

RESOLV™ Contaminant Removal Program Increases Calcium Removal Rates, Eliminates Costly Downstream Impacts, Improves Reliability and Saves Refinery >\$15M in TCO



BACKGROUND

A North American refinery processes Doba as part of their standard crude slate, which is known to contain high oil-soluble calcium levels in the range of 300-350 ppm. This crude represents a significant discount (\$/bbl) to the refiner if all the processing challenges can be handled. The goal: hold improved refining margins, but prevent operational problems.

The main problem associated with Doba relates to high calcium and iron levels that become poisons to FCC catalysts. This affects conversion rates and product yields, increases costly fresh catalyst make up, and can detrimentally impact fuel oil quality.

Acidification at the desalter is the common treat-ment approach. A water-soluble metal salt is formed and transported out of the desalter via the effluent brine. However, not all acids are created equally (Table 1).

For years the refiner used glycolic acid that produced the following impacts – areas for improvement:

- Lower than desirable calcium removal rates (also poor iron removal rates) allowing higher levels of catalyst poisons downstream.
- Very high preheat exchanger fouling rates lead to frequent exchanger cleanings (subsequent reduction in crude charge).

- High levels of organic acid carryover to the atmospheric (and vacuum) tower produced increased neutralizer demand and excessive chemical usage
- Higher than acceptable corrosion rates (wash water, desalter effluent, overhead lines).

An audit of the crude unit was conducted using the RESOLV Engineered Approach to establish a thorough monitoring plan. A complete treatment protocol was proposed and executed by both Nalco and the refinery.

Consequently, Nalco Water's RESOLV Contaminant Removal Program (CRA) was implemented to improve the refinery total cost of operations. Nalco's solution was critical in overcoming the historical problems associated with the competitor program.

Factor	Acetic	Glycolic	RESOLV CRA	Citric
Solids Generation in bottle test	None	Yes	None	Yes
Calcium Removal Efficiency	80 to 90%	60 to 75%	80 to 90%	80 to 90%
Desalting Impact	None	None	None	Deposition
Wastewater Impact	3X	2X	Minimal	3X
Downstream Corrosion	4-10X	4-10X	Minimal	2X
Fouling	Minimal	Fouling	Minimal	Fouling

Table 1: Acid comparison for CRA applications.

ANNUAL SAVINGS

COSTS

Reduced chemical usage
\$540,000

PRODUCTIVITY

Reduced fresh catalyst rates
by 6M/T/day
\$11,000,000

PRODUCT QUALITY

Improved fuel quality
\$350,000

VALUE DELIVERED

\$15,750,000

The key components of this program were to:

- Improve calcium removal rates
- Reduce total overheads neutralizer demand (main tower and vacuum column)
- Reduce crude unit preheat fouling rates
- Reduce COD levels in waste water plant influent
- Reduce poisoning of cracking catalyst and fresh catalyst make up rates (lower fresh catalyst make up rates)
- Maintain good desalting performance

The following is an overview of the unit.

- Throughput rates 200,000 bbls/day (approx. 1200 m³/hr)
- Crude gravity 22-26 API (0.909 – 0.878)
- Inlet Calcium levels 50-100 ppm
- 2 Single Stage Desalting System (parallel)
- 5% wash water

SOLUTION

The treatment program is applied with the combined use of an emulsion breaker and wash water corrosion inhibitor to ensure that the Nalco Water RESOLV Contaminant Removal program meets the customer's objectives. The total program included:

- Proven Nalco Water Demulsifier
- New proven CRA technology
- Proven wash water corrosion inhibitor
- Comprehensive on-site monitoring and optimization program

Figure 1 shows the step-change improvement in metals removal (Ca and Fe) across the desalter(s). The calcium levels have varied from 50-100 ppm in the unit feed and between 5-20 ppm in desalted crude oil. Calcium removal rates increased from an historical average of 72 to 86% (iron removal improved from 39 to 58%).

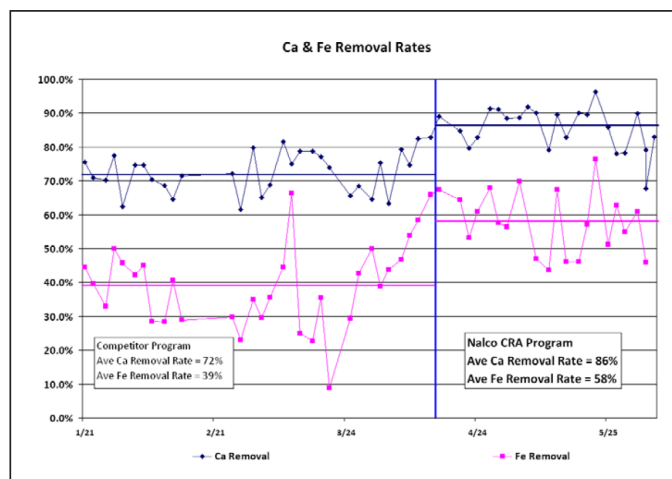


Figure 1: Ca and Fe Removal Rates – before and after Nalco Water CRA program use.

This improved Calcium removal efficiency allowed the refinery to reduce fresh catalyst make-up rates at the RCU by 6 MT/day or \$11,000,000/year in TCO savings!

The Nalco Water program was also more cost effective by approximately 10-15% compared to the competitors' program.

No operational problems were encountered in either desalter during the transition period. Desalting performance remained stable during the evaluation – both desalting and dehydration efficiencies met site KPI's (>90%). This was achieved despite malfunctioning grids and below normal desalter temperatures! There were no issues in the WWTP, effluent exchangers, or in the vessel.

The combination of the RESOLV Contaminant Removal Program provided the refiner:

- Seamless transition from competitor program to our NEW CRA technology. The desalting operation was stable and good dehydration and desalting was obtained.
- The use of the NEW CRA technology reduced the level of organic acid carryover by 55% together with a 50% reduction in neutralizer rates (Table 2).

	Competitor Program	Nalco CRA Program
Total Overheads		
Total Organic Acids	487 ppm	222 ppm
Total Neutralizer Usage	380 gpd	190 gpd
Cost	\$1,095,000	\$555,000
TCO Savings		\$540,000

Table 2: Organic Acid Carryover and Neutralizer Usage rates.

- Fouling evaluation of the hot preheat section of the unit demonstrated a decrease in fouling rate (corrected dP was used). This improved heat transfer corresponds to a significant fuel gas saving at the furnace.
- Evaluation of the WWTP influent COD showed no increase in levels impacting operations.

Comparison of preheat fouling rates and WWTP COD influent levels, with calcium removal rates, reveals a step change in performance between the two programs.

Figure 2 shows how the Nalco Water CRA program favorably impacted downstream units AND delivered increased calcium removal rates. Preheat fouling rates and WWTP COD influent levels both decreased significantly.

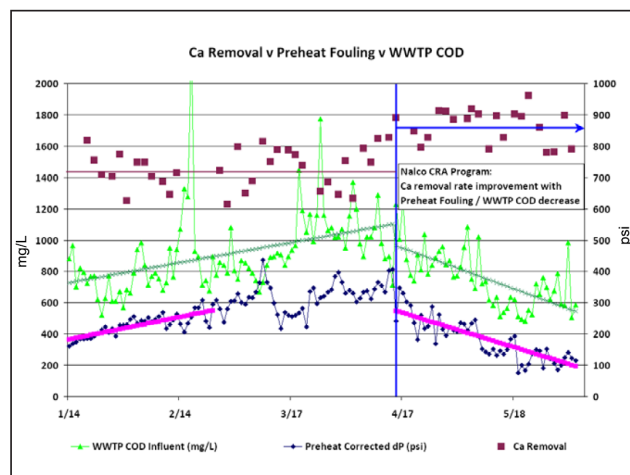


Figure 2: Improved Ca Removal and Downstream Impacts.

- Reduced ash content in decant oil (DCO) and improved fuel oil quality. Calcium levels in the RCU feed were reduced by 48% along with improved ash content in Vacuum Tower Bottoms (VTB) of 30% (Figure 3).

The lower ash content in VTB improved #6 Fuel Oil quality to the point where a settling aid application could be eliminated. This resulted in another \$350,000 in TCO savings!

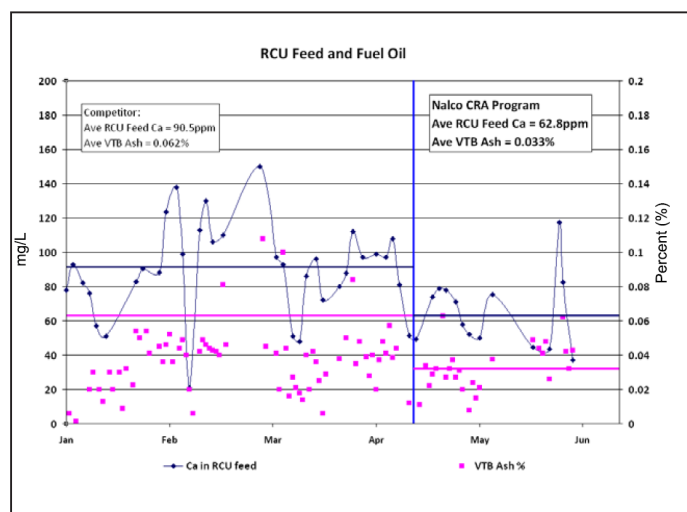


Figure 3: Reduction in RCU Feed Ca and VTB Ash levels.

CONCLUSION

Nalco Water's Contaminant Removal approach together with the total program provided the refiner performance improvements in the following key areas:

- Calcium removal rates >85%
- No fouling in the hot preheat of the unit
- Improved corrosion in wash water/effluent lines
- Reduction in overhead neutralizer rates of >50%
- No issues in the wastewater plant
- Reduction in catalyst poisons at the RCU and improved Fuel Oil quality
- A safe and reliable program to remove calcium from crude.

Including the significant benefit from the reduction in preheat fouling (fuel gas conservation, reduced heat exchanger cleaning, improved crude charge) allows the refinery to realize over \$15,000,000 per year in documented total cost of operation savings!

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