Summary

- Brief Overview of Maxxam Analytics International Corp.
  - Size, scope and general capabilities
- Heavy Oil and Oil Sands Testing
  - Unique attributes for heavy oil and oil sands testing
  - Impacts on analytical testing
- Crude By Rail Sampling and Testing
  - Observations
Company Overview

- 2,500 employees
- >75% possess technical degrees
- 520 Diplomas
- 756 Bachelor Degrees
- 192 Masters Degrees
- 30 PhDs

Receiving and Processing:
- 2,300,000+ samples
- 41,000,000+ results

40 Locations
18 Laboratories
9 Outsourced Laboratories
12 Service Centers

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Receiving and Processing:
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- 41,000,000+ results
Serving our core markets

Energy  Environment  Food  Pharma, DNA, & Forensic Drug Testing
Petroleum Technology & Capabilities

Petroleum Technology Center – 54,000 ft² laboratory space

- Continued and significant investment into science and advanced technology
- Advanced Natural Gas and LPG/NGL GC systems
- Includes Carbon Isotope Analysis (Well abandonments)
- Exclusive Laboratory for Crude Oil Assay & Bitumen Valuation for the Government of Alberta
- Oil sands batch extraction
- Tailings characterization and analysis
- Fuel testing (Diesel, ethanol, aviation, biofuel and coal)
- Crude Oil by Rail testing
Heavy Oil and Oil Sands Derived Bitumen

- Attributes of Heavy Oil and Oil Sands derived material is significantly different than that of conventional crude oils
  - Density
  - Pour Point
  - Water content
  - Sulphur
  - Acid Number (TAN)

- Unique sample matrices sometimes require the combinations of multiple cleaning techniques, such as centrifuging and distilling to obtain representative “clean” samples

- Unique matrices also demand modifications and alterations to existing standard methods (CCQTA testing method work)
Maxxam Bitumen Preparation Techniques

Selection of the cleaning method is based on the various industrial processes used in bitumen production

- **Heavy oils produced by cold flow** could be sufficiently cleaned by **high-speed or ultra-speed centrifuging**

- **Oil sand, core samples, mined bitumen froth samples** that contain relatively high solids will require sample **solvent extraction (hot or cold)** for separation of solids and water from the remaining bitumen

- **SAGD bitumen/water emulsion** usually contain very little solid material that has a negligible effect on required tests. Bitumen prepared by removing water through the **distillation process**
Centrifuging – Heavy Oils

Pros
- No altering of the physical properties of the bitumen
- No solvent addition
- Minimal light ends losses

Cons
- Time consuming process
- Sample size limitation
- Does not entirely remove water and sediment
- Possibility for hydrocarbon stratification due to super speeds
Dehydration of Bitumen by Distillation

Pros

- Light ends lost in the process are mostly recoverable and could be remixed with bitumen
- No solvent addition (bitumen stays native)

Cons

- Partially lost light ends
- Risk of bumping during process
- Sediment and salt will be concentrated in bitumen
- Expensive and time consuming cleaning process
Bitumen Dehydration by Rotovap

- Rotovaps used instead of vacuum distillation
- Modification implemented for the best performance

Extra condenser

Trap for volatiles

Water collection trap in dry ice

Light ends trap in dry ice
Bitumen Density Measurement Challenges

- Need for more accurate density measurement of bitumen
- The samples are too viscous to be injected in the instrument at 15°C
- API density conversion tables are not applicable for bitumen matrix
- Density measurements at elevated temperatures (40, 60 and 80°C) and extrapolation to 15°C provide reliable results
- This method is in use by industry and is in the process to be adopted as industry standard
Crude by Rail
General Observations

- Lots of activity within Western Canada
  - Relative inexperience and knowledge gap at many levels
- Undefined quality requirements
  - What to test for and how often?
- Under appreciated safety requirements
- No rail transloading facility design is the same
  - Presents unique sampling challenges and unique sampling techniques
## Typical Specification

<table>
<thead>
<tr>
<th>Quality Test Name</th>
<th>ASTM</th>
<th>Units</th>
<th>Tariff Restrictions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density @ 15C</td>
<td>D1298/5002</td>
<td>kg/m³</td>
<td>940 kg/m³</td>
</tr>
<tr>
<td>Kinematic viscosity at 10, 20, 30 C</td>
<td>D 445</td>
<td>cSt</td>
<td>350 cSt @10°C</td>
</tr>
<tr>
<td>Reid vapor pressure</td>
<td>D 323A</td>
<td>KPa</td>
<td>103 kPa</td>
</tr>
<tr>
<td>Sediment and Water</td>
<td>D 607</td>
<td>Vol%</td>
<td>&lt;0.5</td>
</tr>
<tr>
<td>Organic Chlorides</td>
<td>D4929</td>
<td>wppm</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Hydrogen sulfide</td>
<td>D5623</td>
<td>wppm</td>
<td></td>
</tr>
<tr>
<td>Volatile mercaptan sulphur</td>
<td>D5623</td>
<td>wppm</td>
<td></td>
</tr>
<tr>
<td>BTEX</td>
<td>GC-FID</td>
<td>wppm</td>
<td></td>
</tr>
<tr>
<td>Pour point</td>
<td>D5853</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td>Salt Content</td>
<td>D3230</td>
<td>ptb</td>
<td></td>
</tr>
<tr>
<td>Olefins</td>
<td>NMR</td>
<td>mass%</td>
<td></td>
</tr>
<tr>
<td>Vanadium</td>
<td>Plasma Analysis</td>
<td>ppm</td>
<td></td>
</tr>
<tr>
<td>Nickel</td>
<td>Plasma Analysis</td>
<td>ppm</td>
<td></td>
</tr>
<tr>
<td>Phosphorus</td>
<td>Plasma Analysis</td>
<td>ppm</td>
<td></td>
</tr>
<tr>
<td>Iron</td>
<td>Plasma Analysis</td>
<td>ppm</td>
<td></td>
</tr>
<tr>
<td>Silicon</td>
<td>Plasma Analysis</td>
<td>ppm</td>
<td></td>
</tr>
<tr>
<td>TAN</td>
<td>D 664</td>
<td>mgKOH/g</td>
<td></td>
</tr>
<tr>
<td>MCR</td>
<td>D4530</td>
<td>Wt%</td>
<td></td>
</tr>
<tr>
<td>HTSD % recovered (vol%) from IBP to FBP</td>
<td>Extended D5307</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Total sulphur</td>
<td>D2622/4294</td>
<td>mass%</td>
<td></td>
</tr>
</tbody>
</table>

### Tariff Restrictions
- **Density**: 940 kg/m³
- **Kinematic viscosity**: 350 cSt @10°C
- **Reid vapor pressure**: 103 kPa
- **Sediment and Water**: <0.5 Vol%
- **Organic Chlorides**: <1 wppm

### Safety Concern

#### Refinery Concerns
- Crude by rail objectives should be identical or similar to pipeline objectives
- Crude by rail spec should be more strict than pipeline spec
- What to producers typically test for?

#### Operational Concerns
- Operational Concerns
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Sampling – Crude by Rail

- Sample - a portion extracted from a total volume that may or may not contain the constituents in the same proportions that are present in that total volume
- Sampling - the steps required to obtain a sample for analysis that is representative of the contents of any pipe, tank, or other vessel
- Crude oils are usually nonhomogeneous - concentration of entrained water is higher near the bottom of the vessel (i.e,. Bottom of a truck)
- Automatic sampling is recommended whenever samples of crude oils are required for custody transfer measurements
- Representative sample (% of rail cars loaded) of manifest and unit trains (ex. 1 in 10, 1 in 20)
Sampling Procedures

- Sampling of crude oils from rail cars is not very well defined by ASTM and API
- ASTM D5842 “Standard Practice for Sampling and Handling of Fuels for Volatility Measurement”
- Consideration: Are there a significant differences in sampling between tank and rail car?
Sample Handling

- ASTM D5854 “Practice for Mixing and Handling of Liquid Samples of Petroleum and Petroleum Products”
- Representative samples of crude oils are required for the determination of parameters used for establishing standard volumes, prices, and compliance with regulatory specifications
- Care and effort are required to maintain compositional integrity of samples from collection to testing
  - Need to minimize light end or component loss for RVP, H2S, light ends, density etc.
- Tank car sampling recommendation - Sample the product after the car is loaded or obtain a mid flow sample
Transport Canada – Protective Direction 31

- Transport Canada release – October 17, 2013
  - Protective Direction 31 released

- Focus is on Crude Oil transported by Rail
  - The requirement is focused on rail transportation but includes road transport for Transportation of Dangerous Goods (TDG)

- Ambiguous requirements for TDG testing and Safety Data Sheet (MSDS) requirements
  - States Classification 3 Packing Group 1 for all crude oil unless supported by safety data sheet
  - Infers new/updated safety data sheets (MSDS) required for products after July 7, 2013
Crude by Rail Testing

- Rail car transportation is regulated by the Railway Safety Act, the Transportation of Dangerous Goods Act and MSDS of products.

<table>
<thead>
<tr>
<th>Physical State:</th>
<th>Liquid</th>
<th>Odour &amp; Appearance:</th>
<th>Dark Brown, hydrocarbon-like</th>
</tr>
</thead>
<tbody>
<tr>
<td>Odour Threshold (ppm):</td>
<td>Not Available</td>
<td>Specific Gravity:</td>
<td>0.7 – 0.8</td>
</tr>
<tr>
<td>Vapour Density (air=1):</td>
<td>2.5 -5.0 (estimated)</td>
<td>Vapour Pressure (mmHg):</td>
<td>280-360 @ 20°C</td>
</tr>
<tr>
<td>Evaporation Rate:</td>
<td>Not Available</td>
<td>Boiling Pt. (°C):</td>
<td>-40 to 530</td>
</tr>
<tr>
<td>Freezing Pt. (°C):</td>
<td>&lt;-60</td>
<td>pH:</td>
<td>Not Available</td>
</tr>
<tr>
<td>Coefficient of Water/Oil Distribution:</td>
<td>&lt;0.1</td>
<td>Percent Volatiles, (v/v):</td>
<td>15 - 30 (estimated)</td>
</tr>
</tbody>
</table>

- Rail companies are being required to have more detailed analytical data about the crude oil load.
- Increased business of moving crude by rail also increases risk.
Conclusion

Crude Oil by Rail

- Need for consistent and detailed sampling procedure for rail cars that are applicable for all types of crude oil transported by rail
- Staff have to be familiar with crude oil loading practices and proper sampling procedures
- Be in control - test the product that are you hauling
- Based on testing, choose the products and blends that are going to ensure safe transport and problem-free unloading
Thank you

Questions?

COQA Presentation – Maxxam Analytics

Heavy Oil, Oil Sands and Crude by Rail Testing

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