Alberta Bitumen Assay Program Overview, Technical Challenges and Learnings

Prepared by Alberta Energy for CCQTA/COQA

October 2014
Introduction

- Alberta Energy (AE)
- Program importance and objectives
- Overview of program design
- Technical challenges/Learnings
  - Sampling
  - Sample preparation
  - Assays
- Results and Key Learnings
  - Sample Preparation
  - Solids impact on density
- Questions
Disclaimer

This presentation was prepared to discuss our experiences in sampling, preparing and testing bitumen samples in Alberta. The Government of Alberta shall have no liability whatsoever to third parties for any defect, deficiency, error or omission in the contents, analyses and evaluations included in this presentation.

Any questions about this presentation should be directed to:

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Alberta Energy

- Steward of Alberta’s energy system for Albertans.
- Develop policy for and manage development of Alberta’s non-renewable resources and renewable energy.
- Grant exploration rights.
- Establish, administer and monitor the effectiveness of Alberta’s fiscal and royalty systems.
- Collect revenues from the development of Alberta’s energy and mineral resources.
- Promote energy efficiency and conservation.
- Encourage investment in Alberta’s energy industry to create jobs and economic prosperity for Albertans.
Importance

- Majority of Oil Sands owned by Alberta.
- Royalty collected on bitumen.
- 2.1 million bpd bitumen produced (2013).
- ~$5.2 billion in bitumen royalties for 2013-14 (55% of all royalty revenue – AE 2013/14 annual report).
BAP Importance

- Over 50% of Alberta bitumen is not sold to third parties and considered non-arms length (NAL) transactions
- NAL bitumen is valued with a bitumen valuation methodology (BVM)
- BVM variable is bitumen density
BAP Purpose

• Data may be used in a variety of ways:
  • Review of BVM
  • Enhances knowledge of oil sands resource
  • Advocacy – studies to show:
    • Carbon pathway
    • Other (i.e. CCQTA studies on volumetric adjustment)
  • Assess value added and other strategies
  • Other general work

• Authority:
  • Section 52 of *Mines and Minerals Act*
BAP Design

- Maxxam Analytics successful vendor in RFP process.
- Independent review of data by Crude Quality Inc. (CQI).
- Assays shared with operator for review and feedback.
- Program set up in phases with initially 23 assays in phase 1 and about 6 assays each subsequent phase.
Challenges: Sampling

- Identifying appropriate sample points – collaboration with operators and Maxxam
- Limit/eliminate light end loss – cooling of thermal samples – maintain target temperature of sample
- Size of samples – one to eight 20L pails for each project – dependent on water cut and naphtha yield
- Safety – standard protocols – no incidents to date
Challenges: Sample Preparation

- Solids content – mining samples - toluene extraction
- Emulsion type – distillation or centrifuge
- Distillation – capture light ends
- Centrifuge – volume limit and density difference
- Multiple methods – “best” option – data comparison
Challenges: Testing

- Test methods for bitumen – altered and adapted as needed (e.g. TAN – ASTM D664 vs. CCQTA method)
- Naphtha volumes – multiple distillations
- Data accurate – various quality controls employed
  - CQI developed protocols for analysis (mass balances and tolerance limits of various parameters)
  - AE compared to other regulatory submissions
  - Operator feedback
  - Retests performed as needed
Accomplishments

- Collected, prepared, and tested 29 samples.
- Gathered significant intelligence of resource.
- Helped develop a standard sample preparation method.
- Developed better understanding of limitations of data.
Key Learnings

- Solids have significant impact on density (1700ppm ~ 1kg/m$^3$).
- Sample collection and preparation can affect results (especially potential loss of light ends from sampling thermal projects – cooling coil).
- Existing test methods for crude oil are not always applicable for heavy oil/bitumen.
Standard Sample Preparation

• No one standard exists for cleaning bitumen samples
• Phase 1 employed “best available method(s)”
• Methods used included
  – Ultra high speed centrifuge
  – Distillation
  – Cold Solvent Extraction
• Phase 2 used proposed hybrid cleaning method and tested impact of preparation whole crude qualities
Centrifuge

- Least invasive
- Only works when significant difference in densities exist
- Can leave significant solids and water suspended in sample
- Doesn’t work with strong emulsions or high sediment content
- Small volumes only
Distillation

- Possible light end losses
- Larger volumes can be prepared
- Concentrates solids
- Samples can “bump”
- Time consuming and relatively expensive
Solvent Extraction

- Light end losses
- Larger volumes can be prepared
- Efficient in removing solids and water
- Samples can “bump”
- May concentrate small particle sediment and salt
- Residual solvent can affect results
Hybrid Method

- Distill light ends and some water
- Capture light ends for later addition
- Add solvent to increase density difference
- Centrifuge and dispose of solids and water
- Distill and remove solvent
- Combine light ends to clean bitumen
Guidelines: general
## Preparation Comparison

<table>
<thead>
<tr>
<th>Sample</th>
<th>Prep. #</th>
<th>Measured Density (kg/m³)</th>
<th>Solids (ppmw)</th>
<th>Water Content (ppmw)</th>
<th>Adj. Density (kg/m³)</th>
<th>Assay Density (kg/m³)</th>
<th>Assay Adj. Density (kg/m³)</th>
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<th>Assay Density (kg/m³)</th>
<th>Assay Adj. Density (kg/m³)</th>
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## Solids Analysis on Bitumen Density

- Various areas and extraction technologies
- Solids collected and analyzed: XRD, SEM, and EDS
- Solids have SG range 2.2 - 3.2
- Impact on bitumen density related to solids volume and density (1700ppm or 0.17% = 1kg/m³)

<table>
<thead>
<tr>
<th>Sample</th>
<th>Measured Density (kg/m³)</th>
<th>Solids-Free Density (kg/m³)</th>
<th>Difference (kg/m³)</th>
<th>Sediment Content (mass %)</th>
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Thank you

Questions?

Contact:
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780 644-7023
charles.ward@gov.ab.ca
Appendix

Additional slides for reference
# Sample 1 Composition XRD

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<thead>
<tr>
<th>Formula</th>
<th>Name</th>
<th>Percentage</th>
<th>Specific Gravity</th>
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<td>Halite</td>
<td>95.6%</td>
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<tr>
<td>KCl</td>
<td>Sylvite</td>
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<td>1.99</td>
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<td>Fe₂O₃</td>
<td>Magnetite</td>
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**Weighted Average Solids Density**

2.24
## Sample 2 Composition XRD

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<td>FeS₂</td>
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<td>5.10</td>
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<td>SiO₂</td>
<td>Quartz</td>
<td>7.1%</td>
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<tr>
<td>NaAlSi₃O₈</td>
<td>Albite</td>
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<td>KAlSi₃O₈</td>
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<td>Fe₃O₄</td>
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<td><strong>Weighted Average Solids Density</strong></td>
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## Sample 3 Composition XRD

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<td>SiO$_2$</td>
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## Sample 4 Composition XRD

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<td>NaAlSi₃O₈</td>
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<td>KAlSi₃O₈</td>
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<td>Fe₃O₄</td>
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<td>TiO₂</td>
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**Weighted Average Solids Density**: 3.20