Considerations in Establishing a Crude Quality Monitoring Program

Eric Vetters
ProCorr Consulting Services
For Joint COQA/CCQTA Meeting, Edmononton, AB
June 7-9, 2016
Outline

• Why Monitor Crude Oil Quality
• Key Factors to Consider
• What to monitor
• Conclusions
What is the quality of crude oil?

• Characteristics of the oil that determine how it will process and the products it will make
  • Inherent properties – e.g. Gravity, Sulfur, TAN, Distillation
  • Non hydrocarbon constituents – water, solids, salt, additives/oilfield chemicals
  • Operationally dependent properties – Light ends/RVP

• Assays used to represent the quality of a crude
  • **Snapshot at a given point in time**
  • Provides the basis for assigning value to a crude when making purchasing decisions

How you define quality is likely to influence how you track quality
### Typical Assay

<table>
<thead>
<tr>
<th>CRUDE OIL</th>
<th>YIELDS AND CHARACTERISTICS OF PRODUCTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GAS</td>
</tr>
<tr>
<td></td>
<td>C1-C4</td>
</tr>
<tr>
<td>TBP Range</td>
<td>%/m/m</td>
</tr>
<tr>
<td>TBP Yield</td>
<td></td>
</tr>
<tr>
<td>Density @15°C</td>
<td>Kg/l</td>
</tr>
<tr>
<td>API Gravity @ 60°F</td>
<td>34,0</td>
</tr>
<tr>
<td>Viscosity @ 20°C</td>
<td>mm²/s</td>
</tr>
<tr>
<td>Viscosity @ 50°C</td>
<td>VBN</td>
</tr>
<tr>
<td>Sulphur</td>
<td>%/w</td>
</tr>
<tr>
<td>Mercaptan Sulphur</td>
<td>ppm</td>
</tr>
<tr>
<td>Hydrogen Sulphide</td>
<td>%/m/m</td>
</tr>
<tr>
<td>Acidity</td>
<td>mgKOH/g</td>
</tr>
<tr>
<td>Parefins</td>
<td>%/v</td>
</tr>
<tr>
<td>Naphthenes</td>
<td>%/v</td>
</tr>
<tr>
<td>Aromatics</td>
<td>%/v</td>
</tr>
<tr>
<td>N+2A</td>
<td>%/v</td>
</tr>
<tr>
<td>Smoke Pt.</td>
<td>mm</td>
</tr>
<tr>
<td>Cetane Index</td>
<td></td>
</tr>
<tr>
<td>Total Nitrogen</td>
<td>%/m/m</td>
</tr>
<tr>
<td>Basic Nitrogen</td>
<td>ppm</td>
</tr>
<tr>
<td>Nickel</td>
<td>ppm</td>
</tr>
<tr>
<td>Vanadium</td>
<td>ppm</td>
</tr>
<tr>
<td>P.Value</td>
<td></td>
</tr>
<tr>
<td>Asphaltenes in NC7</td>
<td>%/m/m</td>
</tr>
<tr>
<td>R.C.C.</td>
<td>%/m/m</td>
</tr>
<tr>
<td>Penetration @ 25°C</td>
<td>dmm</td>
</tr>
</tbody>
</table>

Full essay is expensive and time consuming
Why Monitor Quality

• Crude Quality is not constant
• Crude oil purchase easily largest refinery cost
• How well does the assay reflect the quality of what is actually purchased?

• Benefit of quality monitoring
  • For the refiner – ensure he knows what he paid for
  • Small quality variations can result in significant economic penalties or benefits
  • Can help anticipate or understand operational issues
• Seasonal variability due to changing pipeline specs
• Relatively small batch to batch variability

Data with permission from crudemonitor.ca
• Much larger random variability in solids than inherent properties
• Timing of assay sample can significantly influence perception of quality as relates to sediment content of the crude

Data with permission from crudemonitor.ca
Producer blending CRW condensate to make dilbit will find planning product blending a challenge

Data with permission from crudemonitor.ca
Refiners receiving dilbit made with CRW condensate may not like the variability in C5 content.

Data with permission from crudemonitor.ca
General Considerations

• Decisions
  • Uniform monitoring of all crudes?
  • Taylor specific tests to specific crudes?
  • Test all crudes or only specific crudes?
  • Testing frequency

• Considerations
  • Crude slate – number of crudes processed and relative importance
  • Issues related to specific crudes?
  • How much money is available for testing?
Technical considerations

• Crude source
• Where to test
• Sampling
• Analytical methods
• Contaminant Monitoring
Crude Source Considerations

• Is it a blended crude (e.g. Dilbit)?
• How much processing has been done on the crude?
• For Offshore Crudes
  • Is there associated gas production?
  • Is it from deep water?
  • Is it sourced from a single platform or from a gathering system
  • Does it go through a common carrier pipeline
• For Onshore Crudes
  • Does it come through gathering system?
  • Is it shipped to the refinery by rail or truck?
  • Does it go through a common carrier pipeline?
• If it comes through a common carrier pipeline, are seasonal pipeline specs a constraint?
Where to test?

• Options
  • At the source
  • At some common point(s) in the transportation system
  • At the refinery

• Earlier vs. later
  • Potential to adjust operating plans
  • More complicated logistics for testing
  • Effect of transportation system on quality
Sampling

• Grab sample or composite?
• Sample container?
  • Bomb or can/glass bottle?
  • Concerned about light end handling losses?
• Safety concerns (i.e. H₂S exposure)?
Analytical Methods

• Are methods that fit the budget going to provide meaningful results?
  • Salt by conductivity vs. extraction?
• Are analytical methods available to measure what I want at the levels likely found in my crude (e.g. H2S scavengers)?
Contaminant Monitoring

• Proactive vs. Reactive?
• How to keep it sustainable?
  • Reactive monitoring in refinery process where symptoms most easily observed
  • Source identification studies
  • Establish monitoring plan based on source studies
• Limits of analytical methods
What to monitor?

• Basic Monitoring – Does it resemble what I thought I bought?
  • API gravity, Sulfur, TAN, Distillation

• Critical refinery constraints
  • Specific yields (e.g. light ends or resid)
  • Unit feed quality constraints (e.g. gas oil TAN or Kero smoke point)
  • Operational related issues (e.g. solids & other contaminants)

• What are you looking for?
  • Average properties
  • Variability
  • Sudden shifts in properties
  • Long term drift
Conclusions

• Prudent refiners will closely monitor their feedstock quality to make sure they know what they are buying
  • Caveat Emptor

• One size fits all crude quality monitoring systems do not exist

• Multiple variables will dictate the nature of the monitoring program as well as the specific testing
  • Crudes being processed
  • Budget
  • Refinery constraints

• Data is of little value if not used – defined responsibilities and communication are critical