Crude Oil Quality Management

• From the Reservoir to the Refinery

Presented at Crude Oil Quality Conference

Waynn Morgan and Mark Williams

November 7, 2013
Agenda

• Definition of quality and quality management
• Challenges
  – Reservoir & Upstream quality management
  – Midstream quality management
  – Refinery quality management
• Case histories
• Summary
Definition of Quality

• A perceptual, conditional and somewhat subjective attribute

• Understood differently across the crude oil supply chain
Quality Measurements

**Specification Quality**
How does the crude from one supplier compare to the crude of another supplier; does the crude meet the requirements for the refining process?

**Conformance quality**
Was the crude oil managed properly throughout the crude oil supply chain, with an understanding of the downstream implications of each upstream action?

**Supply Quality**
Is the supply of the crude oil from a sustainable, reliable supply?

**Economic Quality**
Are the operations and product providing a reasonable and maximum return on investment?
Quality Concerns

• Who pays the price / cost of quality?

• What standards have to be met?

• How can these standards be met and profitability be maintained or increased? (Economic quality / quality of earnings)

• What requirements need to be put into place?

• How to make the problem go away?
Challenges in the Reservoir

- Organic Damage
  - Paraffin
  - Asphaltenes

- Inorganic Damage
  - Calcium Carbonate
  - Iron Sulfide

- Other Damage
  - Emulsion
  - Acid Sludge
  - Oil-wet Solids
  - Water Blockage
Typical treating requirements to achieve saleable oil and “clean” water:

• **Oil**
  – Retention time
  – Specialty chemicals
  – Heat to accelerate treatment
  – Adequate mixing
  – Diluent for viscosity, salt, and TAN reduction
  – Off-spec processing

• **Water**
  – Retention time
  – Specialty chemicals
  – Heat to accelerate treatment
  – Adequate mixing
  – Multiple chemical types to facilitate separation
  – Solids handling capabilities
  – Sophisticated equipment to achieve high purity
  – Disposal/source issues
Challenges in Heavy Oil Quality Management

- Emulsions
- High solids
  - 500-700 ptb
  - Organic >> Inorganic
- Crude compatibility > asphaltene instability
  - During blending for viscosity reduction
  - During blending to dilute down contaminate levels, i.e. TAN
  - Heat exchanger fouling
- Metals
- Production methods
Challenges in Shale Oil Quality Management

- **Paraffin**
  - Deposition
  - Emulsion
  - Compatibility

- **H2S**

- **Solids**
  - 100-200 ptb
  - Well workovers, flowbacks, reprocessing

- Composition variability

- “Low-cost”/inexperienced producers
Crude Oil Quality Management
Midstream Challenges
Challenges of Midstream Quality Management

• Insuring the product transported meets the safe handling requirements without creating operational or reliability issues such as corrosion, flow restrictions or discharge limitations
Midstream Transport Challenges

- HS&E and Regulatory
- Equipment integrity and reliability
- Minimize transit times to maximize throughput
- Keep the reservoirs product moving to the refining supply
Transport Challenges – Quality of Earnings

• Focus on quality of earnings
• Impacted by:
  – Trucking – drive and demurrage times
  – Pipelines – barrels per hour / throughput
  – Railcar – turnaround time
  – Marine transport – demurrage
Crude Oil Transport – Quick Fix

• Not “Best in Class”
• Focused on “Make this problem go away!”
• Disadvantages
  – Treatment above stoichiometry to meet disport specification quality
  – Limitations on treatment options to meet the specifications
Midstream Quick Fixes or Emergencies

Typical response issues

- Pour point
- $H_2S$
- Water
- Bacteria
- Corrosion
- Odor control
- Flow improvement
- Pigging
Crude Oil Transport – Long Term Solutions
Refinery Processing Crude Oil Quality Challenges

• Obtain a sustainable feedstock

• Reduce the total cost of operation
  – Conformance
  – Economic quality model
  – Specification

• No “surprises”

• Establishing integrated quality management program with standards of operation
Case Study - 1
Supply Chain Quality Management – Paraffin Issue

• An upstream producer was having issues meeting BS&W specifications

• Cause: Paraffin accumulation
  – Decreased residence time
  – Incomplete emulsion resolution
  – Off specification oil (BS&W)

• Remedy: Eliminate paraffin bottom
  – Increase the residence time
  – Apply heat
  – Allow time for emulsion to resolve > BS&W spec met
Case Study - 1
Supply Chain Quality Management – Paraffin Issue

- Solution for upstream operation
  - Employ hot oil operation to fluidize the paraffin and blend in with other crude, for transport out of facility to midstream pipeline or storage facility.
Case Study - 1
Further Downstream Implications – Paraffin Issues

• The associated pipeline experienced an increased need for additional pigging

• The midstream storage facility saw an increase in the need to deal with tank bottoms
Case Study - 1
Further Downstream Implications – Paraffin Issues

• Marine ROB (remains on board) increase

• Rail ROB increase

• Corrosion of downstream vessels due to under-deposit corrosion

• Crude unit fouling issues in the refinery
Case Study - 1
Total Supply Chain Quality Management – The Solution

• Communications and understanding required of the entire supply chain

• Reduce the paraffin issue at the crude oil gathering facility with the use of chemical treatment

• Supplemental chemical treatment as needed throughout the supply chain

• Segregation of any additional settled paraffin from supply chain distribution channel and moved to location that can handle the paraffin without negative impact
Case Study - 2
Hydrogen sulfide and odor management

• Upstream operations had a requirement to meet 10 ppm H₂S in vapor space for deliveries to rail terminal

• Hydrogen sulfide specification quality met and railcars loaded

• Crude oil also emitted a foul odor
Case Study - 2
Hydrogen sulfide and odor management

- Crude arrived at disport with high H2S and had to be retreated
- Odor issues prevailed
- Root cause for changes was sulfate reducing bacteria in crude oil. Long term operation can result in railcar corrosion issues.
Case Study - 2
Implementing Corrective Actions – Option 1

• Utilize biocide for crude oil movements
  – Advantages
    • reduce risk of \( \text{H}_2\text{S} \) evolution during transport
  – Disadvantages
    • Can impact waste water from storage tanks and refinery that will result in a “bug kill” for the waste treatment plant; increase total cost of operation

• This process ignores the operation and mechanical options that may be viable
Case Study - 2
Long Term Solution for Terminal Operation – Option 2

• Use Total Systems Approach implementing chemical, mechanical and operational actions to solve problem

• Addresses the issues without further downstream implications
Total Systems Approach Solution

• Review and communicate quality issues throughout the supply chain through forums like COQA
• Form and get involved with teams that have the experience in all aspects of the supply chain operation to address the “Best in Class” solutions across the entire supply chain
• Standardize specifications
• Review the processes and determine areas of improvement
Summary

• There are four primary quality measurements.
  – Conformance, specification, supply and economic

• Although they may be defined a bit differently throughout the supply chain, they all focus on improving the quality of earnings, or economic quality

• Each segment of the supply chain has to maintain their own economic quality, which will drive the way that business is conducted.

• Cheap is not necessarily better for the downstream supply chain, but who really pays the cost of quality?
Crude Oil Quality Management

• From the Reservoir to the Refinery

Presented at Crude Oil Quality Conference

QUESTION & ANSWERS