Baker Hughes Downstream Chemicals

Shale Oil Impacts on Refining and Transportation

Larry Kremer
Baker Hughes
Shale Oil Processing Issues

- Wax deposits in tanks
- Emulsion stabilization & water hold up in crude oil
- High filterable solids
- Crude blending
- Overhead corrosion
- Cold & hot train fouling
- Fuel blending
- Odor and hydrogen sulfide
- Cold flow and lubricity properties of fuels

Shale oil quality variability from one field
Characteristics of Shale Production

- Sometimes called ‘tight oil’
- Horizontal drilling was key technology advance
- Hydraulic fracturing of shale formation
- Infrastructure does not exist to meet needs
  - Most shale oil moved by rail or trucks
  - Limited pipelines expanding to meet transportation needs
- Unit trains bring Bakken to east coast, west coast, and gulf coast
- Truck transportation leads to quality fluctuations
- As oil is consolidated into larger shipments, quality variations should be reduced
## Analytical - Eagle Ford Crude Variability

<table>
<thead>
<tr>
<th>Value</th>
<th>Yellow</th>
<th>Red</th>
<th>Black</th>
</tr>
</thead>
<tbody>
<tr>
<td>API</td>
<td>55.0</td>
<td>44.6</td>
<td>52.3</td>
</tr>
<tr>
<td>TAN</td>
<td>&lt;0.05</td>
<td>0.07</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Sulfur</td>
<td>&lt;0.2%</td>
<td>&lt;0.2%</td>
<td>&lt;0.2%</td>
</tr>
<tr>
<td>Asphaltene</td>
<td>0%</td>
<td>0%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Resin</td>
<td>0.5%</td>
<td>3.2%</td>
<td>1.6%</td>
</tr>
<tr>
<td>Filterable solids</td>
<td>176 PTB</td>
<td>295 PTB</td>
<td>225 PTB</td>
</tr>
</tbody>
</table>
Micrograph of Sludge

100 X

400 X
Paraffin Analysis
Bottom of Sample

- Considerable high molecular weight wax in bottom
- High MW = High melting point Some wax melts above 100ºC (212ºF)
Transportation Issues

- Incompatibility with asphaltenic crude oils
- Paraffin deposits
- \( \text{H}_2\text{S} \) – HS&E issue
- Odor – Trains and trucks
- Mercaptans in Utica production
- Tendency to over treat with scavengers can lead to amines in crude unit
Shale Oil Hydrogen Sulfide

• Although low in S they can be high in H_2S
  – HS&E concerns
  – Trucks and trains travel through towns
  – Fittings on sweet tanks may not handle H_2S
• Misapplication can cause downstream issues
  – Excessive chemical use
  – Some scavengers can lead to downstream salting
  – Amine chlorides salts in overhead can be corrosive
Paraffin Deposits

- Transportation
  - Pipelines
  - Barges
  - Trains
  - Cold train exchangers
- Crude storage tank
  - Sludge increase
  - Wall deposits

- H/C Atomic Ratio = 1.5
- 24% Fe + S
- 63% C + H
Cold Train Fouling Trial

- Customer must clean cold train exchangers every 10 days
- Deposits have wax and asphaltene components
- Developed new LIFESPAN™ fouling control additives
- Treatment continued 6 months without cleaning shut down
- Reduction in fouling so significant that customer will not turn off chemical

LIFESPAN is a trademark of Baker Hughes Incorporated
Issues with Asphaltene Destabilization

- Shale oil can destabilize asphaltenic crude
- Problem shows up first as emulsion stabilization
  - Oil in desalter brine
  - Increased BS&W
- Potential destabilization in tankage
- Asphaltene fouling of hot train
- Customers have also seen cold train fouling
- Destabilization can be quantified with the Field ASIT services™ technology
ASIT™ Asphaltene Stability Index Test

- ASIT Test measures the onset of the flocculation of the asphaltenes with high accuracy by inducing the asphaltene precipitation via titration with a paraffinic solvent.
ASIT Blend of Bakken and Cold Lake
Shale Oil Blending

- Paraffins destabilize asphaltenes
- Negative impact on desalter operation
  - Brine quality
  - Rag stability
- Can lead to fouling:
  - Cold train
  - Hot train
  - Furnace
Summary

- Shale oils are paraffinic
  - Low sulfur and TAN
  - Blending issues with asphaltenic crude oils
- Low sulfur but can have H₂S
  - Apply correct product properly
- Paraffin content raises new fouling issues
  - Additives have demonstrated effective control
    - Cold train fouling
    - Hot train fouling
    - Furnace fouling