Troubleshooting FCC Units Processing Light Tight Oils And Unconventional Canadian Crudes

REFCOMM GALVESTON
April 30-May 2, 2014
CatCracking.com

NALCO Champion
An Ecolab Company

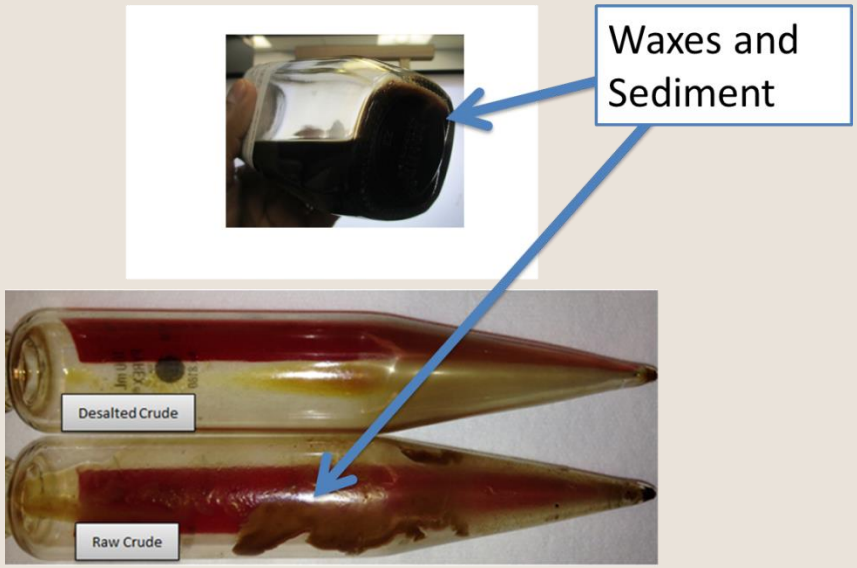
Agenda

- LTO & Canadian Crude Oil Quality
- Problem Areas & Solutions
  - Main Fractionator
  - Riser / Reactor
  - Catalyst Losses

FCC Feed Quality

Light Tight Oil

- Very paraffinic
- High solids content
- Extreme variability in quality
- Fe & V concerns
- Nitrogen (Bakken)
- Low in carbon residue
- Low gas oil and residual oil content

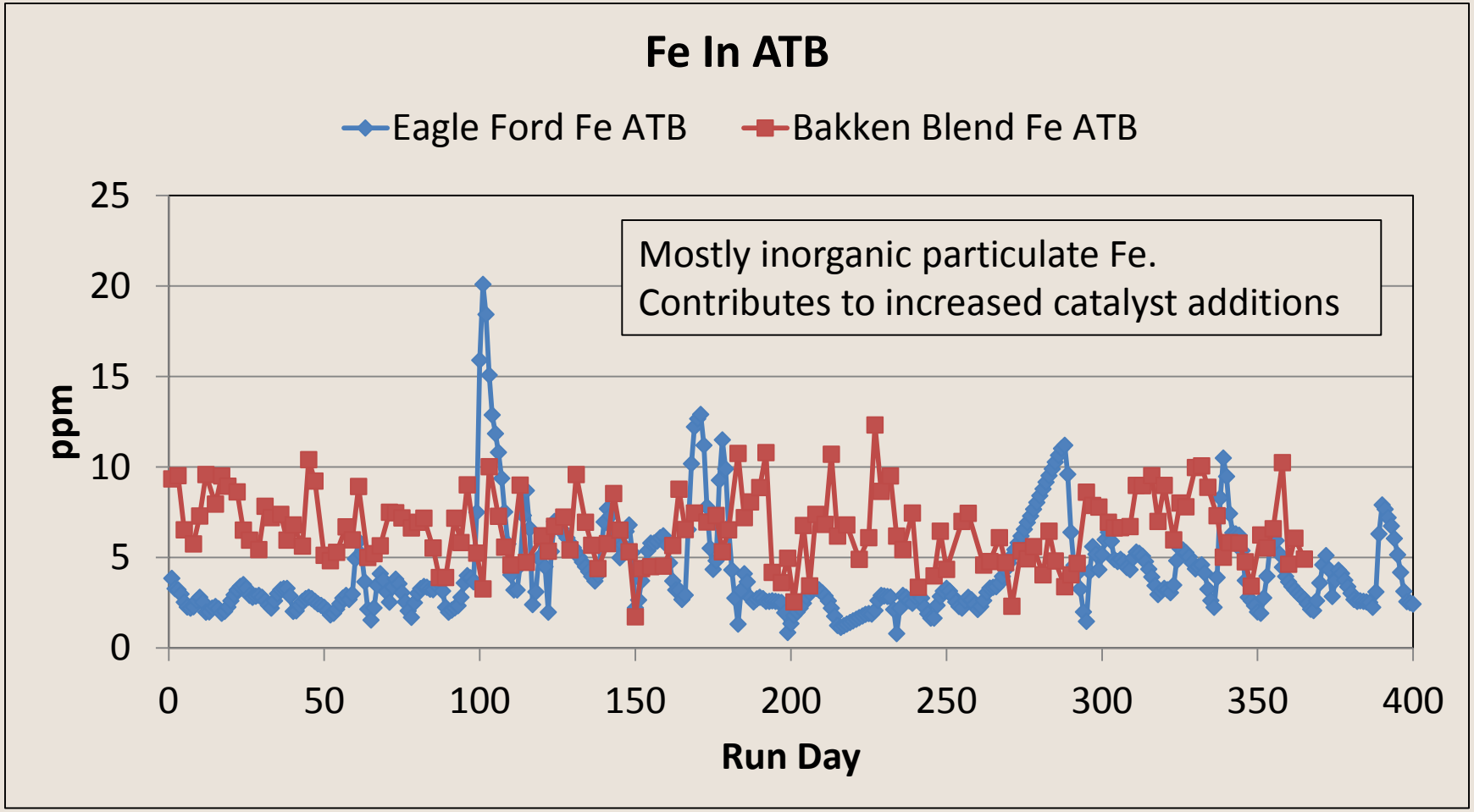


FCC Feed Quality

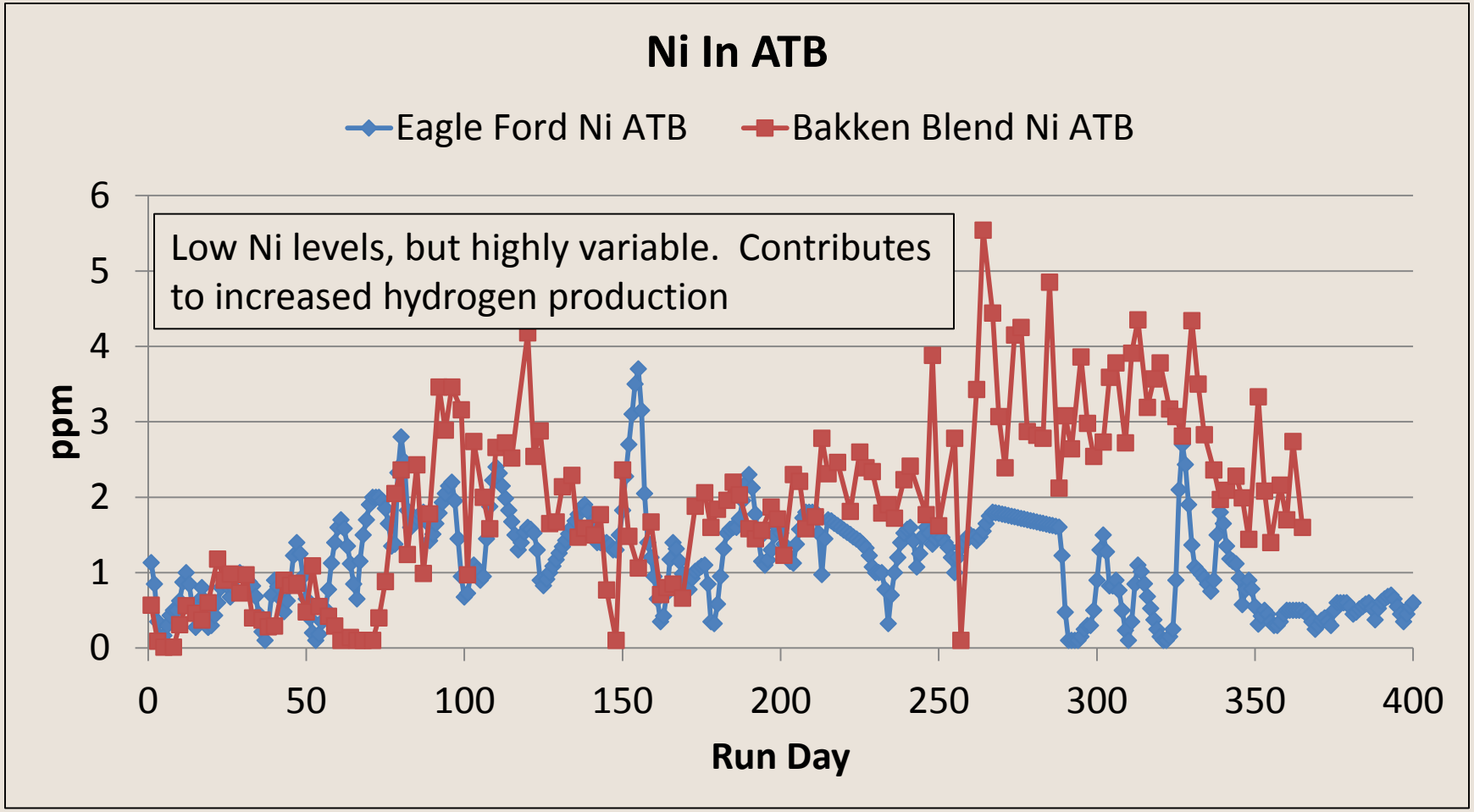
Light Tight Oil

- Very paraffinic
- High solids content
- Extreme variability in quality
- Fe & V concerns
- Nitrogen (Bakken)
- Low in carbon residue
- Low gas oil and residual oil content

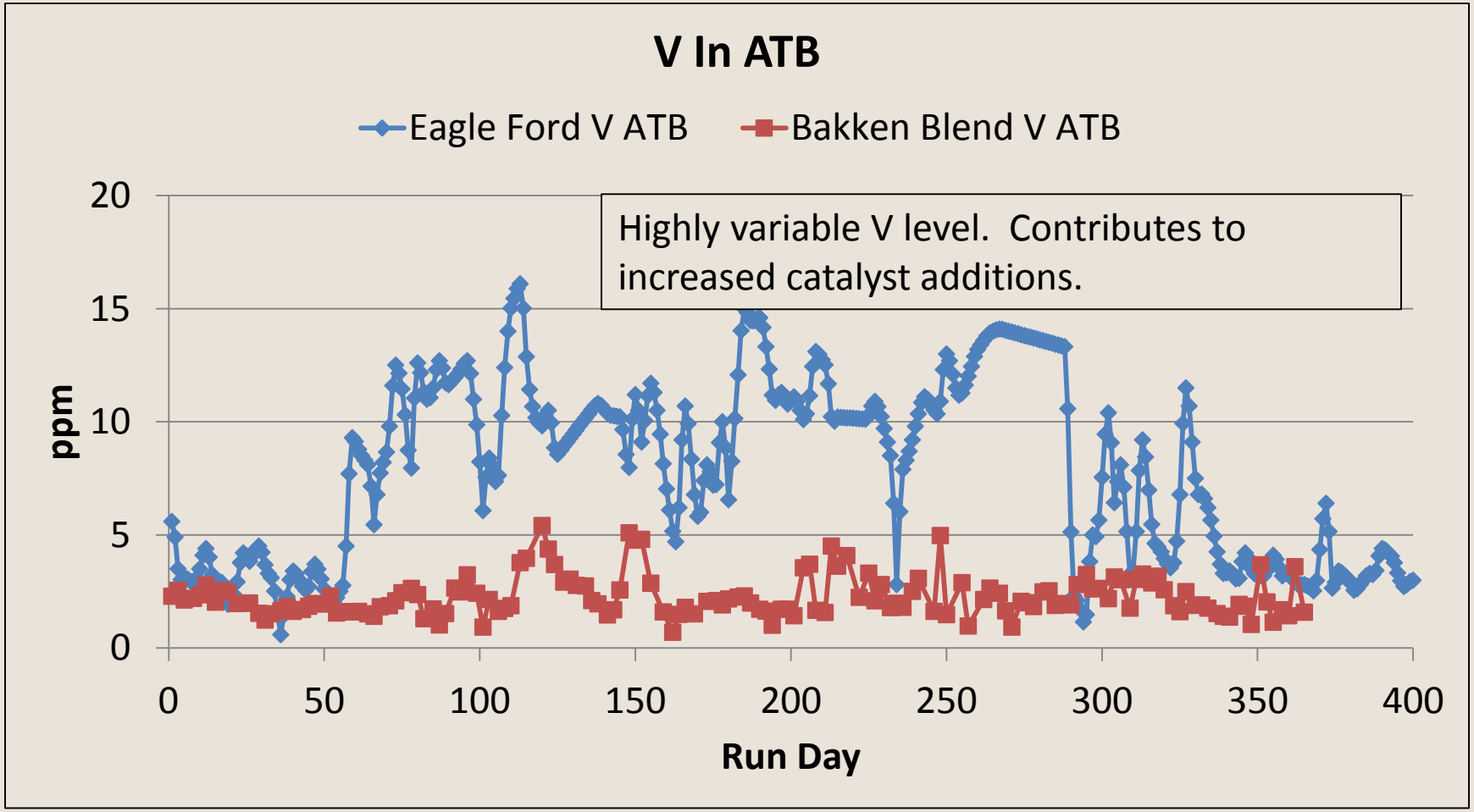
FCC Feed Contaminants in LTO



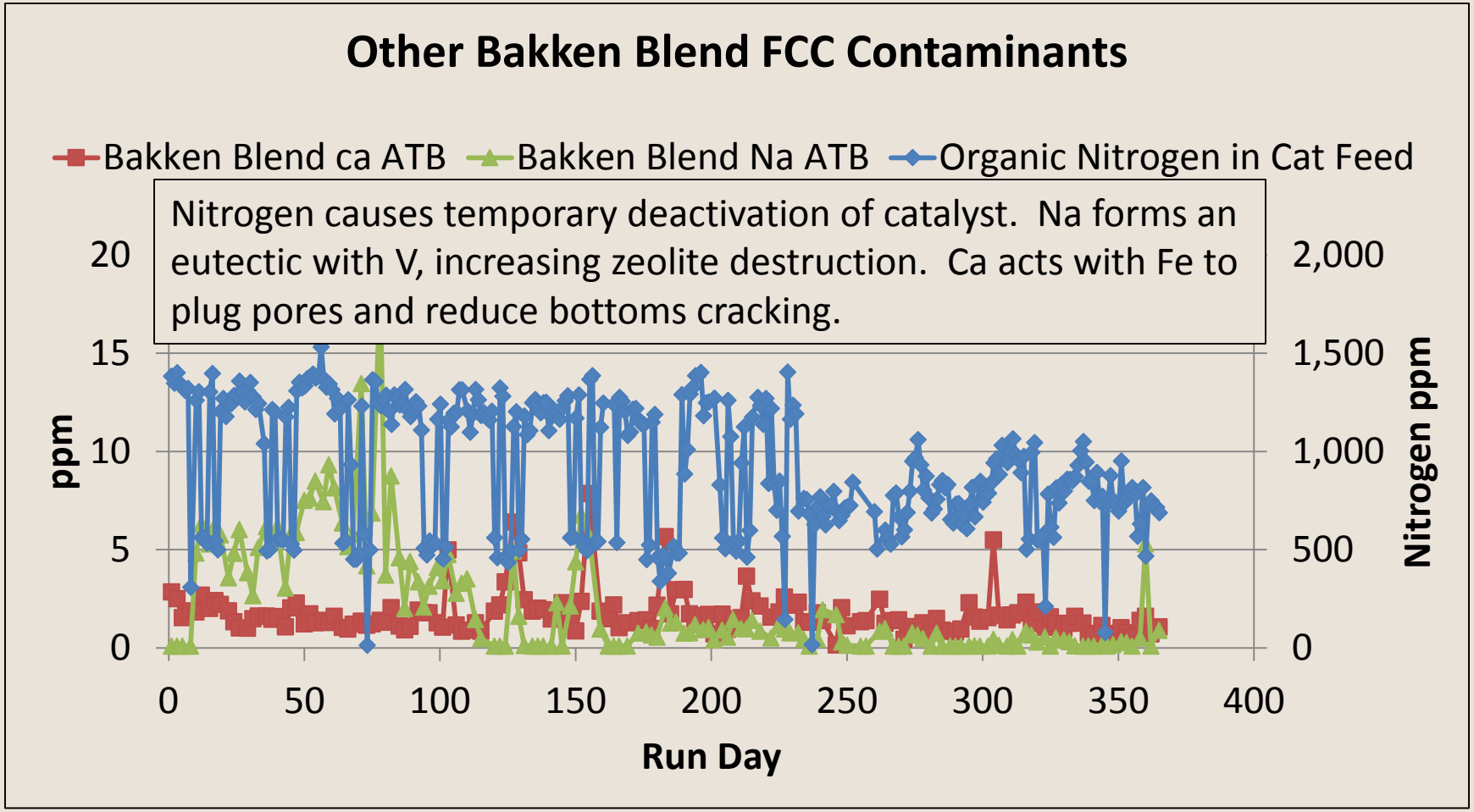
FCC Feed Contaminants in LTO



FCC Feed Contaminants in LTO



FCC Feed Contaminants in LTO

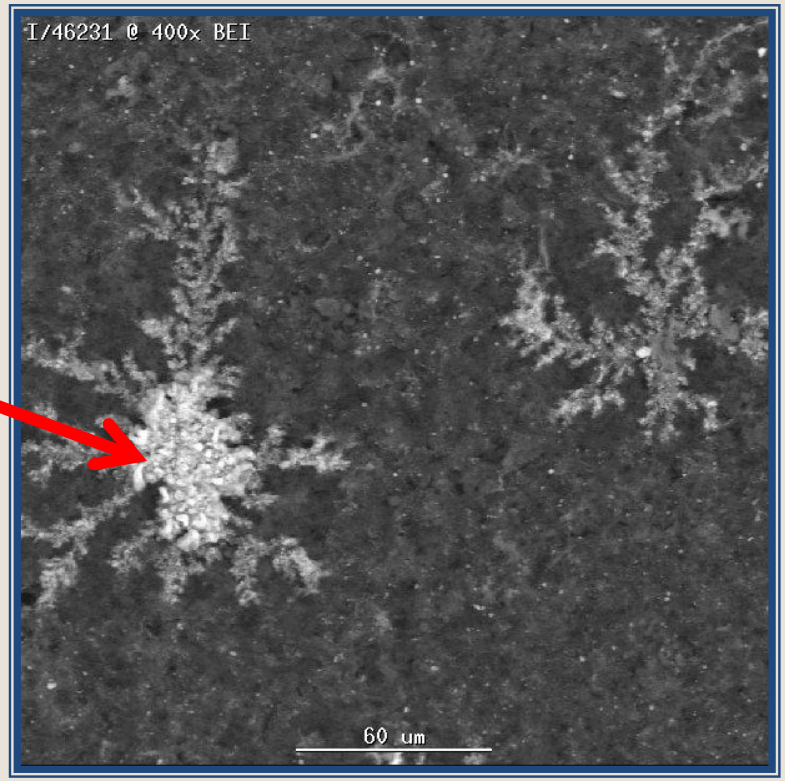


FCC Feed Quality

Heavy Canadian Crude

- Quality depends on source
- High inorganic solids content
- High Ni & V
- Nitrogen
- High carbon residue

Alberta SAGD



BEI 400x

Canadian Crude Quality Depends On Source

	Conventional	Unconventional	Heavy Sour Synbit	Heavy Low Resid	Syncrude	Heavy Sour Dilsynbit
Gravity (^{o} API)	18 - 21	19.9 - 22.5	18 - 19	18 - 19	30 - 35	18 - 20
Sulfur (wt%)	3.1 - 4.8	3.4 - 4	3.1 - 3.2	3.1 - 3.2	0.1 - 0.2	2.5 - 3
Carbon Residue (wt%)	8.72 - 10.55	9.9 - 13.8	8 - 9	< 1	< 1	10 - 15
Ni (mg/L)	47 - 61	57 - 76	55 - 60	4	< 1	50 - 60
V (mg/L)	110 - 166	134 - 194	150 - 160	8	< 1	100 - 120
Nitrogen	2,400 - 3,400	3,500 - 4,500	3,000 - 3,500		500 - 600	1,200 - 1,500

FCC Feed Quality

LTO

- Metals (Fe, V)
- Nitrogen (Bakken)
- Low Carbon Residue

Canadian Crude

- Metals (Ni, V)
- Nitrogen
- High Carbon Residue

FCC Problems From LTO & Canadian Crudes

- Metals → Increased catalyst makeup, hydrogen yield, & ash in slurry
- Nitrogen → Reduced bottoms cracking, fouling (salting), & corrosion
- Changes in carbon residue impact the heat balance

FCC Problems From LTO & Canadian Crudes

- Metals ⇐ Impacts the Riser / Reactor / Regenerator
  hydrogen yield, & ash in slurry
- Nitrogen → Reduced bottoms cracking, fouling (salting), & corrosion
- Changes in carbon residue impact the heat balance

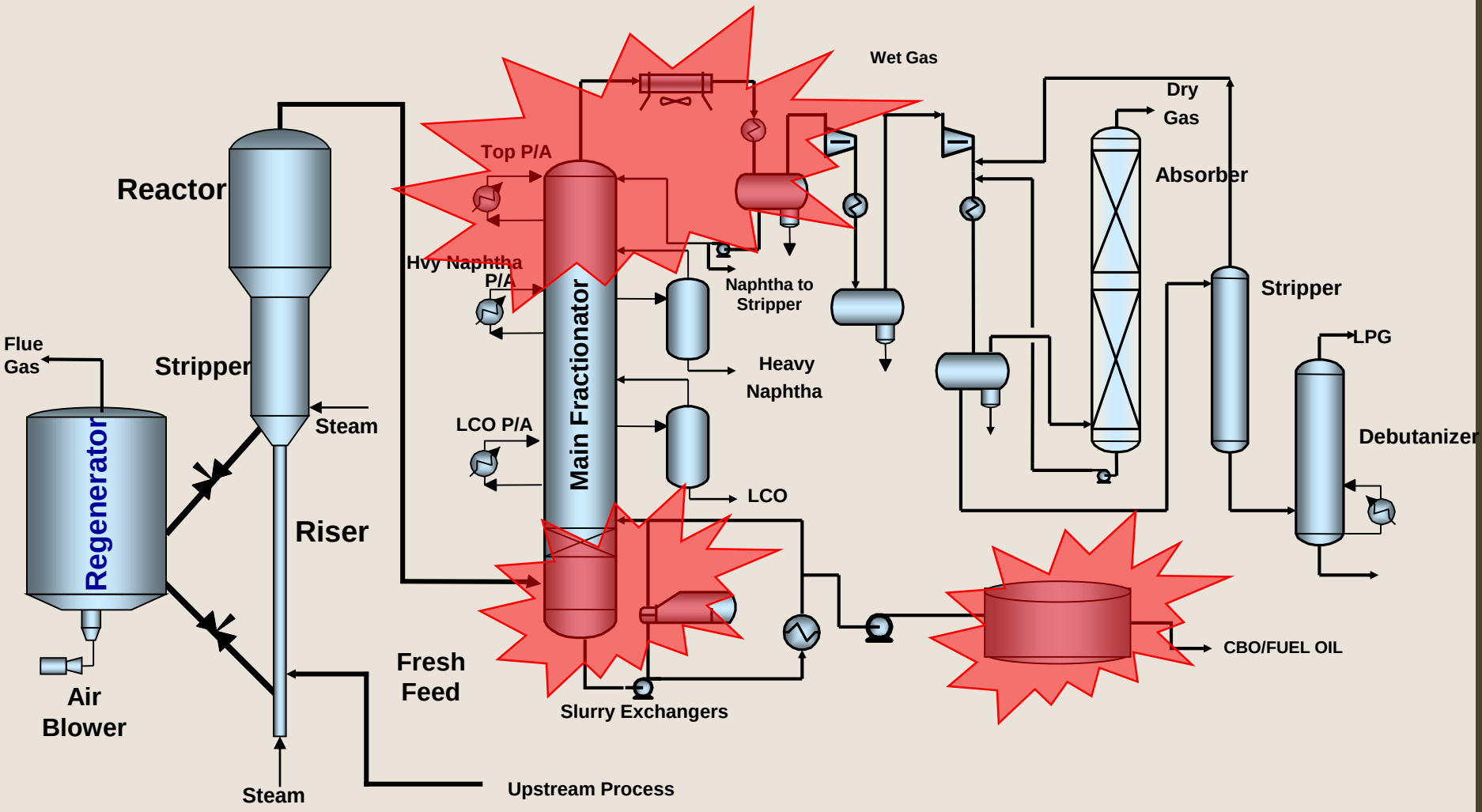
FCC Problems From LTO & Canadian Crudes

- Metals hydrogen yield, & ash in slurry
  - Impacts the Riser / Reactor / Regenerator
- Nitrogen (salting), & corrosion
  - Impacts the Riser / Reactor / Regenerator & the Main Fractionator
- Changes in carbon residue impact the heat balance

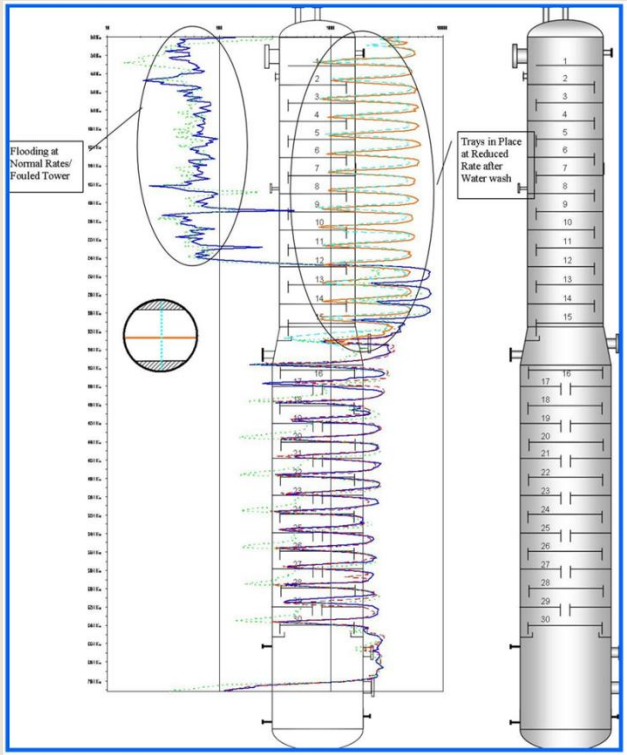
FCC Problems From LTO & Canadian Crudes

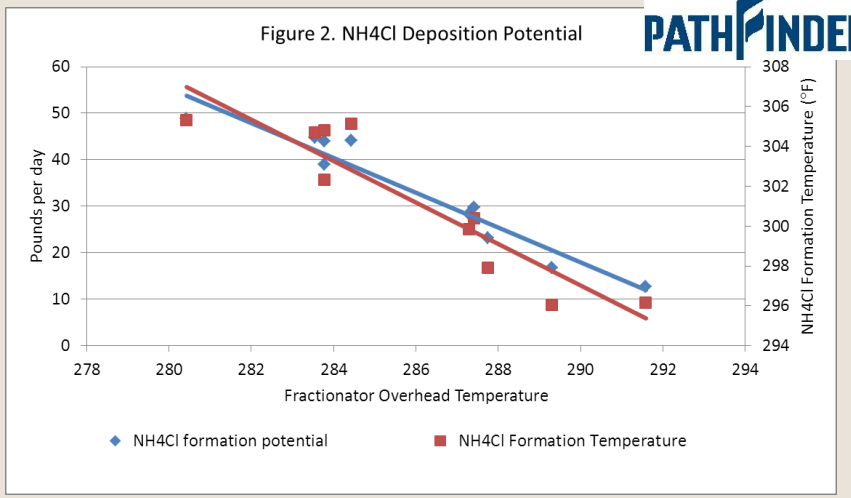
- Metals hydrogen yield, & ash in slurry
  - Impacts the Riser / Reactor / Regenerator
- Nitrogen (salting), & corrosion
  - Impacts the Riser / Reactor / Regenerator & the Main Fractionator
- Changes in carbon residue impact the heat balance
  - Impacts the Riser / Reactor / Regenerator

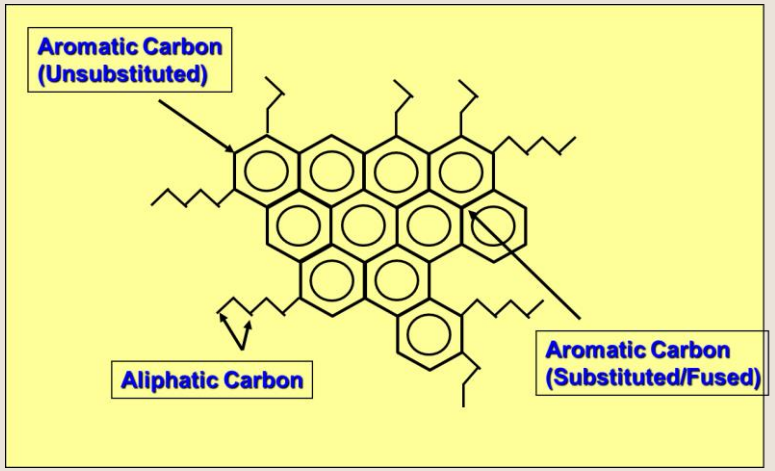
Where Issues Have Been Observed



Salting, corrosion and fouling

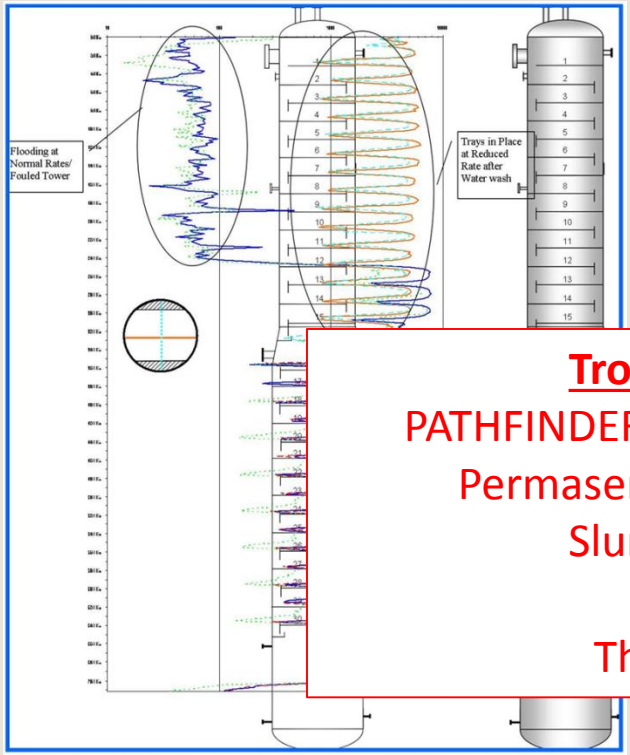


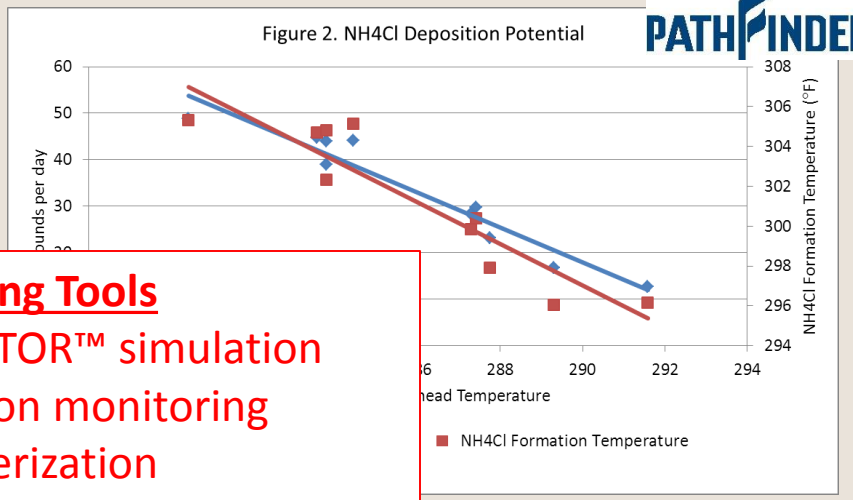




- Find fouling and corrosion potential and measure impact
- Evaluate column performance

Salting, corrosion and fouling





Troubleshooting Tools

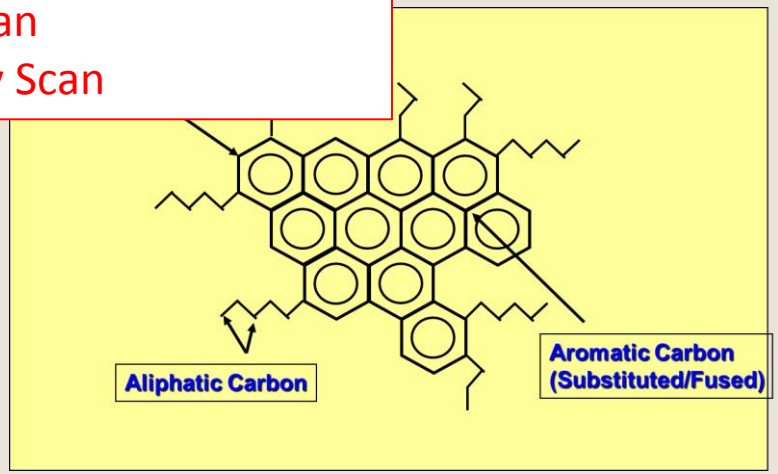
PATHFINDER® & MONITOR™ simulation

Permasense corrosion monitoring

Slurry characterization

Gamma Scan

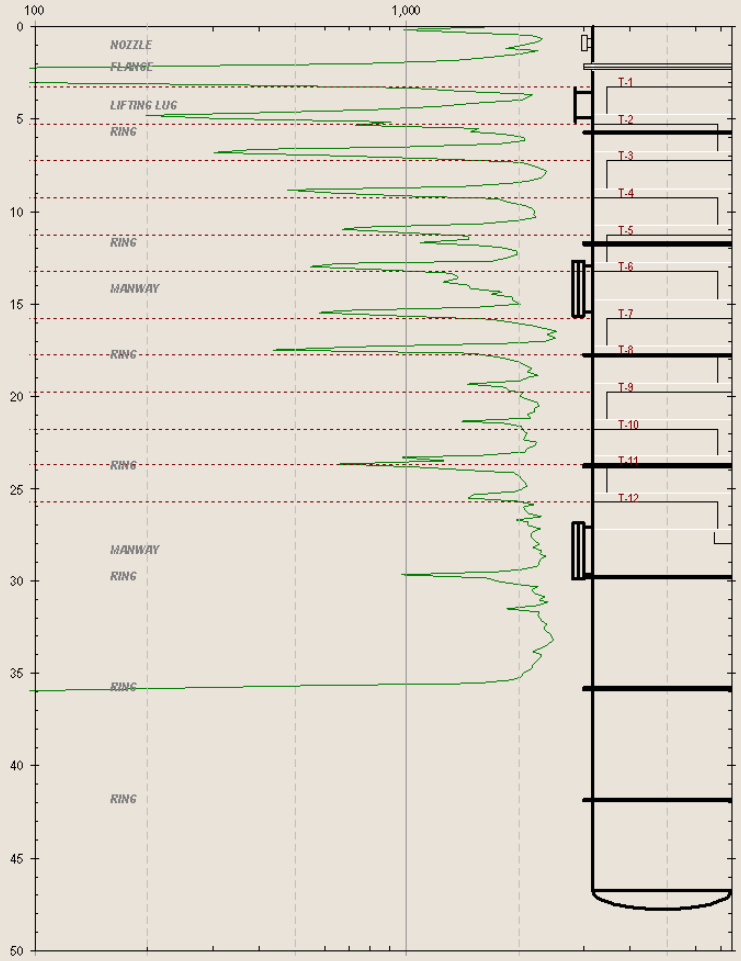
Thermography Scan



- Find fouling and corrosion potential and measure impact
- Evaluate column performance

Scan Found Damage to Stripper Column

- Our Report:
- Trays 9-12 Damaged/Missing
- Trays 4-8 Damaged



Scan Found Damage to Stripper Column

- Our Report:
- Trays 9-12 Damaged/Missing
- Trays 4-8 Damaged

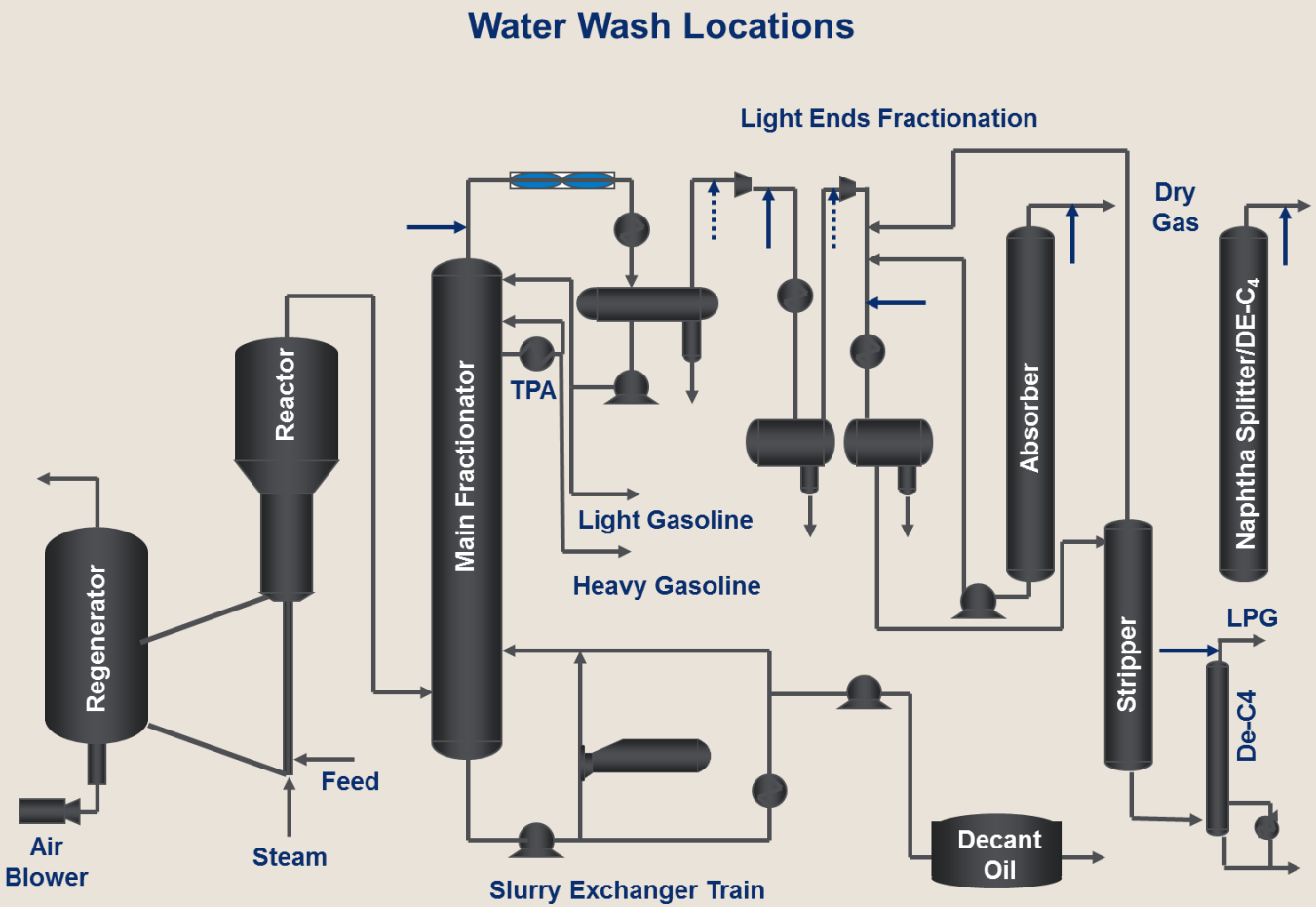
View from

Bottom Manway

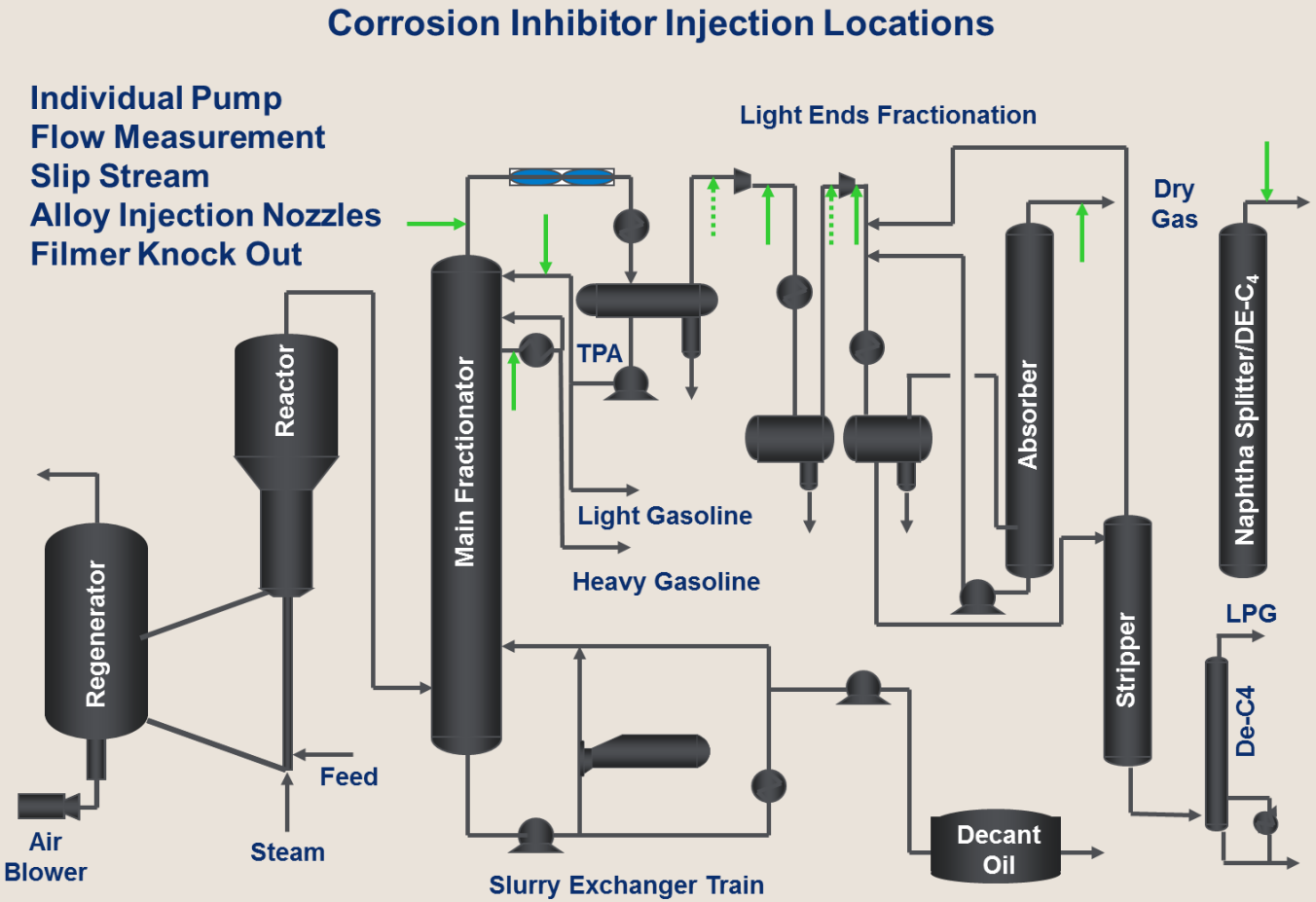
Corrosion and Salt Control Program

- Increase in Nitrogen results in greater salting potential, which can result in throughput reductions and corrosion.
- Salting and corrosion can be controlled through
  - Wash Water
    - 125% of calculated minimum for overhead
    - 3 – 5 gallons / million scf in the Overhead
  - Tower top temperature control over salt formation temperature
  - Salt Dispersants
- Monitor salting through routine lab analysis, software simulation, thermography and tower gamma scans

Corrosion and Salt Control Program

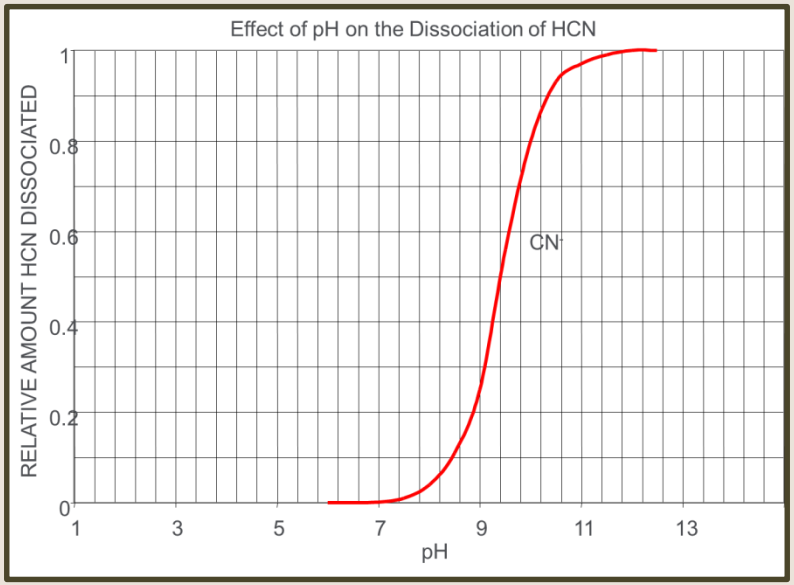


Corrosion and Salt Control Program

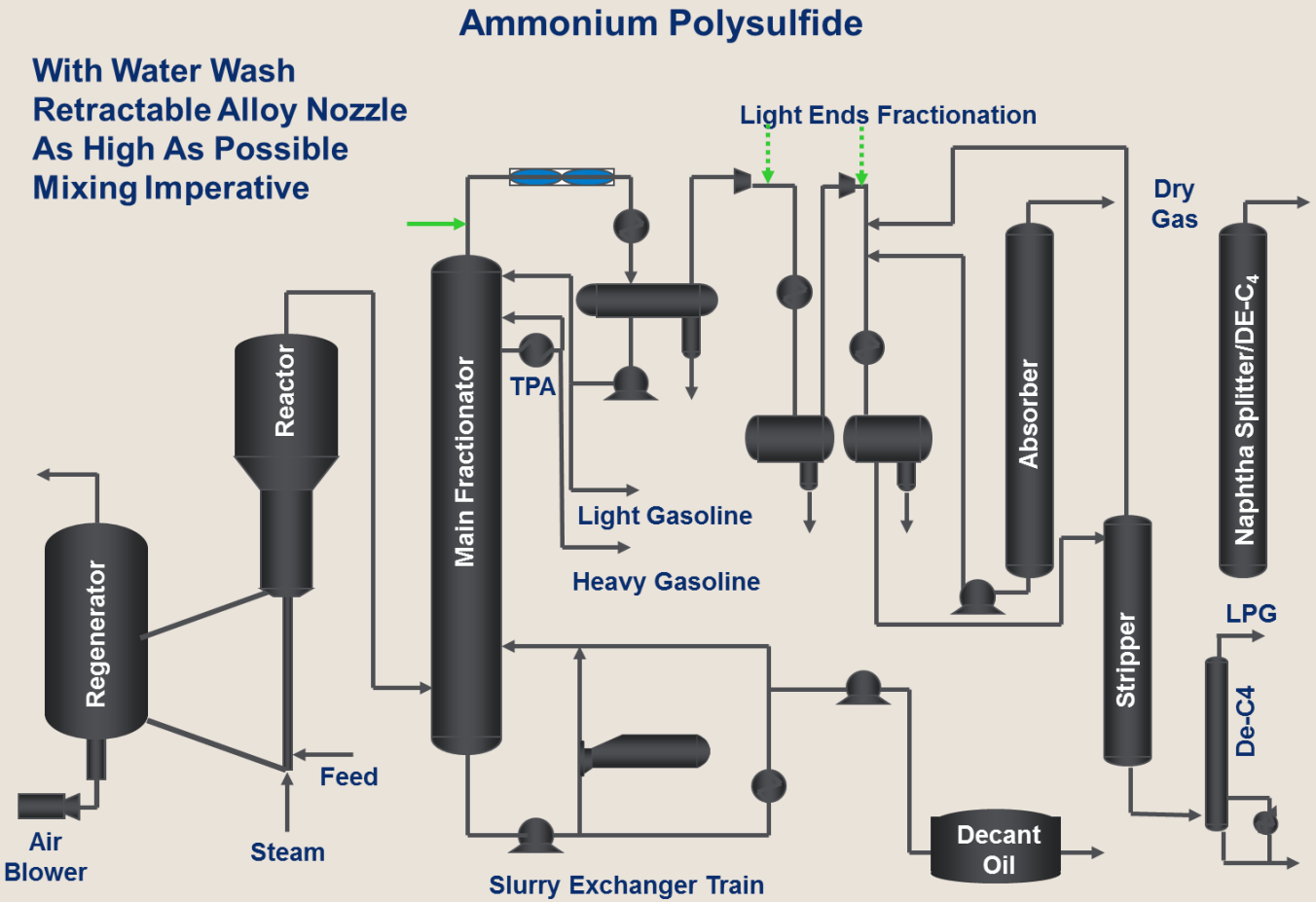


Cyanide Control Program

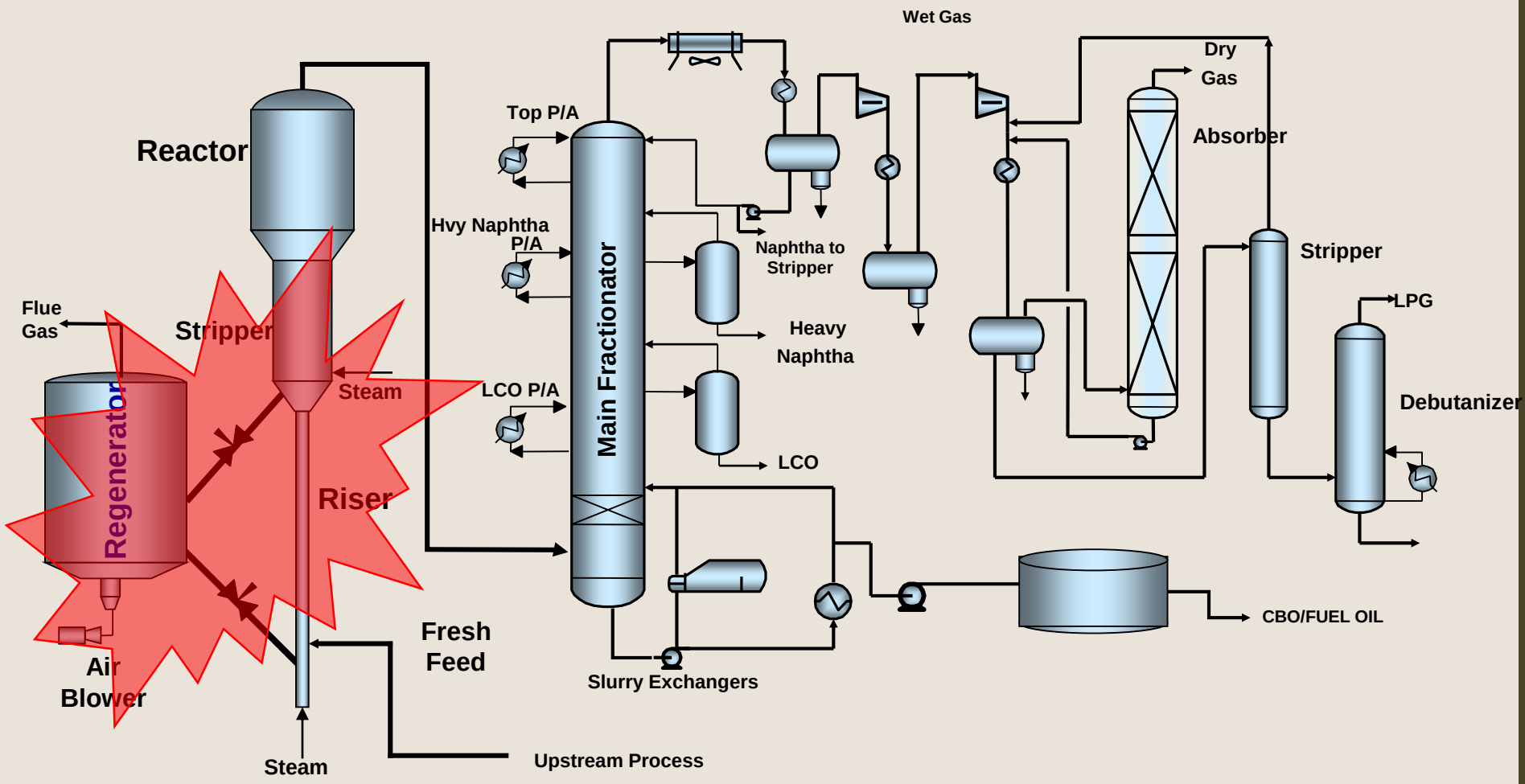
- Increase in Nitrogen results in greater risk of cyanide formation, which can result in corrosion and blistering.
- Cyanide control considerations
  - Controlling CN levels to < 25 ppm (water wash)
  - Controlling pH < 8.5 (water wash)
  - Cyanide scavenger
  - Passivation additive



Cyanide Control Program

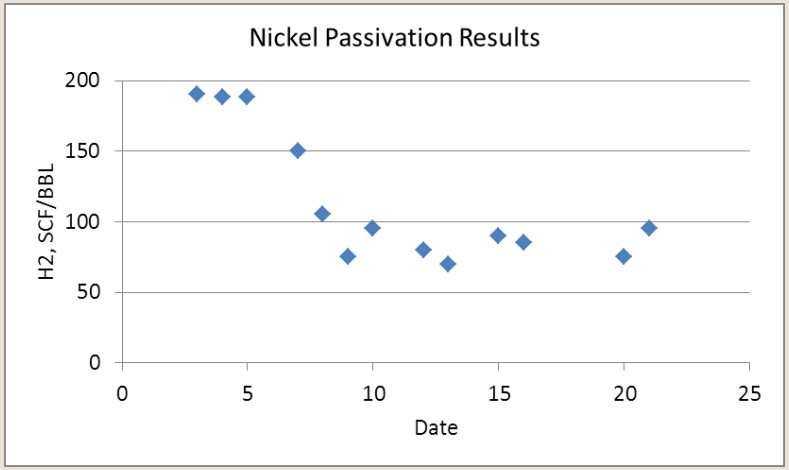


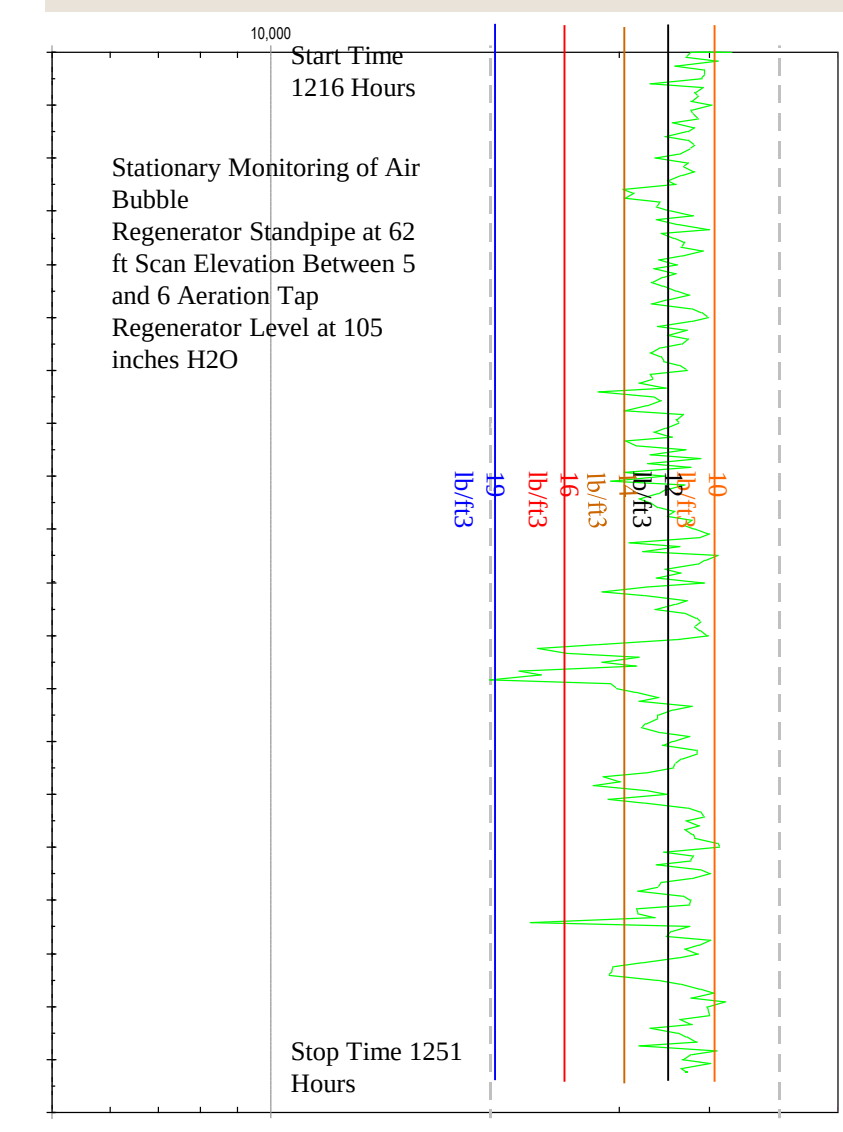
Where Issues Have Been Observed



Increased hydrogen and coke yield

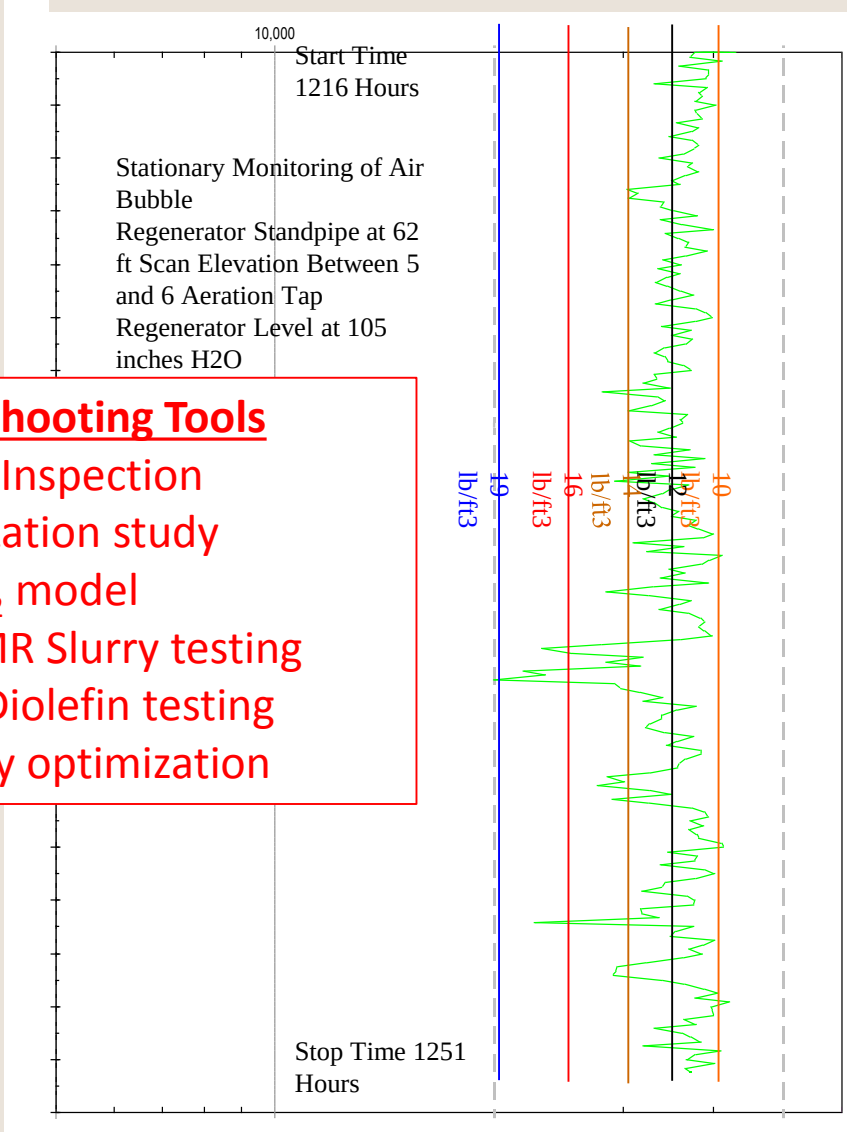
- Mechanical – Operational – Chemical troubleshooting
- Study riser and regenerator
- Evaluate and treat metals





Increased hydrogen and coke yield

- Mechanical – Operational – Chemical troubleshooting
- Study riser and regenerator
- Evaluate and treat metals



Troubleshooting Tools

Riser Inspection

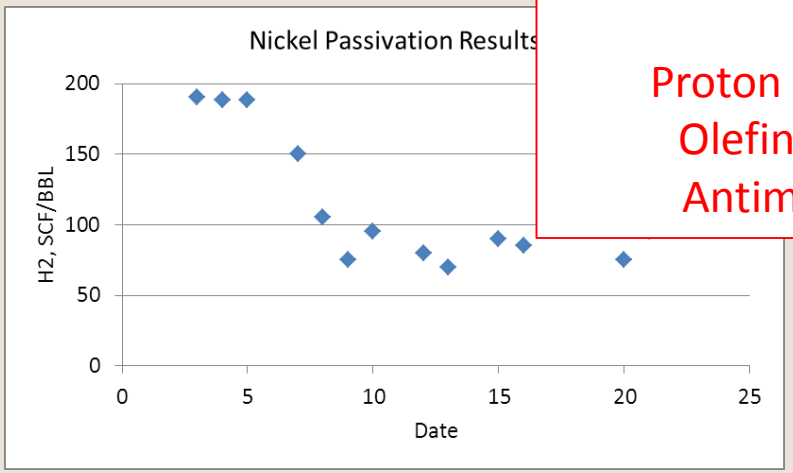
Fluidization study

H_2 model

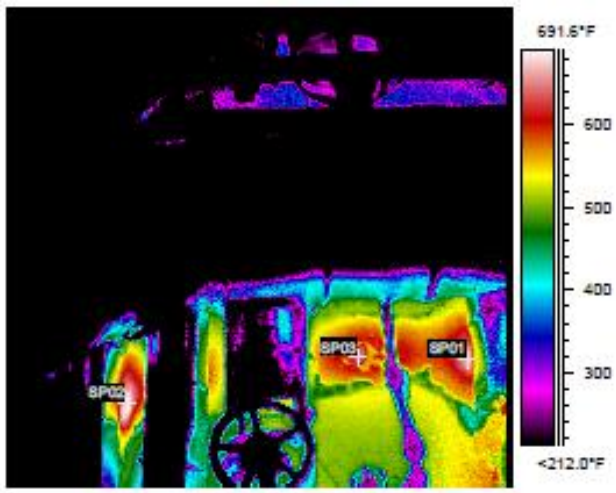
Proton NMR Slurry testing

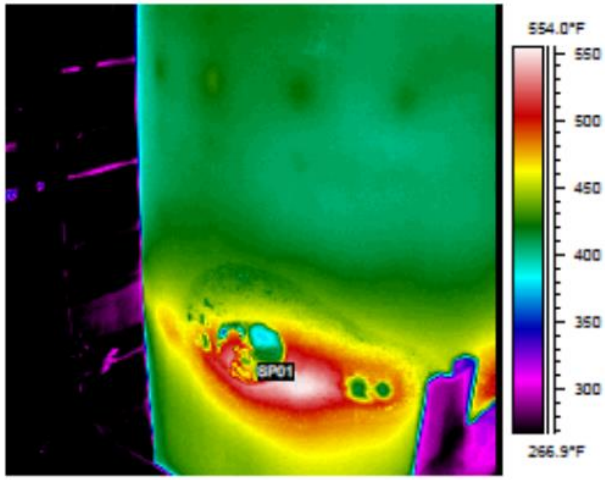
Olefin / Diolefin testing

Antimony optimization

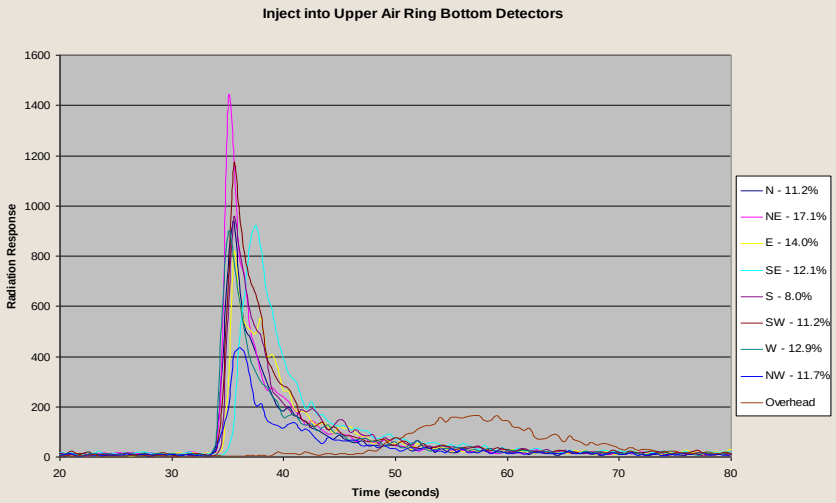


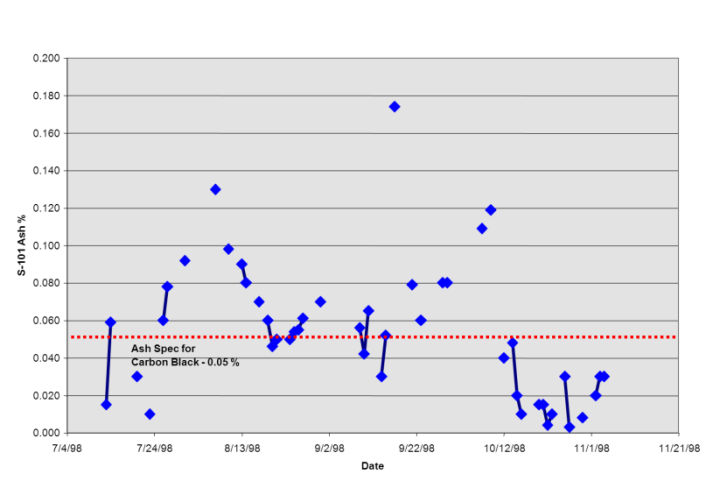
Thermography
Riser & Regen Stand Pipe



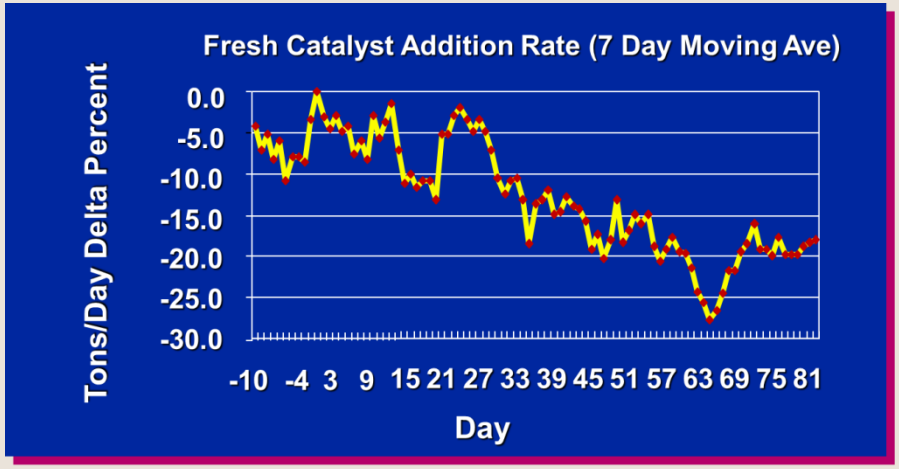


Increased catalyst make up

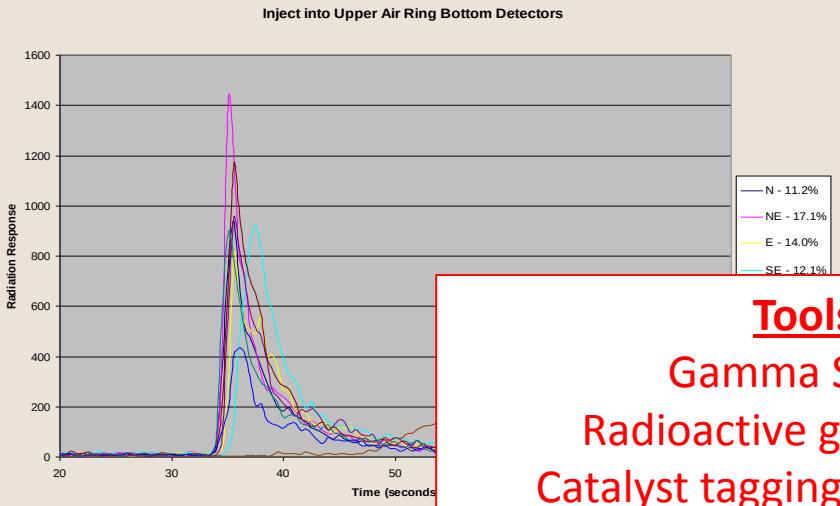


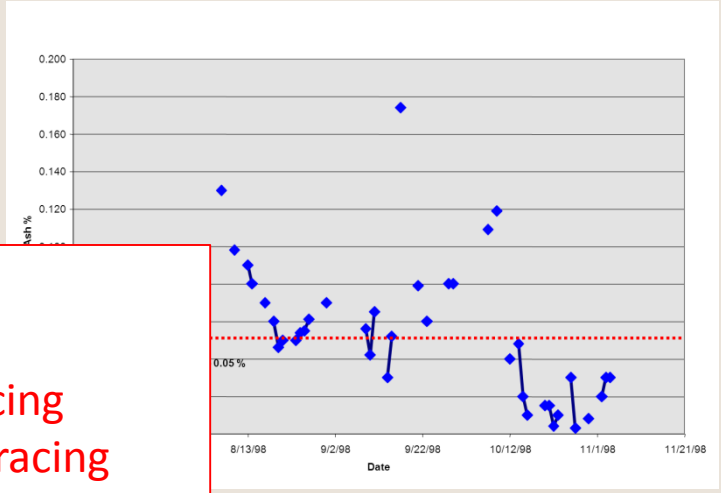


- Evaluate cyclones, reactor stripper, air distributor
- Determine root causes of cat losses
- Passivate Vanadium
- Minimize feed contaminants



Increased catalyst make up





Tools

Gamma Scans

Radioactive gas tracing

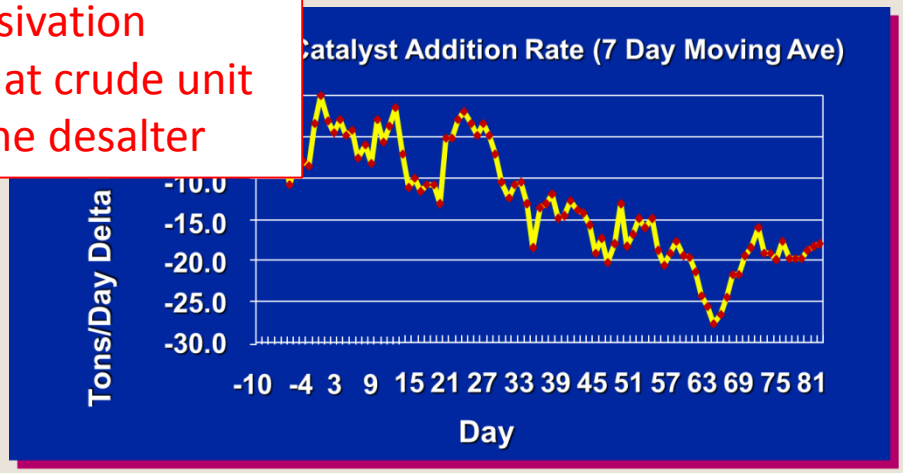
Catalyst tagging and tracing

Vanadium passivation

Caustic automation at crude unit

Iron removal at the desalter

- Evaluate cyclor
  stripper, air dis
- Determine root causes of cat losses
- Passivate Vanadium
- Minimize feed contaminants

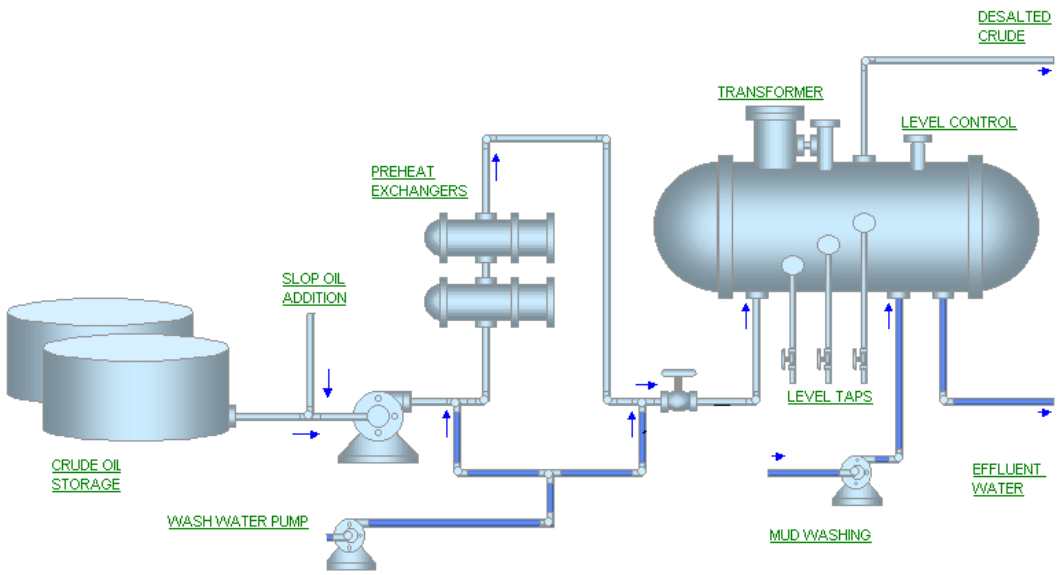


Feed Preparation Sodium Reduction

- Automated caustic injection
- Minimize caustic used to control Crude Unit overhead chloride concentration

Feed Preparation Fe Removal

- Iron Reduction
  - Maximize Solids removal across Desalter with process optimization
  - Further increase Fe removal across 2 stage Desalters with additives technology



Deashing Troubleshooting

Deashing Methods

- Filtration
  - Gulftronics (Electrostatic Precipitators)
  - Mechanical Filtration
- Tank Settling

Tank Settling Considerations

- Temperature > 158 F (70 C)
- Clarified oil viscosity
- Heated/Insulated Tanks Required
- Slurry antifoulant use
- Residence Time
- Placement of Inlet/Outlet Nozzles
- Eventual Cleaning and Waste Disposal

FCC Troubleshooting Tools

Mechanical – Operational – Chemical Diagnosis & Treatment

Chemical Treatment

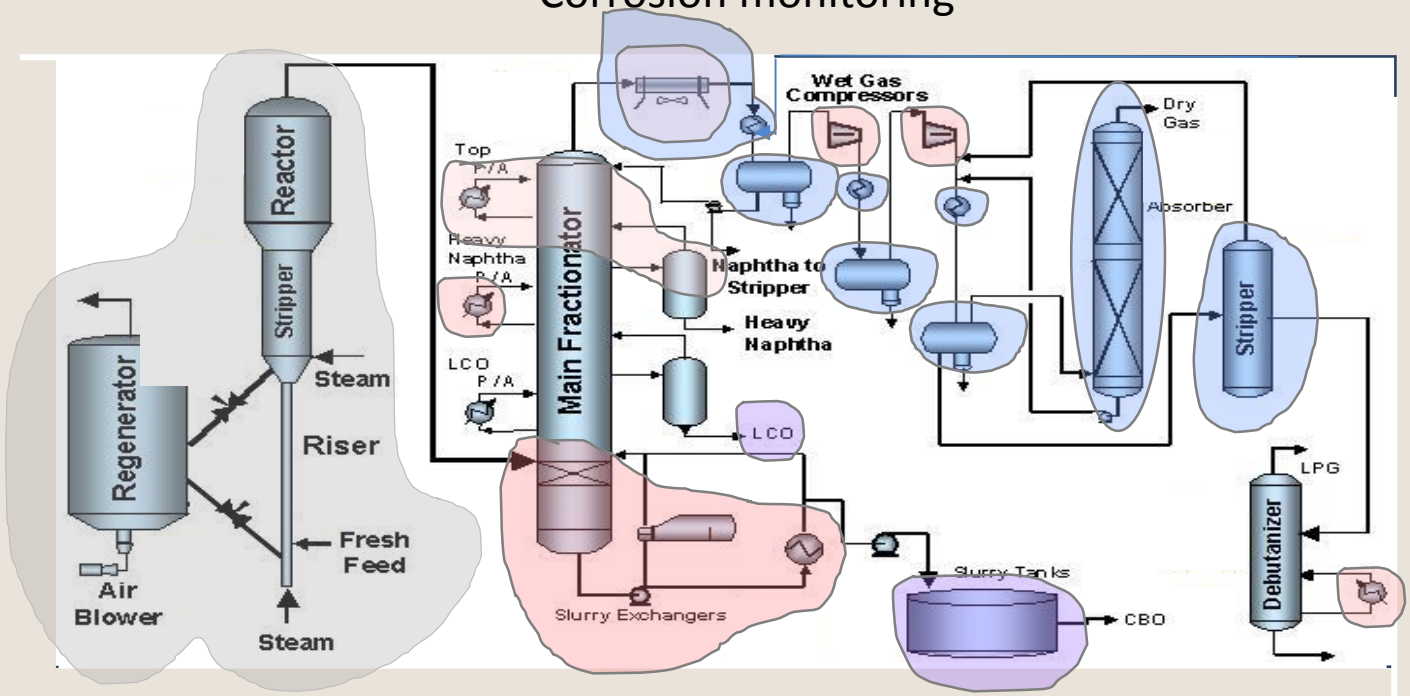
- Corrosion
- Fouling
- Passivation
- Additives

Monitoring Performance

- Simulation (PathFinder, Monitor, and H_2 model)
- Lab testing
- Thermography
- Gamma Scans
- Tracer Studies
- Corrosion monitoring

TAR Support

- Thermography Scans
- Gamma Scans
- Tracer Studies



Unconventional Crudes Quality Summary

Crude / Feed	Quality	Impact at FCC
Canadian Bitumen	High metals (Ni and V) High in Nitrogen	Increased hydrogen and coke yield Increased catalyst make up Increased risk of salting and corrosion
Ultra Light Shale Oils	Low MCR	Heat balance may require torch oil injection which promotes corrosion in FCC main fractionators
Light Tight Oils	Fe, V, and Ca level	Increased catalyst make up, reduced bottoms cracking
Resid and ATB	High metals (Ni and V) High Na High flash point	Increased hydrogen and coke yield Increased catalyst make up Potential coking at feed nozzles

FCC Troubleshooting Tools Summary

Feed quality issue	Problem area	Troubleshooting tools
Salting, corrosion and fouling	Main Fractionator limitations	PATHFINDER & MONITOR simulation Slurry characterization Permasense corrosion monitoring Gamma Scan Thermography Scan
Increased hydrogen and coke yield	Cracking troubleshooting	Riser Inspection Fluidization study H_2 model Proton NMR Slurry testing Olefin / Diolefin testing Antimony optimization
Increased catalyst make up	Catalyst Losses	Gamma Scans Radioactive gas tracing Catalyst tagging and tracing Vanadium passivation Caustic automation at crude unit Iron removal at the desalter