Addressing the Challenges Associated with Canadian Crudes

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Crude Oil Quality Association

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New Orleans

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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)

Country	9-Nov	9-Oct	YTD 2009	8-Nov	YTD 2008
CANADA	2,527	2,363	2,447	2,534	2,482
MEXICO	1,083	1,136	1,237	1,406	1,308
VENEZUELA	890	955	1,099	1,236	1,191
SAUDI ARABIA	848	943	1,023	1,514	1,535
NIGERIA	980	869	783	827	993
IRAQ	458	499	461	476	636
ALGERIA	400	491	483	677	554
ANGOLA	431	450	477	450	509
RUSSIA	425	385	570	445	473
COLOMBIA	237	292	282	176	201
UNITED KINGDOM	190	278	249	245	242
VIRGIN ISLANDS	205	215	275	338	323
ECUADOR	155	180	187	229	217
BRAZIL	268	174	319	286	261
AZERBAIJAN	74	134	69	71	74

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

Source: U.S. Energy Information Administration

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All Proposed WCSB Pipeline Projects

Source: Canadian Association of Petroleum Producers, June 2009 Crude Oil Report

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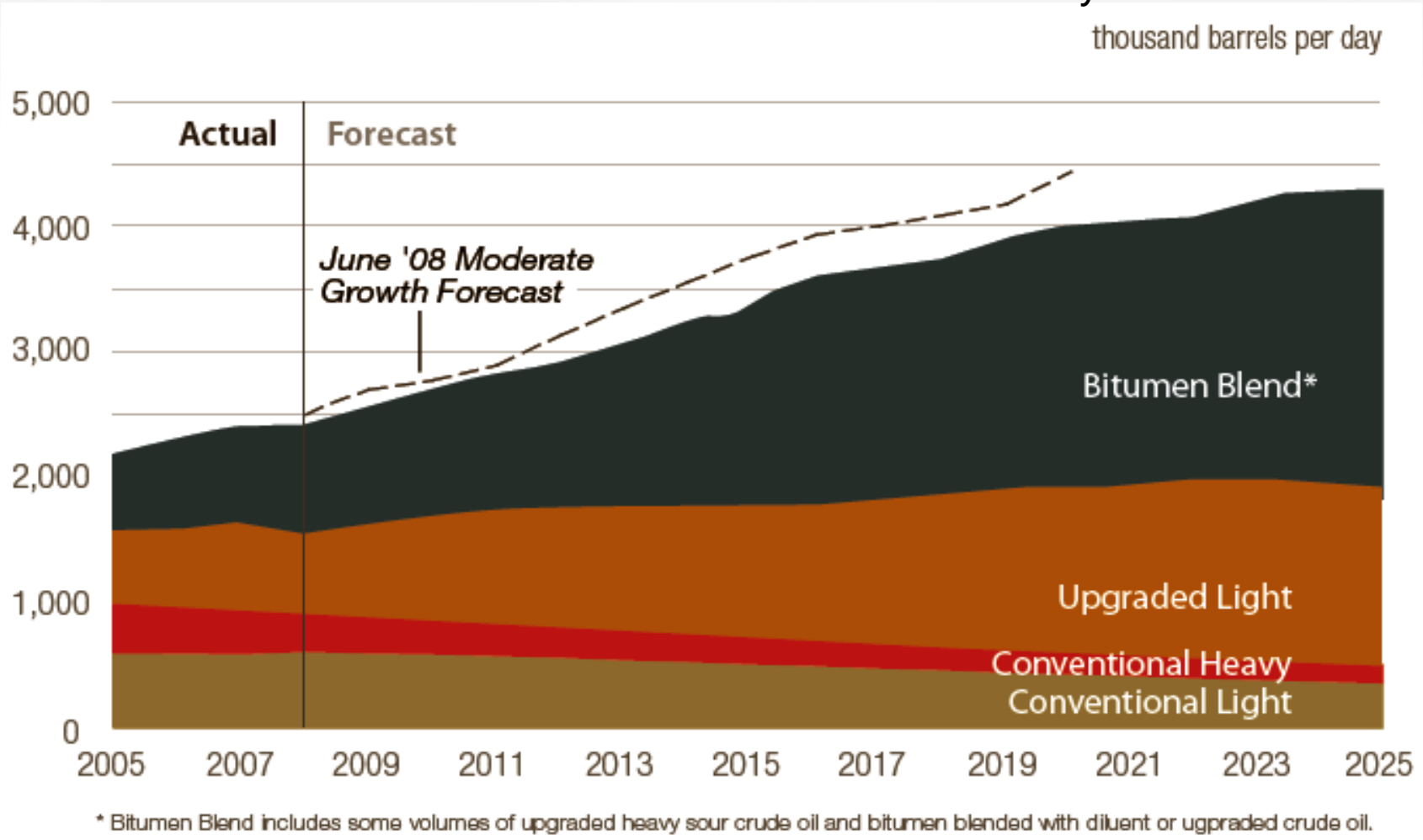
Projected Growth in WCSB Supply

Bitumen blend forecasted to increase to 2.4 MM BPD by 2025



Source: Canadian Association of Petroleum Producers, June 2009 Crude Oil Report

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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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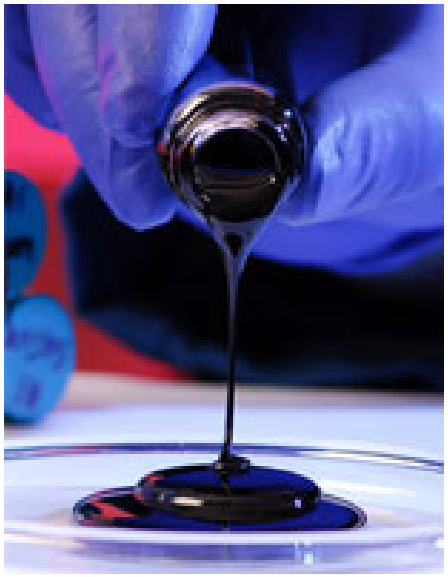
Crude Quality

- Wide variability
  - Solids
  - Asphaltenes
  - Non-extractable salts
  - Amines – H_2S 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

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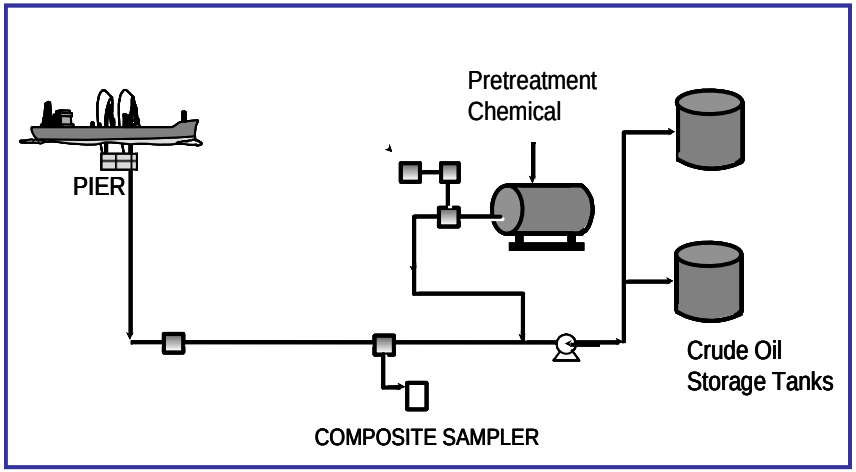
Crude Oil Management

- 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



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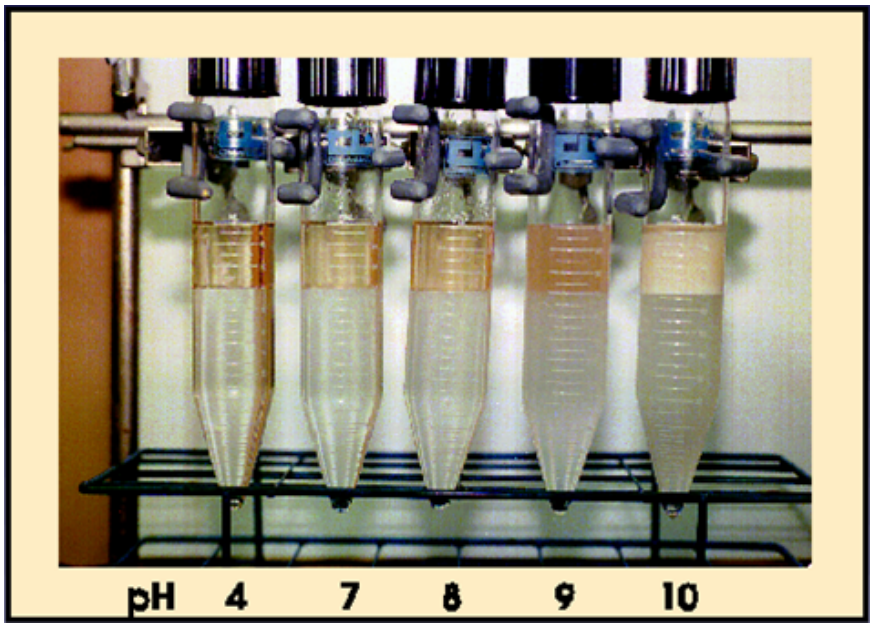
Wash Water

- 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.

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Mixing Energy

- Wide range of mixing energy is used
- Determining best setting is key
  - Dehydration and salt removal
  - Solids removal

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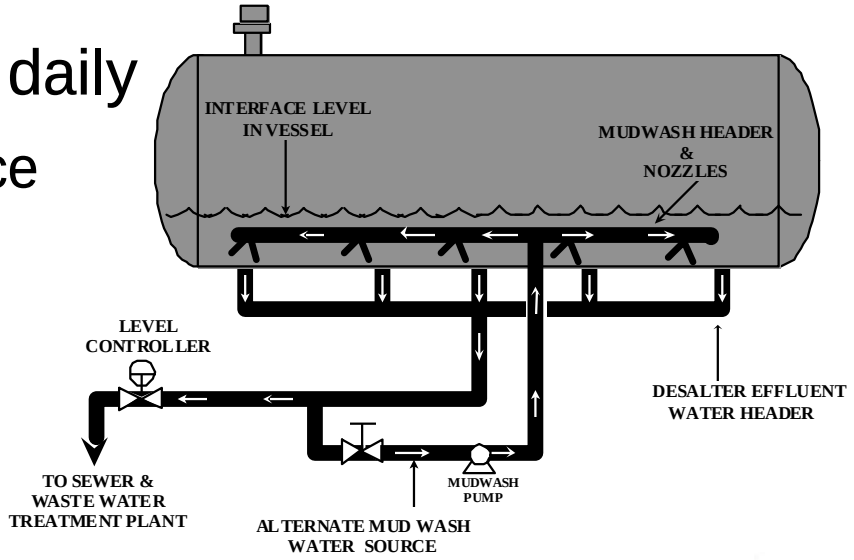
Mud Wash Practices

- 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

Design of a Typical Desalter Mudwash System



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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

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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

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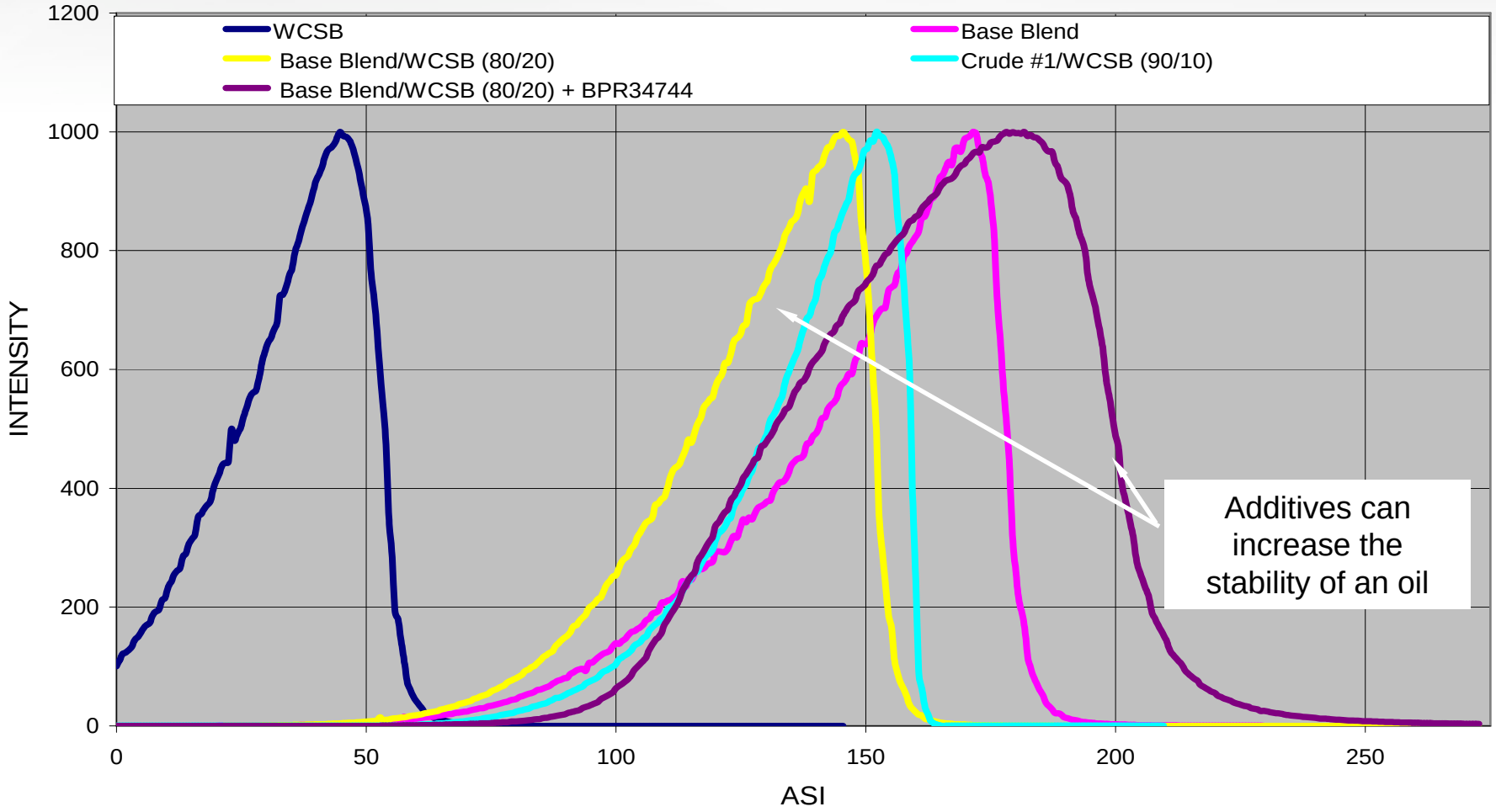
ASIT Test Results



Unstable < 130 Moderately Stable 130-200 Stable >200

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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

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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

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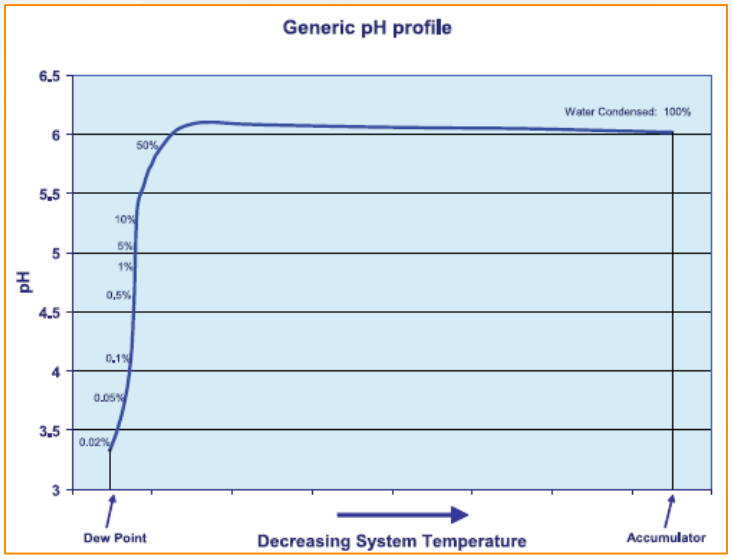
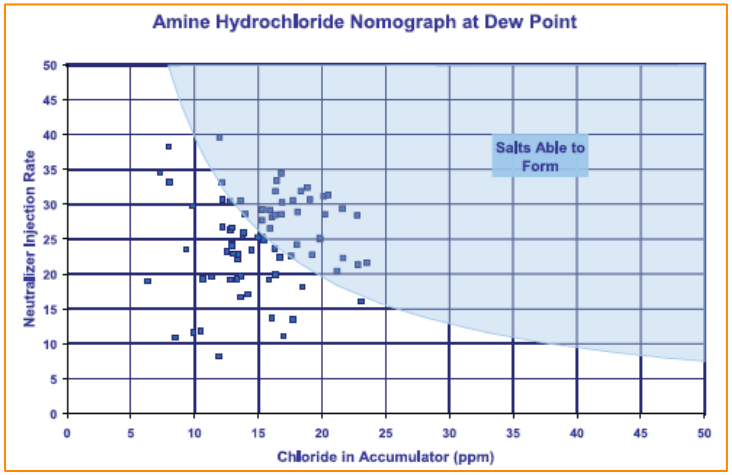
Ionic Model Thermodynamic Simulations





- 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

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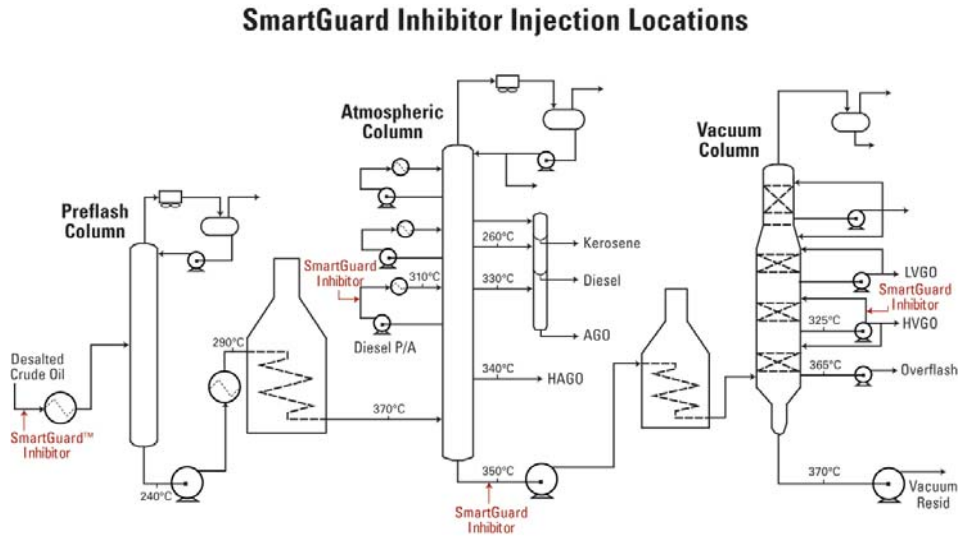
High Temperature Naphthenic Acid Corrosion

- 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



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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

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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

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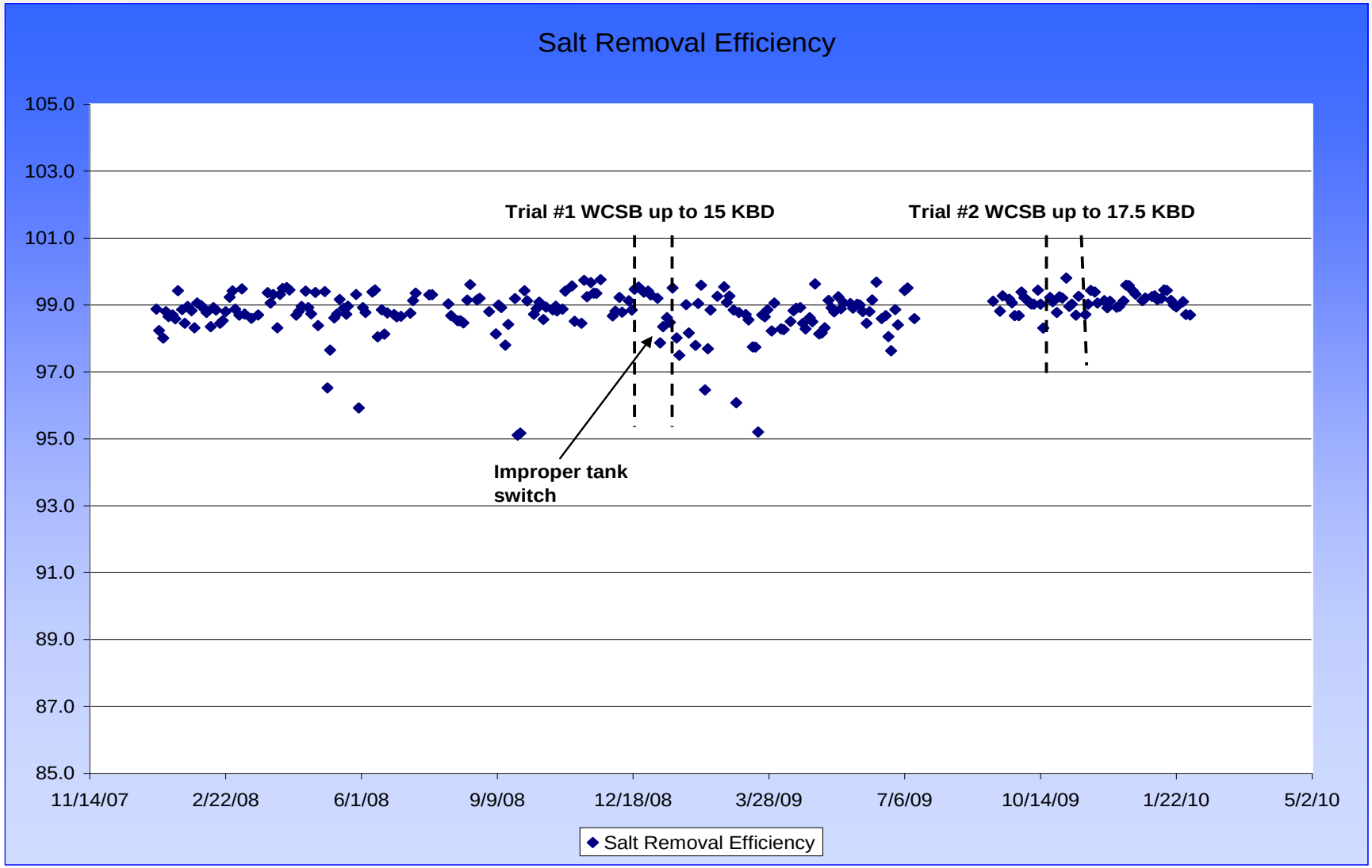
Case History 1 Program Results



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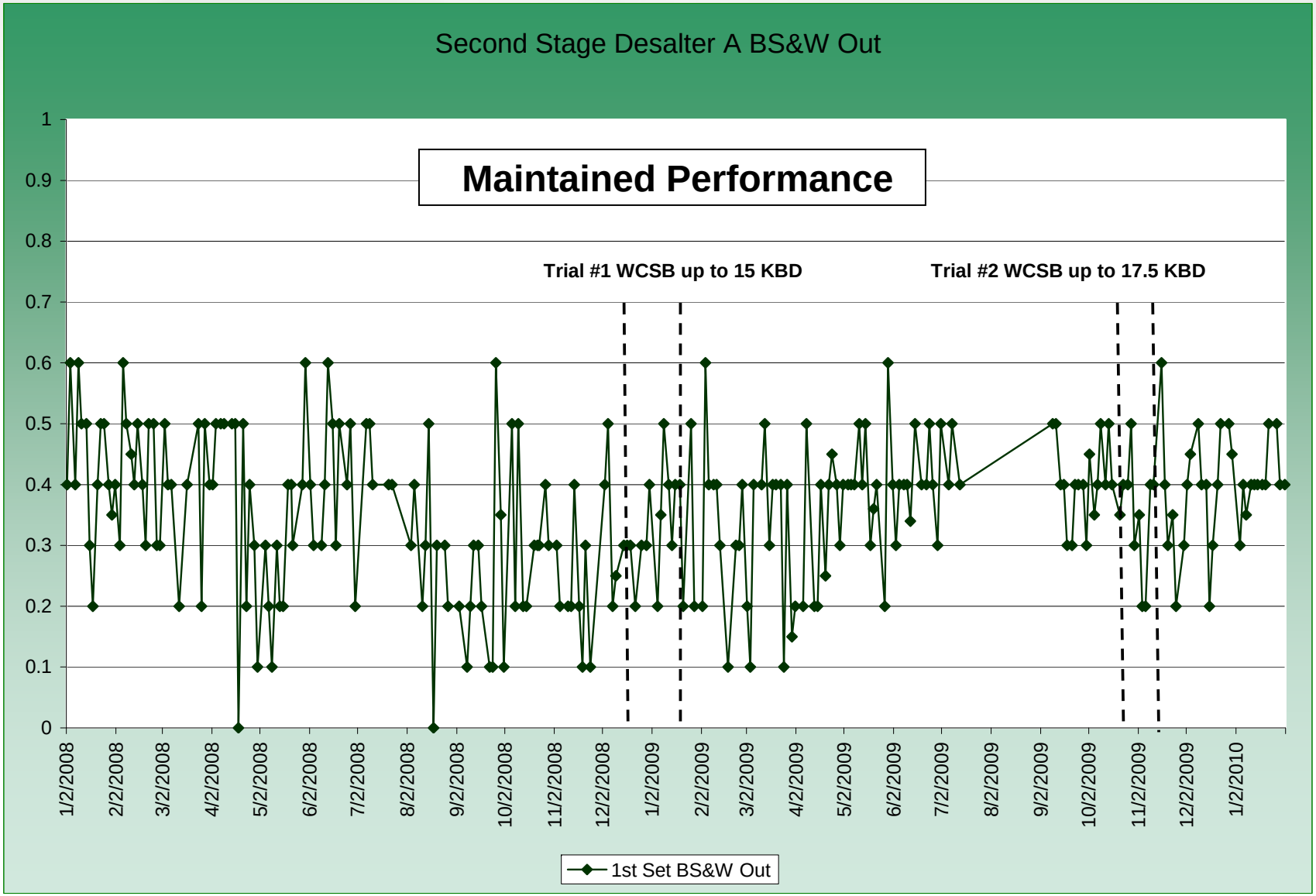
Case History 1 Program Results Cont.



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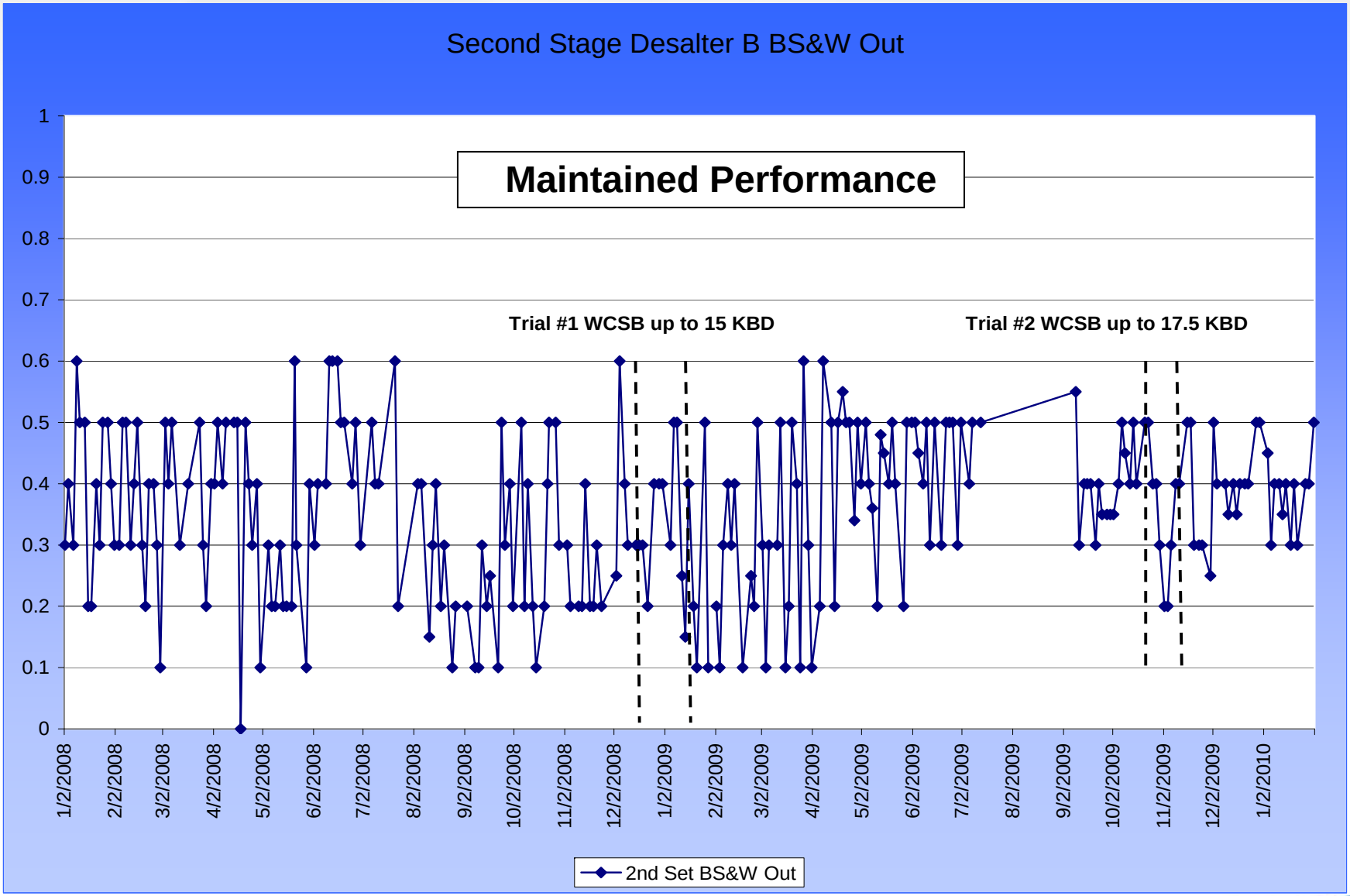
Case History 1 Program Results Cont.



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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

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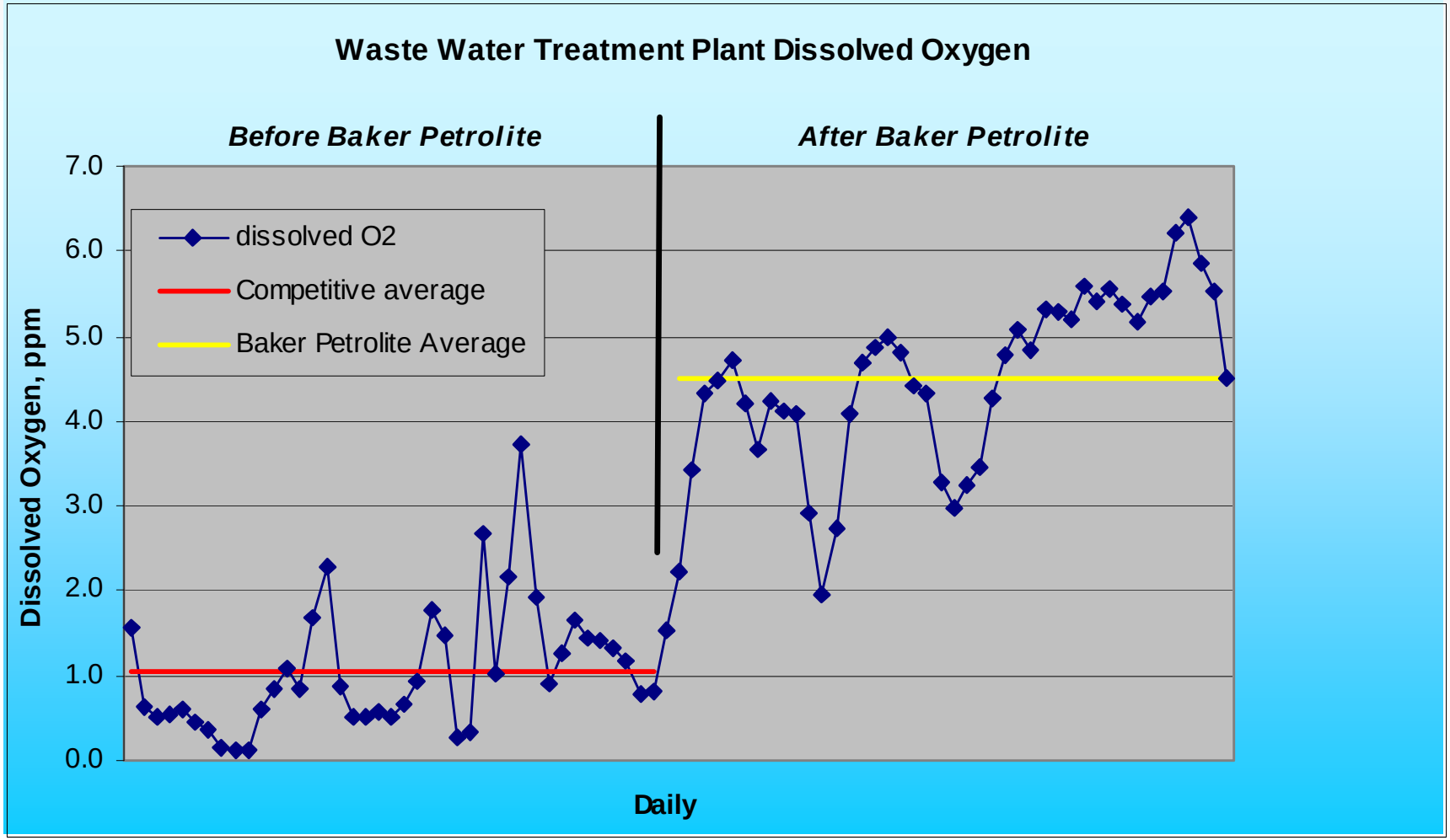
Program Results: D.O. in WWTP



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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%

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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%

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WCSB Case History 3 – Program Results

Desalter Effluent Water
- Before Pretreatment Program

Desalter Effluent Water
- After Pretreatment Program

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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

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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)

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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

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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

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