CASE STUDY

Gulf Coast Natural Gas Liquid (NGL) Plant Uses PURATE™ Chlorine Dioxide Technology to Avoid $2 Million in Production Losses and Operating Costs

eROI[SM] by Ecolab

ANNUAL SAVINGS

COSTS

Avoided production losses
$1.8 million

ENERGY

Costs associated with operating additional cooling water pumps
$106,000

VALUE DELIVERED

$2 million

BACKGROUND

When microbial fouling problems reduced the efficiency of a depropanizer overhead condenser, this Gulf Coast natural gas liquid (NGL) plant used operational data to identify and troubleshoot the problem and Nalco Water's PURATE chlorine dioxide technology to bring the system back to peak efficiency, avoiding $1.8 million in production losses and fuel costs.

Depropanizer Operation

A fractionator column separates lighter from heavier components of a NGL stream. The depropanizer separates propane (C_3) from heavier components (C_{4+}), as shown in Figure 1, a typical four-column fractionator.

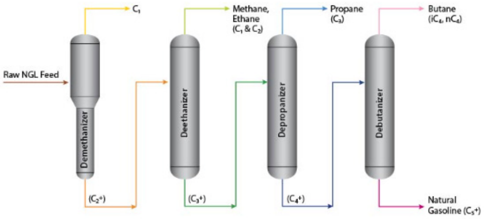

Figure 1: A four-column fractionator. The depropanizer separates propane (C3) from heavier components (C4+).

Controlling product quality to an impurity specification maximizes profit and requires tight control.

As shown in Figure 2, operating costs drop as the concentration of impurities in the product approach the specification limit.

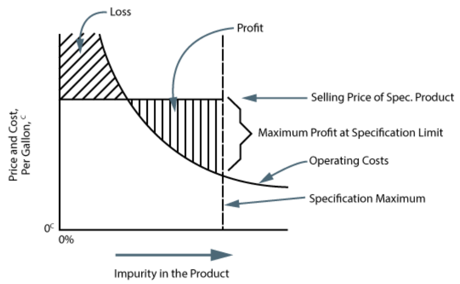

Figure 2: Economics of Fractionator Operation

Raw NGL enters the tower as shown in Figure 3. A reboiler heats the NGL in the bottom of the tower, volatilizing lighter components, in this case propane (C_3). The rising, hot propane vapor heats the raw NGL as it falls through the distribution trays. The reboiler keeps the tower bottoms hot enough to volatilize the lighter components, but sometimes — because of variability in raw NGL composition or changes in NGL flow — heavier components vaporize along with the desired components and end up in the overhead product, adding impurities that compromise finished product quality.

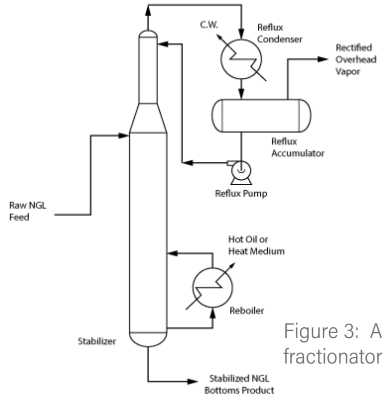

Figure 3: A refluxed fractionator column

Reflux can improve the quantity and composition of the overhead vapor. A reflux condenser draws off the overhead vapor, condenses the unwanted heavier components and exhausts the purified lighter components. The cooler, heavier, condensed fraction returns to the tower where it cools the rising vapor. Top tower temperature control is achieved by regulating the reflux flow rate.

A refluxed tower improves finished product quality and recovery, but unnecessarily high reflux rates increase operating costs. Because the condensate returned to the tower is relatively cool, the reboiler must add more heat to the tower bottom to

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to revaporize the reflux. Without the additional heat, lighter components do not volatilize, remain in the bottoms product and move to the next stage in the fractionator rather than leaving as finished product.

The overhead condenser is critical to this operation. Cooled by recirculating cooling water, scale or fouling of the waterside inhibits its efficiency. Corrosion results in premature asset failure, increased downtime and excessive repair costs. A fouled condenser cannot remove heat as efficiently, requiring more cooling water to achieve the same temperature. If flow cannot be increased, production must slow. In cases of severe fouling, the condenser cannot deliver enough reflux to control the top temperature, allowing too many impurities into the final product, necessitating rework or product rejection.

SITUATION

An industrial cooling water system represents an ideal environment for microbial growth. Warm, flowing, oxygen- and nutrient-rich water provides everything bacteria need for growth. As their numbers multiply, biodiversity alters their behavior. Planktonic organisms — those existing in the bulk water — adhere to heat transfer surfaces where they form sessile populations and multiply until they number 10 to 100 times more bacteria than the planktonic populations.

Growth of a large sessile population impacts a cooling system by insulating heat transfer surfaces. Microbial slime is 4.5 times more insulating than mineral scale, as shown in Figure 6. The slime forms as sessile bacteria excrete polysaccharides as a byproduct of their metabolism. The slime layer protects the organisms, traps nutrients and sediment and creates a new environment, under the layer, for anaerobic bacteria. These microbes thrive in oxygen-free environments and excrete corrosive hydrogen sulfide (H_2S) gas as a metabolic byproduct. Microbial Induced Corrosion (MIC) is common in cooling systems with poorly controlled sessile populations.

This plant draws cooling water from deep wells and operational and chemical requirements preclude the use of acid for pH control. The relatively high pH — 9.0 – 9.5 — makes the most common microbial control agent, sodium hypochlorite (bleach) relatively ineffective, so chlorine dioxide, generated on-site using Nalco Water's PURATE Chlorine Dioxide Technology is used in this system.

Chlorine dioxide is a fast-acting biocide and is particularly effective in high pH systems and those with process contamination. It also penetrates microbial slime masses much more effectively than other oxidizing biocides.

SOLUTION

PURATE generates chlorine dioxide using a two-component process. As shown in Figure 4, the PURATE product, a blend of sodium chlorate ($NaClO_3$) and hydrogen peroxide (H_2O_2), reacts in the PURATE generator with sulfuric acid (H_2SO_4) producing, as shown in Figure 5, chlorine dioxide (ClO_2), oxygen, sodium sulfate (Na_2SO_4) and water.

Nalco Water's PURATE Chlorine Dioxide Technology can help to reduce chemical deliveries by 80% when compared to bleach or bleach/bromine treatments.

Plant operators monitor normalized initial temperature difference (NITD), the difference between the incoming distillate temperature and cooling water inlet temperature normalized for flow. A rising NITD indicates a loss of condenser heat exchange capacity. Efficiency losses manifest as higher overhead pressures, lower production rates and higher operating costs.[1]

Nalco Water combines an on-site technical expert with innovative technology to deliver the outcomes customers need to compete in challenging markets. When an increasing NITD indicated a problem, the engineering staff worked with their on-site Nalco Water representative to diagnose the cause and develop a plan to prevent operational problems and minimize operating costs.

As shown in Figure 5, an effort was made in mid-March to optimize the chlorine dioxide dosage and assess the impact of chlorine dioxide on the yellow metal corrosion inhibitor in the system, generator production was decreased from 1.5 lbs/hr to 1.0 lbs/hr.[2] NITD was relatively high at this time and algae growth was noted, but operational data, including microbial testing, indicated normal conditions. No impact was measured on the yellow metal corrosion inhibitor.

On March 28, a turbidity spike was noted and attributed to operational changes related to a three-day outage that started

Sodium Chlorate + Hydrogen Peroxide

$$2NaClO_3 + H_2O_2 + H_2SO_4 \longrightarrow 2ClO_2 + O_2 + Na_2SO_4 + 2H_2O$$

PURATE + Sulfuric Acid → Chlorine Dioxide + Oxygen + Sodium Sulfate + Water

FIGURE 4: The PURATE Process

[1]Target NITD: 15°F

[2]Chlorine dioxide is fed at the stated feedrate four times per day.

that day. When brought back online, the chlorine dioxide application rate was increased again to 2.0 lbs/hour to address the algae concerns and an additional cooling water pump was put in service to increase cooling water flow and bring down the NITD. On May 19, the dosage was increased to 4.0 lbs/hour and, on May 23 to 6.0 lbs/hr. Prior to this change, algae growth was brought under control, but the NITD remained high. On June 17, a non-oxidizing biocide was added to further penetrate and remove any biofilm accumulated in the system. Within a few days, the additional cooling water circulating pump was taken offline and, following an additional non-oxidizer application on July 7, NITD had returned to its target. System efficiency and production rates were restored and asset damage from MIC prevented.

To prevent a recurrence of this problem and to reduce the time needed to assess the impact of operational and chemical changes, the plant engineering staff decided to adopt an innovative digital technology used on other plant cooling water systems: Nalco Water's OMNI™ Heat Exchanger Reliability Program. This digital offering collects operational data, performs efficiency calculations, compares current performance to design performance under similar conditions and, utilizing the Ecolab Global Intelligence Center (EGIC), provides technical guidance and advice.

The plant engineering staff estimates the implication of the production loss between mid-March and June 1 to have been about 3,000 – 5,000 barrels per day. At $1.00/barrel ($0.03/gallon), the cost associated with the lost production was between $228,000 and $380,000. Had the problem not been quickly detected, a corrective action plan established and the solution implemented, the plant could have absorbed $1.8 million in additional annual costs, not including the added energy costs associated with operating additional cooling water pumps which would have added an additional $106,000 in energy related costs. These efforts were particularly important at this time of very high NGL prices. Producing as much on-spec product as possible, at the lowest cost during times of high prices maximizes profits.

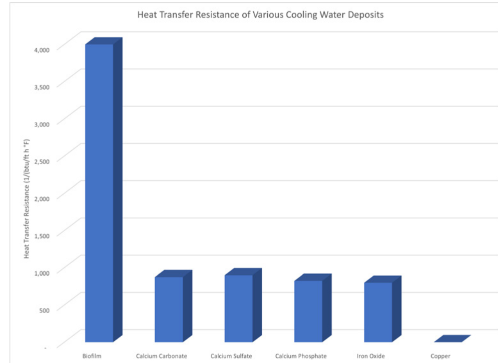

Figure 6: Comparison of the heat transfer resistance of various cooling water deposits. Microbial slime is 4.5X more insulating than mineral scale.

RESULTS

With the adoption of OMNI Heat Exchanger Reliability and PURATE Chlorine Dioxie Technology, Nalco Water and this plant have the chemical, analytical and troubleshooting tools to find, fix and prevent condenser problems quickly and accurately. It is the combination of Nalco Water on-site technical expertise and innovative technology that deliver results that matter. In this case, it's almost $2 million dollars in production loss avoidance, asset reliability and operational cost reduction.

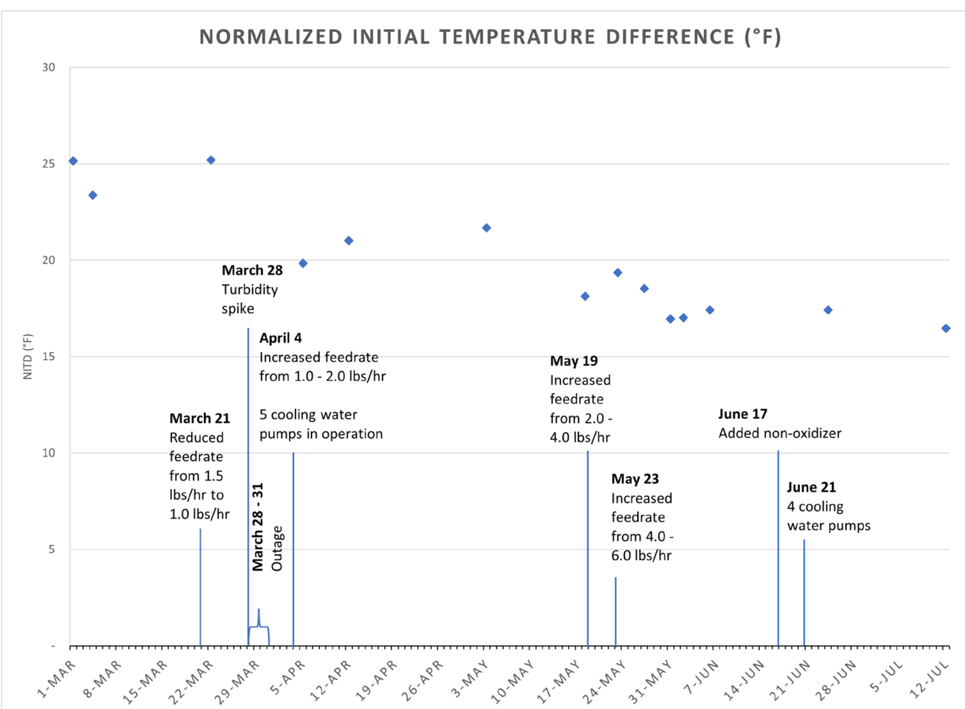

Figure 5: A declining Normalized Initial Temperature Difference (NITD) trend indicates an improvement in condenser efficiency and heat transfer

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