Identifying Western Canadian Crude Specifications - Impacts on Refiners, Upstream Technology Development, and Marketability

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Outline

• Crude oil fractions & refinery
• Unconventional crudes & value differential
• Crude quality specifications
  • Density/viscosity
  • Diluent effects
  • TAN
  • Asphaltenene and olefins
• Technology Development perspective
Crude Oil Fractions

- Light Distillate
- Middle Distillate
- Heavy Distillate
- Residuum

WTI

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The Refinery

Primary Revenue:
- Gasoline
- Jet fuel
- Kerosene
- Diesel fuel

Processing:
- Saturation
- Desulfurize
- Catalytic reforming
The Refinery

Require Upgrading:
- Gasoline
- Diesel fuel
- Fuel oil
- Pet coke
- Asphalt

Processing:
- Saturation
- Desulfurize
- FCC
- Vacuum

distillation
- Thermal cracking
- Catalytic reforming
- Alkylation

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Unconventional Crudes

Typically sold as blends with lighter material
Value Differential

Heavier crudes generally trade at a discount to WTI

- 2008 to 2012 – discount averaged $16.50/bbl
- Other factors (e.g. transportation)

Price sources: NYMEX WTI, (NGX & NetEnergy blended)
To upgrade or not to upgrade...

Upgrading heavy fractions to higher value products (typical):

- Coking
- Hydroprocessing

Downsides:

- Coking – “unstable product”, low yields
- Hydroprocessing – hydrogen requirements
- Capital cost of upgrading facility – refinery components
- Refineries have upgrading capacity
Crude Quality Specifications

Primary crude quality specifications:

- Density
- Viscosity
- Basic Sediment & Water
- Sulfur

Secondary quality characteristics:

- TAN
- Olefins
- Asphaltene
- H$_2$S Sulfur
- Metals
- Vapour pressure
Density and Viscosity

Pipeline crude specifications:

<table>
<thead>
<tr>
<th></th>
<th>Density</th>
<th>Viscosity</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>(kg/m³)</td>
<td>(°API)</td>
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<tr>
<td>Pipeline Specification (1)</td>
<td>940</td>
<td>19</td>
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<tr>
<td>Bitumen (2)</td>
<td>1015</td>
<td>8</td>
</tr>
<tr>
<td>Condensate (3)</td>
<td>600 - 775</td>
<td>51 - 104</td>
</tr>
<tr>
<td>Synthetic (4)</td>
<td>860</td>
<td>33</td>
</tr>
</tbody>
</table>

To meet pipeline spec, lighter material needs to be added:

• Condensate ("Dilbit")
• Synthetic crude ("Synbit")

Sources: (1) NEB Tarriff No. 282, (2) Speight, J. G., Coal, Shale, Natural Bitumen, Heavy Oil, and Peat – Vol II – Natural Bitumen (Tar Sands) and Heavy Oil, (3) Enbridge CRW Pool Specifications, (4) www.crudemonitor.ca.
Economics of Bitumen Diluent Addition

Required to meet density/viscosity:

- ~30% condensate
- ~50% synthetic

Price sources: NYMEX WTI, (NGX & NetEnergy blended)
Dilbit – But the refiners like it, right?

Unfortunately no:
- Same amount of gas oil/resid (just diluted)
- Low-quality naphtha
“The Box”

- Bitumen producers want to sell bitumen, not dilbit/synbit
- Downstream refiners want bitumen, not diluted bitumen
- Bitumen needs to be diluted to pipe to market
- Diluent is simply the packaging to get bitumen to market
- Additional transportation costs
- “The box” takes up pipeline space!

Technology Development challenge:

REDUCE PACKAGING!
Total Acid Number (TAN)

- Pipeline/refinery corrosion is a significant concern
- Bitumens and heavy oils have higher TANs than lighter crudes

- High TAN crudes (TAN > 1.0)
- Low TAN crudes (TAN < 1.0)

- Due to corrosion concerns, high TAN crudes have limited markets – heavily discounted price

- Are high TAN bitumen blends highly corrosive?
TAN – Corrosivity of Dilbits

Highlights of recent TAN studies:

• Comparison of synbit, dilbit, conventional crudes
  • High TAN bitumen crudes not a corrosion concern under static or flow conditions
  • No clear correlation between TAN and corrosivity
• Pipeline corrosion due to dilbits is very unlikely

If dilbits are more acidic, why aren’t they more corrosive?

• Acidic strength, Nature of the acid
TAN – Organic Acid Corrosivity

Source of data: "NACE Northern Area Western Conference 2010 Proceedings" Heather D. Dettman, Nana Li, Dhanuka Wickramasinghe, and Jingli Luo, Natural Resources Canada, 2010, Figure 2. Reproduced with the permission of the Minister of Natural Resources Canada, 2013.

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Two more properties: Asphaltene and Olefins

- Asphaltene
  - Heaviest fraction of bottoms
  - Highly aromatic – insoluble in diluents
  - Issues with precipitation, emulsions, fouling
  - Difficult to crack

- Olefins
  - Molecules with double-bonds
  - Byproduct of thermal conversion
  - Strict pipeline specifications
  - Risk of fouling
Technology Development Perspective

- Historical Technology Development areas:
  - Water – Improve cost & environmental performance
  - Production – new methods, reduced costs
  - Greenhouse gases
- Crude quality represents a key area for future technology development:
  - Increase value of Western Canadian product
  - Improve transportation scenarios
  - Increase market access
  - Improve safety and environmental parameters
Acknowledgements

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CCQTA