Addressing the Challenges Associated with Canadian Crudes

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Crude Oil Quality Association
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Outline

• Why bother?
• What is different about these crudes?
• Program strategies employed by Baker Petrolite
• Case histories
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## Oil Import to the U.S.

### Total Imports of Petroleum (Top 15 Countries)
(Thousand Barrels per Day)

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**Note:** The data in the tables above exclude oil imports into the U.S. territories.

**Source:** U.S. Energy Information Administration
All Proposed WCSB Pipeline Projects

Source: Canadian Association of Petroleum Producers, June 2009 Crude Oil Report
Projected Growth in WCSB Supply

Bitumen blend forecasted to increase to 2.4 MM BPD by 2025

Source: Canadian Association of Petroleum Producers, June 2009 Crude Oil Report
Wide Variety of Crudes Available

- Traditional production
- Thermal, other in-situ production methods
- Mining operations
- Output from upgraders
  - Hydrotreated premium products
  - Various other blends
- Bitumen blends
  - Dil Bits
  - Syn Bits
  - Syn Dil Bits
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Crude Quality

• Wide variability
  – Solids
  – Asphaltenes
  – Non-extractable salts
  – Amines - \( \text{H}_2\text{S} \) scavengers
  – TAN

• Process challenges
  – Wide stable emulsion
  – Poorer dehydration
    • Poor desalting
  – Higher oil in the effluent
  – Potential increase in overhead corrosion
  – Higher risk for high temperature corrosion
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Desalting: Tools used for Program Optimization

• Review of operational variables impacting performance
  – Tank farm practice
  – Slop addition practice
  – Wash water
  – Mixing energy
  – Mud wash practices

• Evaluation of feedstock
  – EDDA screening
  – Asphaltene stability study using ASIT™ technology
Crude Oil Management

- Crude oil tank farm pre-treatment
  - Does not require water draw in tank
  - Improves solids control
  - Stabilizes asphaltenes
  - Reduces oil under carry

- Proper slop handling
  - Segregation
  - Injection practice
  - Treatment
    - Dehydration
    - Solids removal
Wash Water

- Injection rates
  - 6 to 9% for improved dehydration and solids removal
- Wash water pH
  - 5 to 8 acceptable

Naphthenic acids impact on oil/water emulsion stability at various pH.
Mixing Energy

• Wide range of mixing energy is used
• Determining best setting is key
  – Dehydration and salt removal
  – Solids removal
Mud Wash Practices

• Solids can rapidly build in desalter vessel
• Mud can harden with time
• Best to use recycled effluent water
  – Need mud wash pump
  – Don’t starve wash water
• Desired frequency is at least daily
  – Western Canadian experience
    • 15 minutes per shift
    • Continuous
Feedstock Evaluation

• Pre-screen blends, individual crudes
  – Bench top “EDDA” screenings for emulsion resolution speed, efficiency
    • Oil soluble emulsion breakers
      – Includes Baker Petrolite’s new XERIC™ Heavy Oil Demulsifiers
    • Solids wetting agents
    • Water soluble polymers, when required
ASIT Test Indicates Asphaltene Instability

• Some WCSB crudes and blends can contain unstable asphaltenes
  – High asphaltene bitumens
  – Paraffinic materials used to dilute bitumens

• Several potential problems
  – Precipitation in tankage
  – Desalter upsets
  – Fouling
  – Foaming

• Can be used to identify unstable blends
• Also used to screen most effective asphaltene stabilizing chemicals
ASIT Test Results

Additives can increase the stability of an oil

Unstable < 130  Moderately Stable 130-200  Stable >200
Corrosion: Crude Tower and Overhead System

- WCSB crudes can increase tower and overhead system corrosion potential in two key ways:
  - Non-desaltable chlorides in WCSB blends
    - Higher chloride loadings in the tower and overhead system
  - Low boiling organic acids from thermal degradation of high TAN crudes
    - Higher organic acid loadings in the tower and overhead system
    - Naphthenic acids also increase hydrolysis of inorganic chloride salts in the desalted crude
  - Both mechanisms increase neutralizing agent demand
  - Both mechanisms increase the risk of neutralizer-hydrochloride salt fouling and under-deposit corrosion
Corrosion: Tools Employed for Troubleshooting and Optimization
TOPGUARD Overhead Corrosion Control

• Review of Operational Data
  – Correlate effect of operational and crude slate changes
    • Non desaltable chlorides

• Review of Traditional Monitoring Methods
  – Identify variations in corrosion rates via coupons and probes

• Analytical Techniques
  – Compositional sample analyses to identify corrodents present
  – Metallurgy analyses of coupons to identify mechanism of attack

• Ionic Modeling Calculations
  – Ammonium and amine chloride salt formation risk
  – pH profile
  – Water wash requirements
Ionic Model Thermodynamic Simulations

- **Acid corrosion**
  - Dictated by pH
  - Most severe at dew point
  - Rigorous electrolyte simulation to determine pH profile

- **Under-salt corrosion**
  - Dictated by salt deposition
  - Salts are acidic, absorb water
  - Thermodynamic data for organic amine-HCl salts
High Temperature Naphthenic Acid Corrosion

- Can be a concern with bitumen blends
- Impact depends on characteristics of overall crude slate processed
- Several mitigation options have been used successfully with WCSB feedstocks:
  - Blending
  - Metallurgy
  - Chemical inhibitors
Use Conventional Approaches to NAC Control

• Assessment
  – Process equipment evaluation
  – Feedstock/process stream characterization

• Mitigation
  – Crude blending to TAN limit
  – Metallurgy upgrade
  – Chemical inhibition

• Surveillance/Monitoring
  – Design effective monitoring protocols
  – Use data to optimize corrosion management program
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WSCB Case History 1

- Refinery’s ability to process heavy Canadian crude limited
  - Poor dehydration
  - Poor brine quality
- Tested crude blend samples to select best chemical treatment program
  - Asphaltene stabilizer
  - Oil-soluble emulsion-breaking chemical
  - Solids wetting agent in wash water
Case History 1 Program Results

• More than doubled the amount of heavy Canadian crude being processed
  – 7.5 KBPD to 17.5 KBPD

• Maintained salt removal efficiency

• Dehydration performance maintained
Case History 1 Program Results

Salt Removal Efficiency

- Trial #1 WCSB up to 15 KBD
- Trial #2 WCSB up to 17.5 KBD
- Improper tank switch
Case History 1 Program Results Cont.

Second Stage Desalter A BS&W Out

Maintained Performance

Trial #1 WCSB up to 15 KBD
Trial #2 WCSB up to 17.5 KBD

1st Set BS&W Out
Second Stage Desalter B BS&W Out

Maintained Performance

Trial #1 WCSB up to 15 KBD
Trial #2 WCSB up to 17.5 KBD

2nd Set BS&W Out
WCSB Case History 2

• Refinery upgraded desalter for heavy Canadian crudes
  – Poor desalter effluent water quality
  – Low dissolved oxygen in WWTP
• Pre-screened crude blend samples to select chemical treatment program
  – Oil soluble emulsion-breaking chemical
  – Solids wetting agent in wash water
  – Polymer when needed
• Desalter operating variables optimized in the field
Program Results: D.O. in WWTP

Waste Water Treatment Plant Dissolved Oxygen

**Before Baker Petrolite**
- dissolved O2
- Competitive average
- Baker Petrolite Average

**After Baker Petrolite**
- dissolved O2
- Competitive average
- Baker Petrolite Average

Dissolved Oxygen, ppm

Daily
WCSB Case History 2 Program Results

• Can run 250 PTB solids in crude charge
  – Salt removal and dehydration maintained
• Filterable solids removal remained at 80%
• WWTP operation improved
  – COD reduced
  – DO increased
  – No longer affected by oily brine
• Overall chemical usage dropped nearly 50%
WCSB Case History 3
Crude Oil Pretreatment Program

• Desalter upsets when processing heavy oil sands crude oil
  – Up to 3,000 ppm oil in desalter effluent water
  – Caused problems in WWTP

• Implemented crude oil pretreatment program
  – With pretreatment, effluent water oil content decreased to an average of 140 ppm
  – Improved WWTP operation
  – Odor emissions reduced
  – Filterable solids removal efficiency increased from 27% to 42%
WCSB Case History 3 - Program Results

Desalter Effluent Water - Before Pretreatment Program

Desalter Effluent Water - After Pretreatment Program
WCSB Case History 4
Asphaltene Stabilizer

• Desalter problems
  – High current draw
  – Water carryover
  – Solids, oil in desalter effluent water
  – WWTP overloaded

• Root cause analysis
  – Asphaltene destabilization
  – Sour Canadian crude, high in asphaltenes
WCSB Case History 4
Chemical Treatment Recommendations

• Continuous crude oil pretreatment using surfactants
• Used asphaltene stabilizer for heavy sour crude shipments
• Continued emulsion breaking chemical use on crude unit, but at reduced rate (~50% reduction)
WCSB Case History 4
Program Results and Benefits

- Allowed more aggressive crude blending
- Significant reduction in oil under-carry
- WWTP no longer burdened with oily effluent water
- Increased unit throughput
- Significant return on incremental chemical treatment program investment
Rising to Canadian Crudes Challenges

• Many realized benefits for improving your Canadian crude processing capabilities
  – Reduced feedstock costs
  – Increased feedstock flexibility
  – Increased unit throughput
  – Improved refinery profitability

• These benefits are being achieved while minimizing operating risk
  – Maintain unit integrity and reliability
  – Ensure product quality
  – Ensure environmental compliance