Optimizing The Application Of Paraffin Inhibitors And Hydrocarbon Balance Considerations To Assess The Impact On Paraffin Control

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What is paraffin?

Paraffin is a high molecular weight hydrocarbon component that is extracted from the formation with gas and liquids.

In general, two mechanisms exist to allow paraffin to move with gas and/or oil – thermal condition associated with downhole temperature and bulk hydrocarbon compositional solubility.
Common Misperceptions

- The paraffin content of a crude signals a problem.
- Crudes containing high amounts of wax are low gravity or "heavy" crudes.
- Paraffin inhibitors work by changing the amount of wax in the crude.
- Paraffin inhibitors can be used to prevent deposition in all cases.
Paraffin Destabilization

- Phase change or change in solubility of natural solvents as hydrocarbon material balance changes with temperature and pressure reduction

- Reduction in temperature allows paraffin to crystallize
  - Changes due to thermal transfer
  - Changes due to expansion cooling

- Solids in the oil promote and stabilize paraffin crystals
  - Sand, clay, silt, iron sulfide, etc.

- Thermal profile of equipment
## Deposition – Rules of Thumb

<table>
<thead>
<tr>
<th></th>
<th>HIGH FLOW RATE</th>
<th>LOW FLOW RATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Both oil and pipe wall above cloud point</td>
<td>No Deposit</td>
<td>No Deposit</td>
</tr>
<tr>
<td>Oil below cloud point, pipe wall slightly warmer</td>
<td>No Deposit</td>
<td>No Deposit</td>
</tr>
<tr>
<td>Oil above cloud point, pipe wall slightly below cloud point</td>
<td>Thin, very dense and hard coat of high-melting wax</td>
<td>Thicker, softer, lower-melting wax; little entrained oil</td>
</tr>
<tr>
<td>Oil above cloud point, pipe wall much cooler</td>
<td>Thick, dense, hard coat of high-melting wax; little entrained oil</td>
<td>Thick, soft, mushy, wide-melting range wax; much entrained oil</td>
</tr>
<tr>
<td>Oil below cloud point, pipe wall colder</td>
<td>Thick, soft, mushy, wide-melting range wax; much entrained oil</td>
<td>Thick, soft, mushy, wide-melting range wax; much entrained oil</td>
</tr>
</tbody>
</table>
Chemical Solutions

Chemical solutions for paraffin related problems include:

- An **Inhibitor or Dispersant** to Prevent Deposition

- A **Solvent or Dissolver** to Remove Precipitated Paraffin
Solutions for Paraffin

- **Inhibitors** – *continuous, squeeze*
  - Alter the structure of paraffin crystals as they form
  - Typically restrict agglomeration of crystals
  - Impact viscosity and pour point of the liquid
  - Typically applied at a temperature above the cloud point

- **Dispersants** – *continuous*
  - Attach to paraffin crystals to prevent agglomeration
  - Typically allow for stable dispersion of paraffin in a liquid

- **Solvents** – *continuous, slug, batch*
  - Dissolve paraffin
  - Different mechanisms in neat form vs. liquid matrix
  - Can assist with saturation of gas
Viscosity of Inhibited Crude

Viscosity Profile

Temperature (F) vs. Viscosity (cP)
**Inhibited Crude**

Untreated:
Numerous connected crystals

1000 ppm Inhibitor
Few isolated crystals
Inhibited Crude

Untreated:
Crude completely gelled

1000 ppm Inhibitor
Crystals have grown, but are kept separate
Inhibited Crude

Untreated:
WAT 141 °F
Numerous small crystals

1000 ppm Inhibitor
WAT 136 °F
Few large crystals
Paraffin Control Basics

- **Paraffin content**
  - Cannot predict whether or not deposition will occur.
  - Thermal conditions, hydrocarbon mass balance, and solid matter presence are the key drivers of deposition.
  - Treatment is volumetric. More paraffin, more chemical.

- **Deposition driver(s)**
  - Should be evaluated prior to application design.
  - Mechanical or operational changes may prevent deposition.
  - Nodal analysis – differences in the system flowstream.
  - Application point is key to all chemical initiatives.

- **Chemical application**
  - Must be relative to deposition site.
  - Must consider all 4 phases – gas, oil, water, solids.