



3D CRUDEFLEX

Expanding your view on crude unit operations

ecolab.com/nalco-water

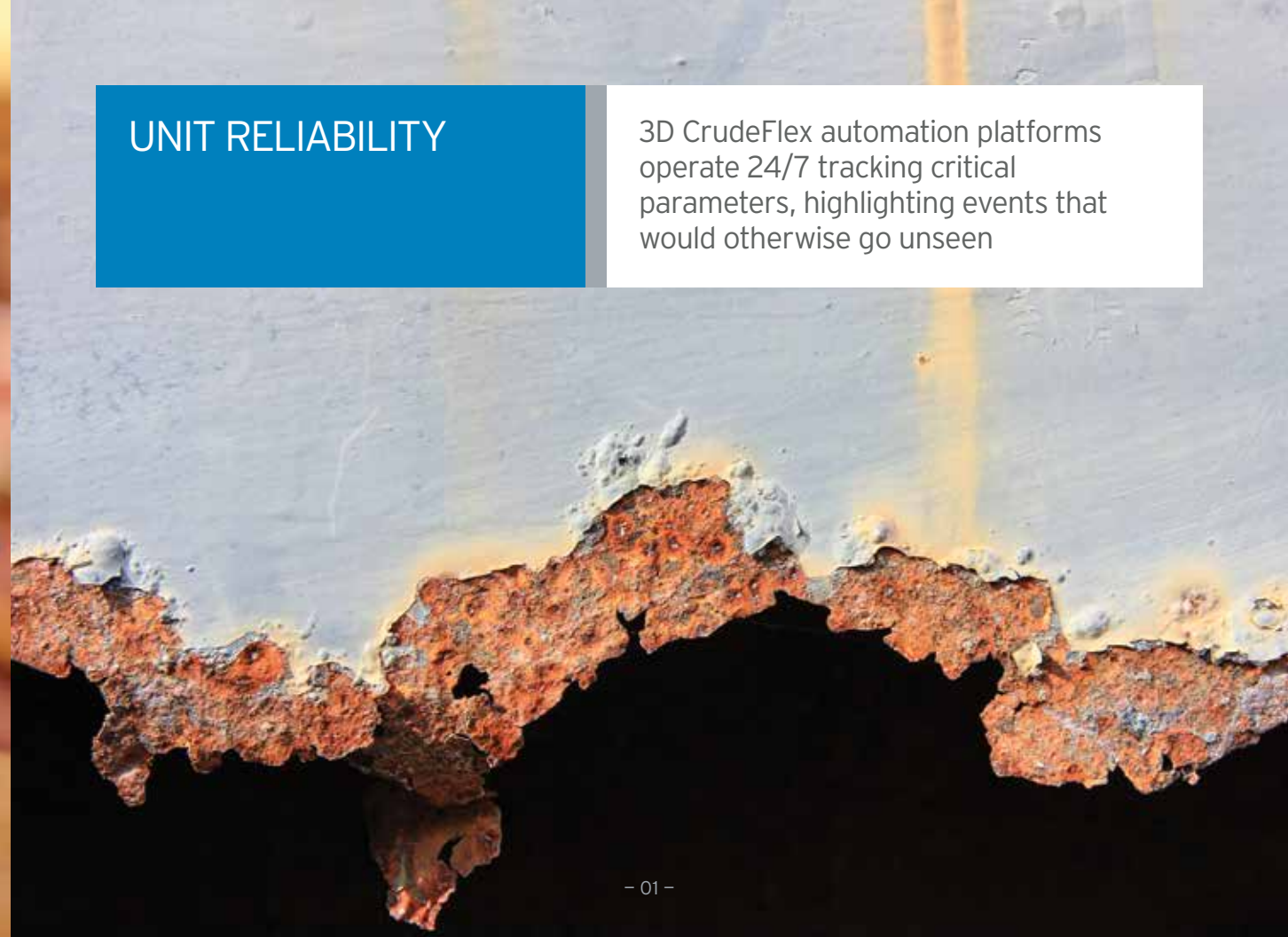
NALCO Water
An Ecolab Company

RISK VS OPPORTUNITY
why compromise?



UNIT RELIABILITY

3D CrudeFlex automation platforms operate 24/7 tracking critical parameters, highlighting events that would otherwise go unseen



PROCESS OPTIMIZATION

Increased data leads to improved decision making, mitigating threats and leveraging opportunities

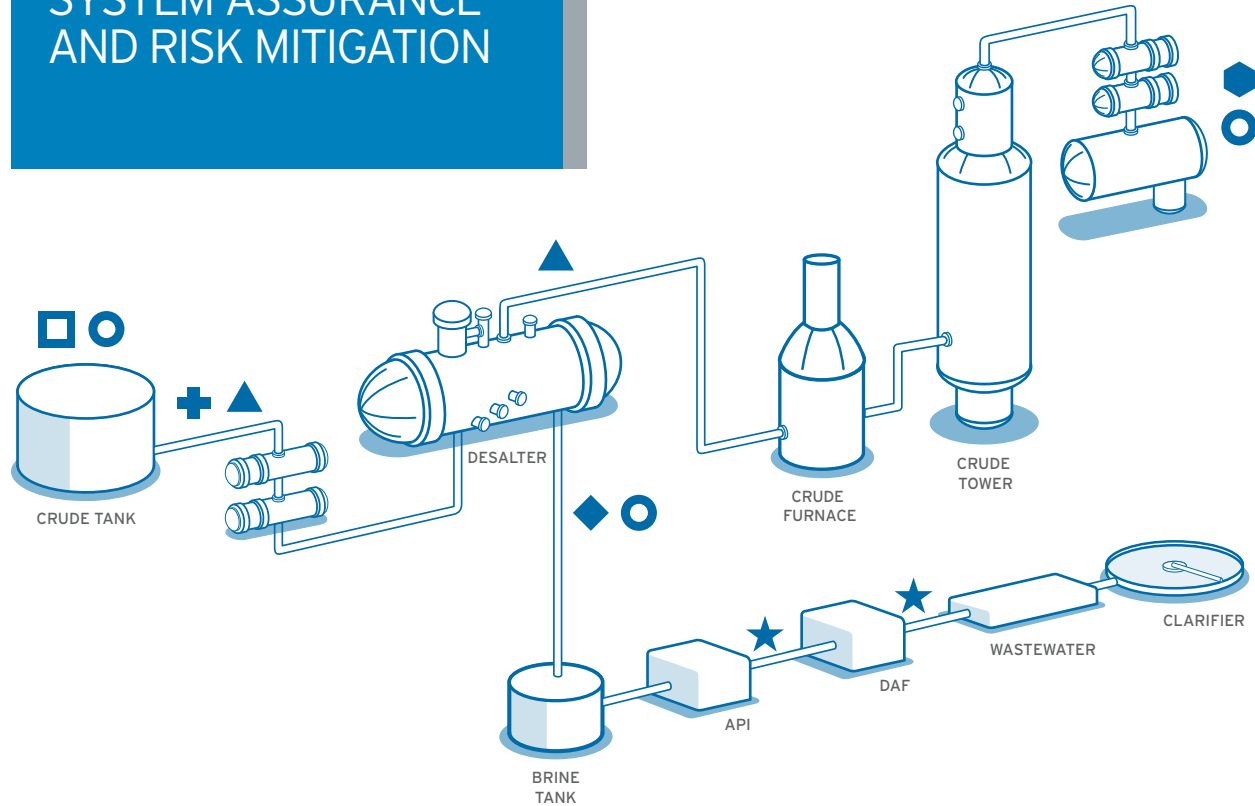


CRUDE FLEXIBILITY

Effective risk reduction allows refiners to pursue more opportunistic crude slates



SYSTEM ASSURANCE AND RISK MITIGATION



□ CrudeFlex Crude Processing Consulting Service

⊕ CrudeFlex Crude Blending Service

⬢ 3D TRASAR™ for Crude Overhead Systems (3DTCOS)

▲ 3D CrudeFlex Online Salt Analyzer (OSA)

○ Pathfinder Amine Test (PAT)

◆ 3D TRASAR™ for Brine (3DT-Brine)

★ 3D TRASAR™ for Wastewater (3DTWW)

REAL-TIME INSIGHTS SINCE 2010

Innovative online analyzer helps identify corrosion root cause saving \$6.7 Million per year

Putting a Stop to Corrosion Events



PROBLEM

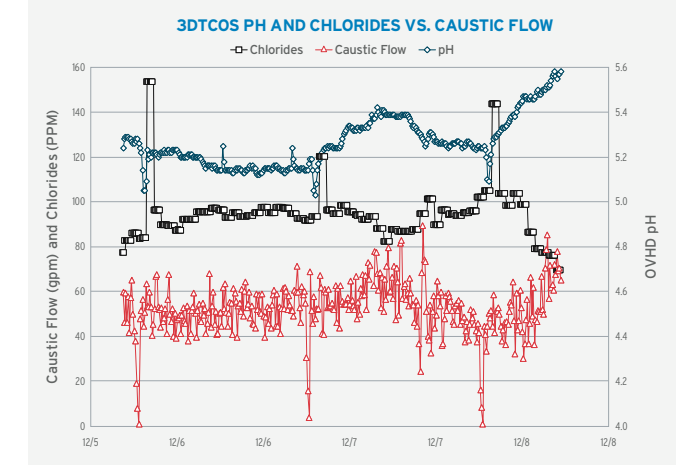
A large Gulf Coast refiner experienced a series of corrosion failures on the atmospheric overhead line, resulting in significant downtime and repair costs. Routine sampling suggested periods of very low pH (pH < 3) in the condensed water for 12+ hours, but the root cause was still unknown.

The site conducted a RCFA with Nalco Water, the first action being to increase sampling frequency. A 3D TRASAR™ Technology for Crude Overhead System (3DTCOS) was installed and connected to the DCS for improved understanding of the real-time behavior of the overhead, with alarming capabilities for process conditions with high corrosion risk.

RESULTS

The 3DTCOS tracked pH dips and chloride spikes, linking back to mud washing on the desalters. Each event caused short-term pressure fluctuations and a drop in caustic dosage. A mechanical survey was conducted identifying mud wash piping pressure interferences and operational differences between the desalter trains as the root cause.

3DTCOS was critical to understanding mechanical, operational, and chemical causes of this corrosion event, with reliability savings calculated by the refiner greater than \$6.7M/year.



CONFIDENCE selecting crudes

CrudeFlex Services contributes \$41 Million in profitability through crude flexibility



Reliably Predicting Crude Processing and Blend Stability



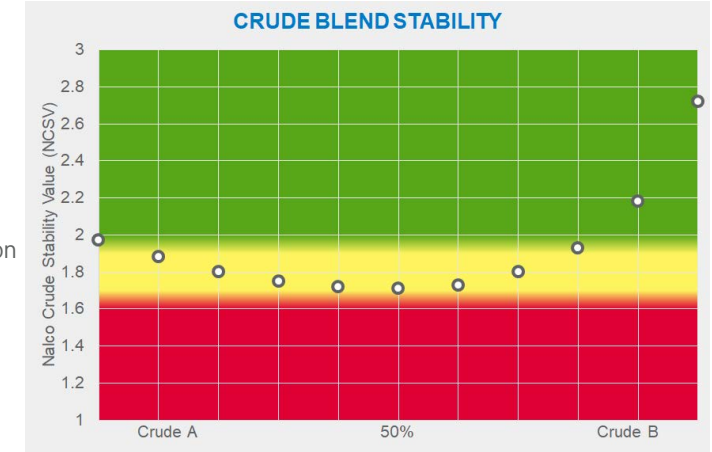
PROBLEM

A large US refiner desired to improve profitability by blending from a selection of various opportunity crudes. The variability in the characteristics of these crudes introduced significant risk of unstable blending, and consequently threatened processing reliability.

To achieve operational goals, the site relied heavily on Nalco Water CrudeFlex Crude Blending Service for information regarding expected processing challenges of these crudes, and predictions for stability of proposed crude blends.

RESULTS

Nalco Water used the CrudeFlex Crude Processing Consulting Service and CrudeFlex Crude Blending Service to provide valuable information that guided successful selection and blending of various opportunity crudes. The refiner was able to proactively mitigate expected processing challenges and avoided the undesirable, costly impacts of unstable crude blends by injecting asphaltene stabilizer chemistry only when necessary. Consequently, the refinery achieved significant profitability improvement from crude flexibility attributing \$41 million in additional profit in one year due to the blend stability predictions from Nalco Water.



MANAGE RISK with online control

Automated corrosion control program improves reliability and eliminates need for \$5 Million capex

Providing Real Corrosion Improvements

PROBLEM

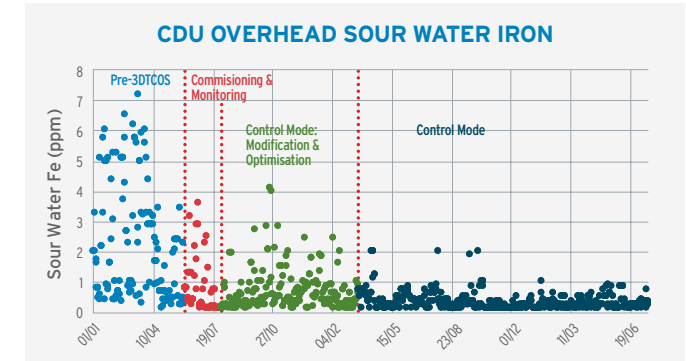
A European Refiner running opportunity crudes, experienced difficulty in controlling the overhead corrosion. This challenge demanded constant attention, but with varying crude quality, corrosion control suffered from frequent low pH events (pH <5).

Historically, the crude unit overheads were sampled daily for pH, chlorides, iron and ammonia. To improve corrosion performance, the refinery employed 3DTCOS technology, with the view it could avoid a \$5M capital project to upgrade the system to a more corrosion resistant metallurgy.

RESULTS

Starting in Monitor Mode, the “learning phase” was catching potential upsets as they happened with manual changes to improve performance. Progressing to Control Mode tightened corrosion performance further. The graph shows improvements realized on pH and Fe (controlling neutralizer), growing the data collection to over 17,500 points a year and, with chemical control, the performance gain continued.

This step-change in performance realized with 3DTCOS increased unit reliability and system assurance, while real-time analysis and chemistry control enhanced crude flexibility. This higher confidence to catch upsets meant the \$5M metallurgy upgrade project could be avoided.





OPTIMIZE CONTROL
at moment of demand

Online analysis and control provides the right amount of chemical at the right place at the right time

Achieving A Step Change In Control



PROBLEM

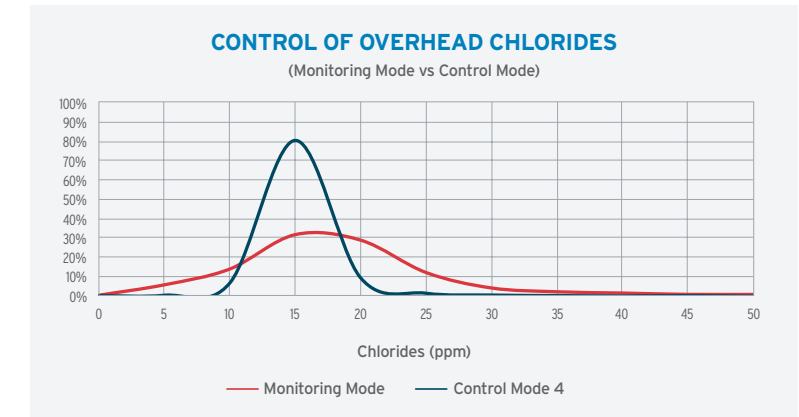
A Gulf Coast Refiner was incurring costs of \$2.5M due to salt fouling of their overhead heat exchangers. After deciding against a number of proposed mechanical changes, the refinery installed the 3DTCOS technology, utilizing real-time continuous analysis to link chemical addition directly to the demands of the system, to improve chloride control.

RESULTS

Starting in Monitor Mode, the increased sampling frequency showed that the chloride KPI performance, thought to be 90% within the specification limit of 20ppm, was in fact only 80% compliant with a high degree of variability.

Moving to Control Mode significantly improved the chloride KPI compliance to 97% and reduced the variability from optimizing the amount of caustic injected. This in turn substantially reduced the risk of salt formation, and demonstrated the value of the real time analysis.

With 3DTCOS, the complete treatment program (including caustic) was controlled efficiently at the moment of demand.



RESPOND to upsets as they happen

Analyzing salt-in crude online allows for real time desalter optimization



Process Change Impacts Desalting



PROBLEM

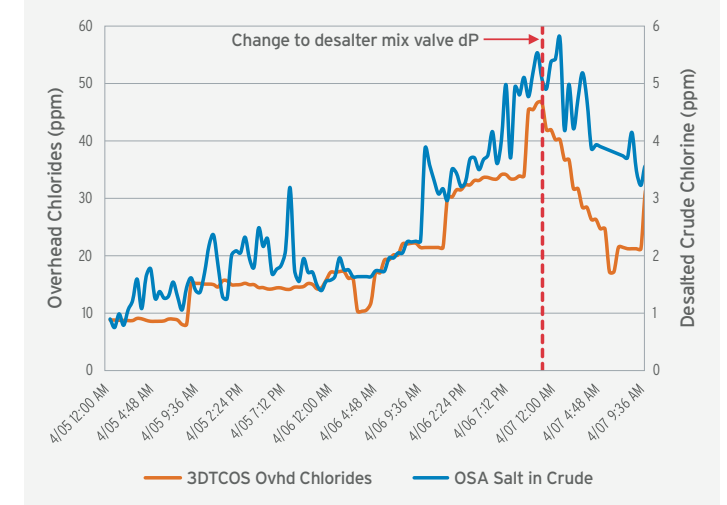
A Gulf Coast Refiner installed the new Online Salt Analyzer (OSA) on the desalted crude outlet, complimenting the 3DTCOS already in use on the overheads. Shortly after commissioning the OSA, they experienced an issue with one of their two fired heaters, and as a consequence, feed rates to the unit were reduced.

RESULTS

Refineries are often unaware of the impact even a small upset can cause. In this case, the OSA began to register a sharp increase in salt exiting the desalter, brought about by the cut in crude feedrate. This was supported by 3DTCOS data showing an increase in overhead chlorides at almost the same time.

The online analyzers alerted the Operations Team to these increases and it was quickly determined that the reduction in feed rate caused a reduction in the mix valve dP, impacting desalting efficiency.

Once recognized, the mix valve dP was reset and the salt in crude and overhead chlorides reduced almost immediately, returning to typical levels.



INFORMED DECISIONS balance opportunity vs risk

PATHFINDER Amine Test provides an added layer of protection from tramp amines

Manage Risks Posed By Tramp Amines

PROBLEM

A European Refiner began to experience increased levels of tramp amines in some of their most frequently processed crudes. The ingress of tramp amine impacted overhead pH control and increased the risk of salt formation in the CDU overhead. The use of an Amine Removal Program reduced the salting potential, but increased nitrogen loading in desalter effluent heading to the Effluent Treatment Plant (ETP) elevating the risk of the refinery breaching final discharge consent limits.

RESULTS

Nalco Water introduced a field test to speciate amines that is quick and accurate, offering a significant improvement over the current difficult and time consuming analysis. The PATHFINDER™ Amine Test (PAT) can determine the concentration of various amines including the most prevalent tramp amines in crude, MMA and MEA.

Previously, the refinery was being reactive to tramp amine issues. However, with the implementation of the innovative PAT, the quick analytical turnaround time gave the refinery an early warning of potential issues. Optimization of the Amine Removal Program and / or diverting the contaminated desalter effluent stream away from the ETP, minimizes risk to the CDU and lowers the potential of breaching discharge consent limits.



MAXIMIZE PROFITS minimize costs

Providing crude flexibility while
mitigating tramp amine risks

Best Practices To Handle Tramp Amine Risk



PROBLEM

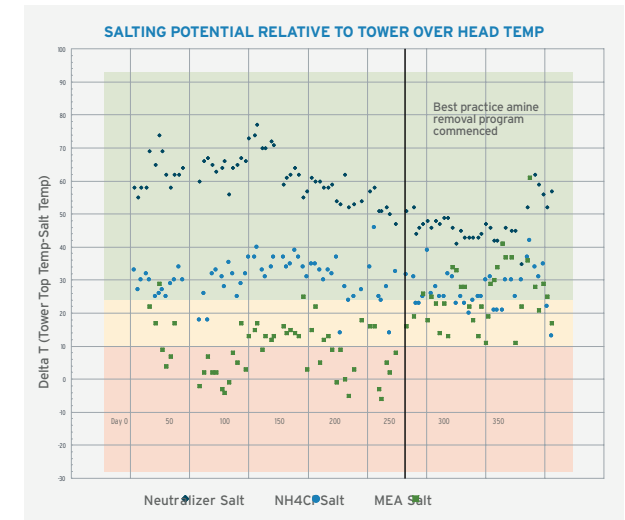
A Gulf Coast refinery processing high rates of light-tight oils (LTO) was concerned about potential downstream impacts from tramp amine contamination. The site needed the data necessary to make informed decisions on appropriate mitigation strategies.

The main issue was the high potential for amine salt (MEA Chloride salts) formation in the top of the tower at current operating conditions. The refiner did not want to forego higher margin jet/kero production rates by raising the tower top temperature, or change the crude slate to a higher cost blend, that would avoid the salting potential.

RESULTS

Partnering with Nalco Water, a step-wise approach was initiated whereby the refinery crude flexibility would remain intact. The first step involved the PAT to provide frequent amine data. The second called for acidification best practices that effectively remove the offending MEA.

Now armed with regular MEA data, a more optimized acid dosage could be set to ensure the target amine removal rates would be achieved, avoiding salting and moving out of the danger zone. The value of this approach is estimated at \$4-5M in reliability gains.





**ELIMINATE
VARIABILITY**
optimize performance

Robust monitoring and control achieves consistent performance without compromising asset reliability

Tramp Amine Removal Automation With 3DT-Brine



PROBLEM

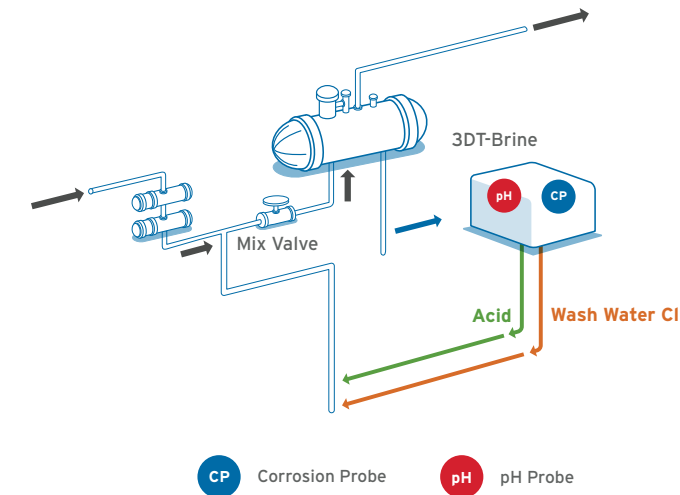
A Gulf Coast refinery processing a highly variable crude slate was continually looking for innovative mitigation strategies allowing them to run as much LTO as they could process. Their focus was how to best handle MEA contamination in the crude. The desalters already had a new online pH control system, but it failed within two months of operation.

Without a reliable means to monitor and control the acid dosage, the risk was acid over-dosing (potentially causing ETP de-nitrification issues) or under-dosing (leading to a higher potential of amine salting in the crude tower).

RESULTS

Upon consulting with Nalco Water, the new 3D TRASAR™ Technology for Brine (3DT-Brine) was installed. This unique piece of automation provides online pH, turbidity, and corrosion monitoring. It is cost effective, increases system assurance, and optimizes chemical consumption while still achieving amine removal targets regardless of the rate of LTO processed in the blend.

The pH controls the acid injection rate (5.5-6.0) and the corrosion rate (MPY) adjusts the wash water corrosion inhibitor to target < 5 MPY. The unit can also be used to monitor oil under-carry and potentially optimize mud washing practices.



GUARD against variability

3D TRASAR™ Technology for Wastewater manages the variability from high solids crudes, improving TCO

Wastewater Automation Delivers Reliability and Crude Flexibility



PROBLEM

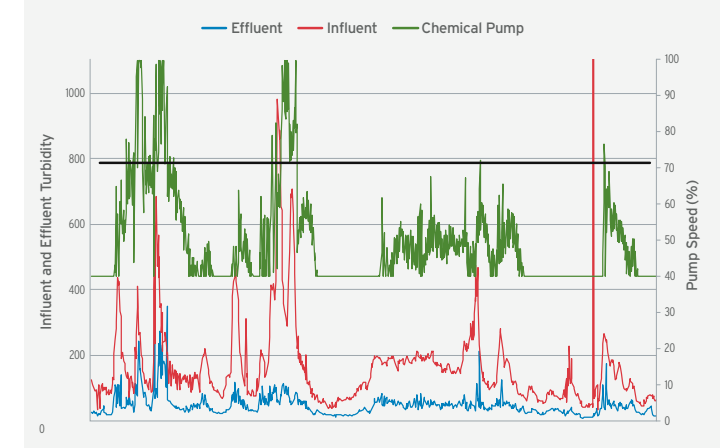
A Canadian refinery was unable to reach targeted run rates for discounted heavy Canadian crude, due to consistently poor effluent quality. The plants' primary treatment configuration was designed to handle the solids loading, but the influent variability was challenging the system control by manual treatment adjustments, and as such, excursions were still occurring.

RESULTS

After completing a thorough MOC (Mechanical, Operational, Chemical) system audit, Nalco Water recommended and implemented the 3D TRASAR™ Technology for Wastewater (3DTWW). This automation platform measures influent and effluent contaminant load and adjusts chemical when and where needed.

Even with average influent turbidity levels higher by 60%, the effluent contaminant loading was improved by 24%, vastly improving reliability of the wastewater operations, reaching a higher compliance level on discharge KPIs.

On top of the improved reliability, the site was able to reduce sludge by 600 MT per year, and process more of the discounted heavy Canadian crude by an additional 315,000 bpd.





CORE BENEFITS

Core Benefits of 3D CrudeFlex Technology

- In challenging environments, refiners should not have to compromise potential opportunities vs risk
- Increased level of insight enables refiners to proactively manage crude unit threats and allows safe processing of a more opportunistic crude slate
- 3D CrudeFlex technology provides an enhanced level of system assurance by mitigating process upsets before they escalate and considerable damage occurs
- Case histories demonstrate how predictive tools and real-time data from 3D CrudeFlex can deliver a step change in crude distillation unit and effluent treatment plant reliability

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GOALZERO
SAFETY MATTERS

The safety of our associates, customers and communities is vitally important. From the way we operate, to the products we develop, to how we partner with customers, our goal is zero: zero accidents, zero incidents and zero environmental releases.

At Nalco Water, safety is more than a metric, it's a mindset. It's how we conduct ourselves, every day, everywhere it matters.

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