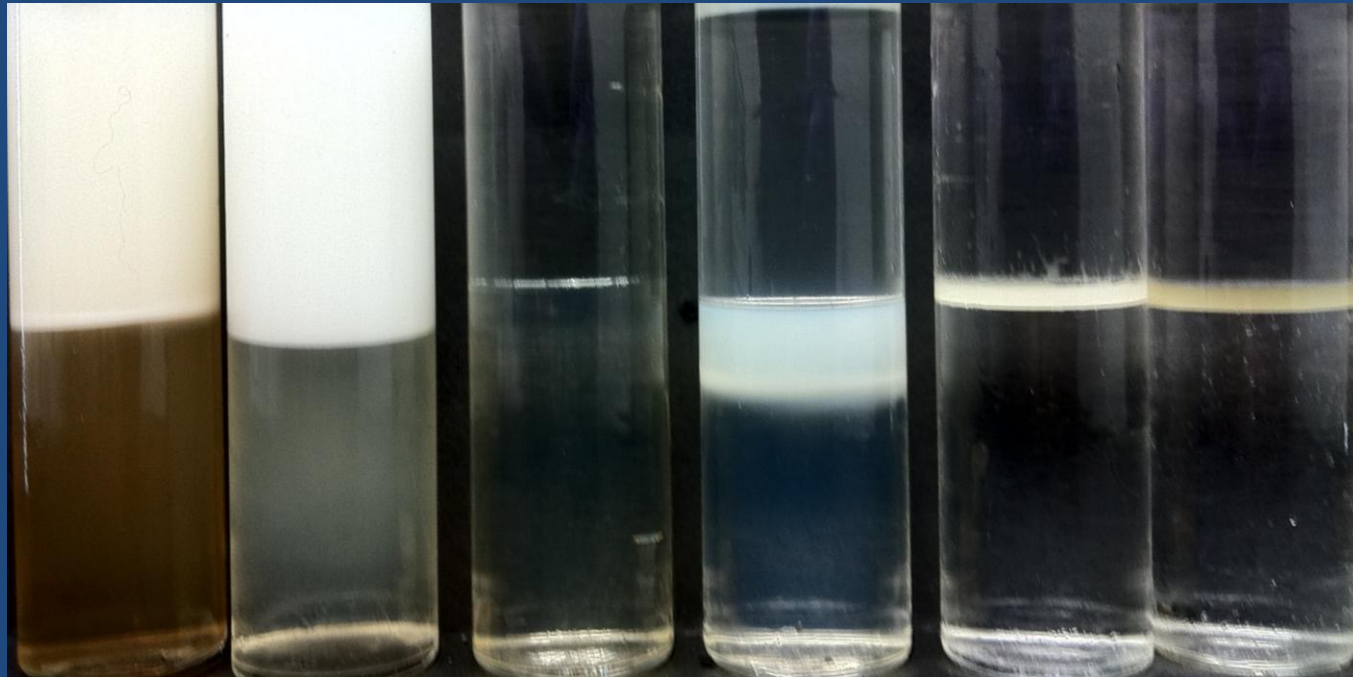
Effect of Demulsifiers and Al on Water Content in N/B 0.7, Sampled at top after 24 hours at 91C



Nonyl Phenol Oxyalkylate Resin



Phase behavior of Champion demulsifiers with varying EO/PO at WOR=1, 3.5%NaCl brine



CR-4210 CR-4211 CR-4212 CR-4214 CR-4216 CR-4218

EO/PO

6

3

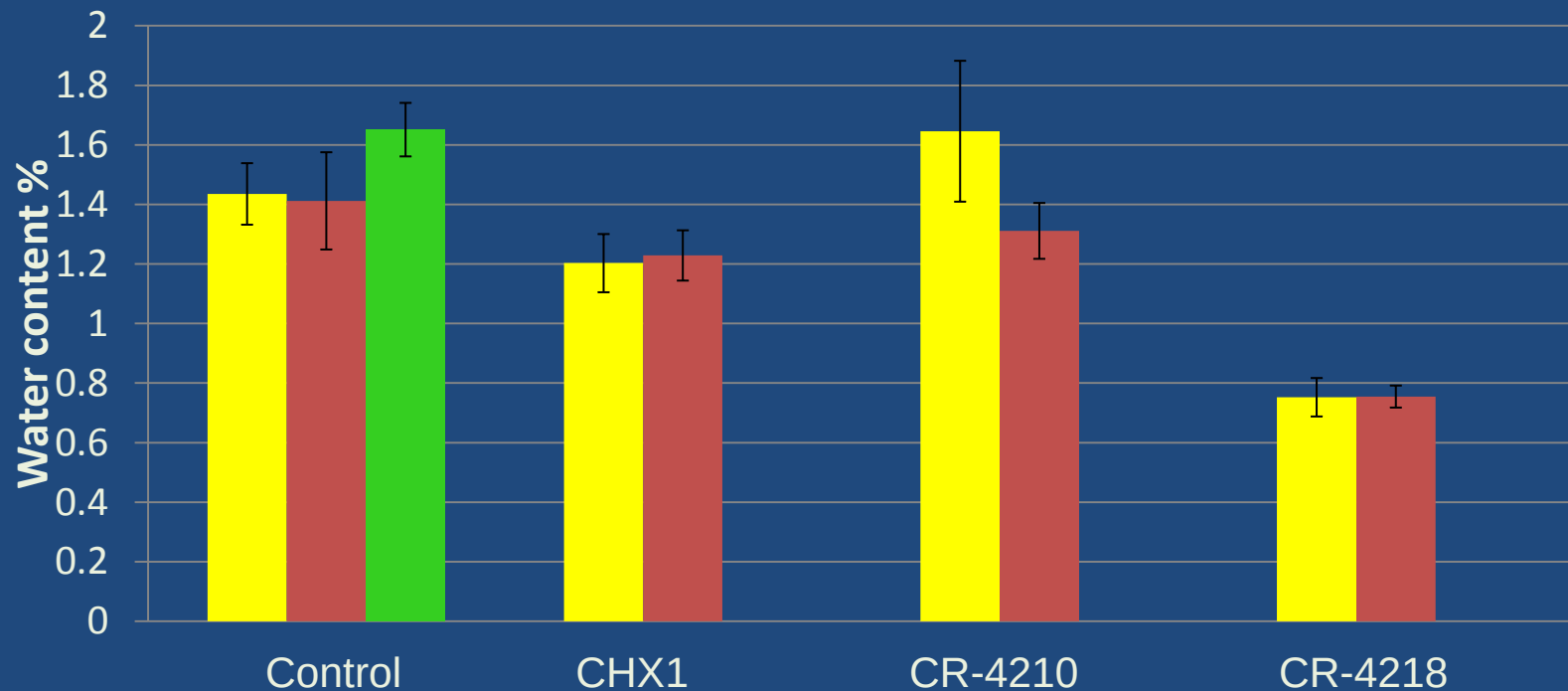
1

0.75

0.5

0.33

Average water content % of N/B=0.7 sampled from middle after heating at 80° C for 24 hours



100ml samples in prescription bottles

Conclusions

- Using hydrophobic slide and cover slip allowed visualization of water drops in submicron range in diluted bitumen
- Karl-Fischer analysis of this diluted bitumen after one year settling time indicated water content around 0.6 wt%
- Demulsifiers PR-3 and CHX1 each dosed at 100ppm reduced the top layer of bitumen water content < 0.5%
- AI also reduced water content in the top bitumen layer
- Best water content reduction obtained with demulsifier having lowest EO/PO

Acknowledgements

- Funding provided by NanoAlberta program
- Bitumen and Naphtha samples and procedures provided by Syncrude R&D
- Demulsifier and Asphaltene Inhibitor samples and procedures provided by Champion Technologies
- Yu Bian, Maura Puerto, Jose Lopez Salinas, Gautam Kini for laboratory assistance

Bottle Number & Demulsifier	BS&W after 5 minutes of centrifugation (from middle) After 2hrs at 80C	Water Content by Karl-Fischer after 2 hours at 80C (from middle) After 2 hours at 80C		Water Content by Karl Fischer after 24 hours at 80C Sampled from Middle / Top
		Rice	Champion*	
1. Control A	1.6	1.22	0.87	1.44 / 0.93
2. Control B	1.5	1.22	0.92	1.41 / 0.84
9. Control C	1.8			1.65 / 0.95
3. CHX1	0.8			1.20 / 1.17
4. CHX1	0.9			1.22 / 0.91
5. CR 4210	1.6			1.65 / 1.04
6. CR-4210	1.4			1.31 / 1.08
7. CR-4218	0.8	0.73	0.55	0.75 / 0.71
8. CR 4218	0.8	0.53	0.54	0.76 / 0.56

Bottles 1, 2, and 9 were used as Control, i.e. no demulsifier was added to these.

*Champion used Metrohm 795 KFT Titrino with Fluka 34800 Hydranal Solvent. This solvent system contains methanol, imidazole, and sulfur dioxide.