

PURATE™ Technology Reduces Biofouling and Improves Heat Transfer In a Once-Through Seawater Cooling System



INTRODUCTION

A major refinery complex in the Middle East has a history of chronic leaks on the seawater heat exchangers of their once-through seawater cooling system. Their goal is to be a global integrated energy and chemical company, with a focus on maximizing value creation across the hydrocarbon chain. However, challenges within the cooling system compromises their goal of minimizing operating costs in their refinery operations.

BACKGROUND

Management on-site was very focused on reducing the number of heat exchanger failures and improving the heat exchanger performance across the refinery. The leaks had been identified by the inspection department as being caused by under-deposit corrosion associated with biofouling. Biological growth was visible at the seawater inlet settling basin and the seawater outfall. The once-through seawater cooling system has a flow rate of around 20,000 m³/hr and serves various process applications across the refinery. Because of biofouling, cooling water flow rates were reduced in some of the critical heat exchangers and performance was impaired.

Historically, chlorine gas had been used to chlorinate the seawater, followed by a period using sodium hypochlorite. A chlorine dioxide program had previously been tried, however management had been unsatisfied with the monitoring and control system in place, as well as the safety aspects surrounding the storage of the chemicals and the operation of the generating equipment. The refinery had reverted back to using sodium hypochlorite with very unsatisfactory results.

The customer asked Nalco Water to provide alternative chlorine dioxide technology to maximize the productivity of the refinery through improved cooling water efficiency and plant reliability, as well as reduce the total cost of operation associated with the fouling and localized corrosion.

SOLUTION

Nalco Water assessed the situation from a chemical, mechanical and operational perspective and proposed an improved biocide program designed to prevent biofouling and improve the refinery's reliability and efficiency. Nalco Water proposed the PURATE technology

ANNUAL SAVINGS



ENERGY

Improved heat transfer savings by
700,000 MBTU

Natural gas savings of

\$4 MILLION



GREENHOUSE GASES

CO₂ emissions prevented by over

37,000
tons per year



ASSETS

Reduced maintenance costs by

\$0.5 MILLION

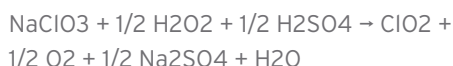
VALUE DELIVERED

Savings of over

\$4.5 MILLION

PURATE Technology

PURATE is the Nalco Water patented technology to produce ClO₂ from sodium chlorate (NaClO₃) with 100% theoretical efficiency. This is a chlorine free method to produce ClO₂, which is prerequisite for an AOX free operation.



PURATE generators are manufactured to the highest safety standards specifically for the Purate process. PURATE and sulfuric acid are fed to a reactor inside the generator using chemical metering pumps, where they react to produce chlorine dioxide. The reaction products are absorbed into a water stream via the venturi eductor. Interlocks governing water flow and reactor pressure ensure the safe operation of the ClO₂ generator. The concentration of chlorine dioxide in the effluent water from the generator is typically in the range of 500-3000 mg/l. A process flow diagram of a typical generator is shown in Figure 1.

Key Benefits of ClO₂

- Chlorine free process - no AOX or THM formation
- Preferred oxidizer for removing biofilm and preventing biofilm formation
- Practically pH independent (pH 4-9)
- Very effective for controlling Legionella, Gardia, cryptosporidium etc.
- Effective against mussels

A 6-month trial period was enacted and Nalco Water brought in a complete PURATE dosing and control package, delivered in a specially designed container. Each generator included four independently controlled dosing points.

Trial performance was tracked by monitoring a variety of parameters:

- Safety
- Visual inspection - Seawater strainers & fouling plates
- Microbiological testing

- Chlorine dioxide residuals and ORP readings
- Seawater heat exchanger performance

The PURATE program initially began as a clean-up phase due to the considerable amount of marine life in the basin as well as the seawater system itself. The injection points were located upstream of the seawater intake screens, and a number of fouling plates were inserted in different locations to measure the effectiveness of the chlorine dioxide.

At the chlorine dioxide start-up, the dosage was carefully monitored and slowly increased over the first few weeks. Gradual clean-up was essential as dislodging the excessive growth rapidly could lead to clogging in the system. After a careful clean-up phase, the dosing strategy was optimized towards enhanced heat exchanger performance.

RESULTS

The careful clean-up of the badly fouled system started with a slow increase of the dose rate until residual chlorine was detected at the outfall - indicating a cleaner system - and the dose rate could be reduced stepwise to its normal operational level. This process took three months, during which constant improvements were achieved without disrupting operations. Figure 2 shows how the Colony Forming Units (CFU) dropped during the trial period. Most importantly, a log 2 reduction in sulphate reducing bacteria (SRB), responsible for the localized pitting corrosion beneath biofilms, was found.

Upon treatment, an immediate improvement in heat transfer was observed. Figure 3 shows the overall heat transfer co-efficient of the condenser in one of the four MED

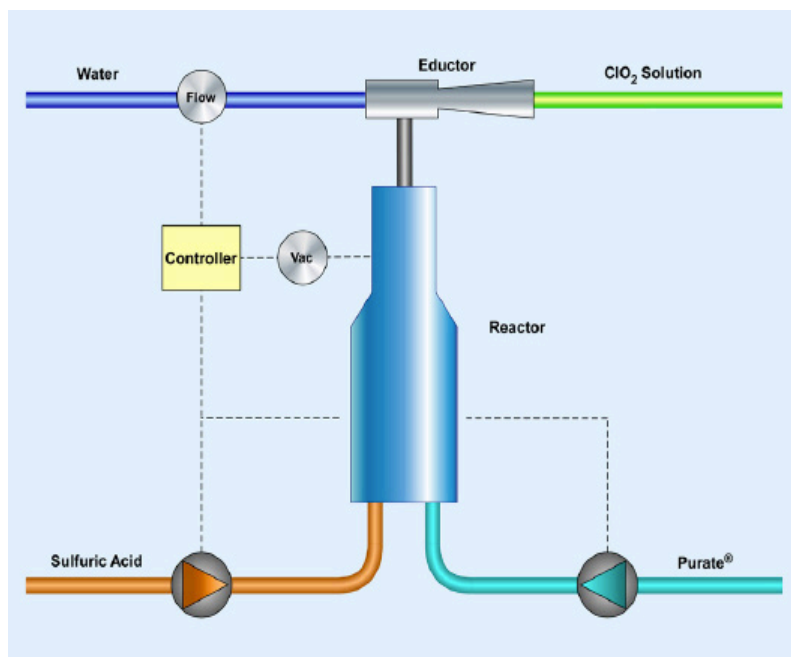


FIGURE 1: PROCESS FLOW DIAGRAM OF A TYPICAL GENERATOR

desalination systems. The heat transfer efficiency increased by a factor of four, significantly improving the desalination throughput. While Figure 4 summarizes the results of the trial.

CONCLUSION

Nalco Water’s PURATE technology delivered significant improvement to the seawater circuit, and the customer decided to implement PURATE as the best long-term solution to biofouling. The improved safety standard met the agreed upon key personal and environmental safety criteria. Visual inspection point showed the PURATE system is extremely efficient in cleaning the seawater basin, as well as the heat exchanger surfaces.

Enhanced biofouling control also improved heat transfer performance, resulting in annual savings of \$4 million. By maintaining a cleaner seawater system, maintenance costs could potentially be reduced by \$500K annually.

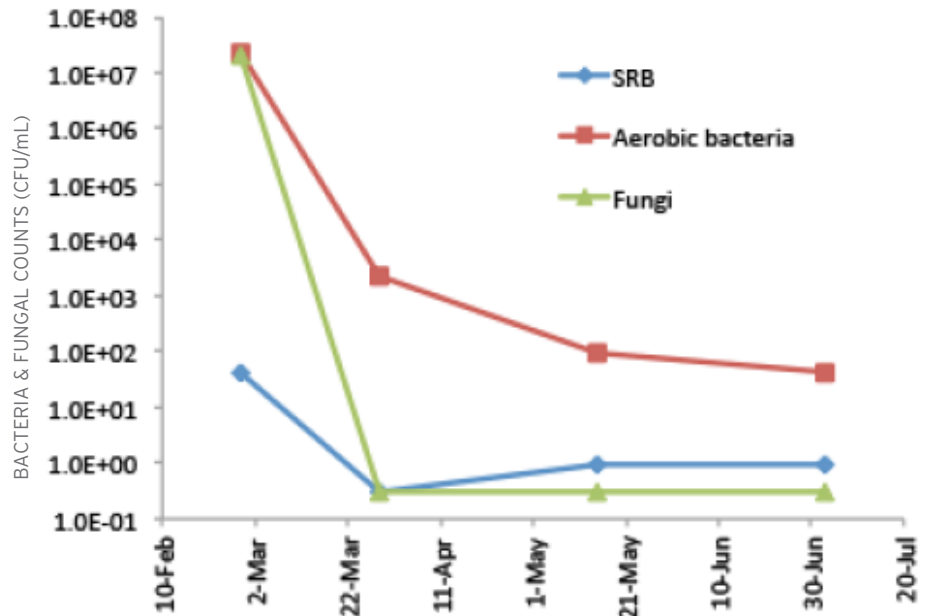


FIGURE 2: MICROBIAL AND FUNGAL COUNTS IN SEAWATER SYSTEM

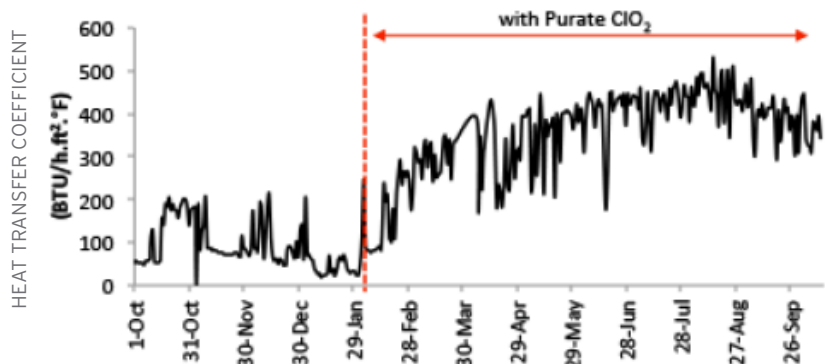


FIGURE 3: MED TRAIN C HEAT TRANSFER COEFFICIENT IMPROVEMENT

ASPECT	IMPROVEMENT
Safety	A safer system for employees & the environment
Monitoring & Control	Rigorous testing, additional ORP monitoring recommended
Analysis & Visual	Log 2 to Log 7 reduction in TVC, Cleaner Surfaces
P15-VDU Strainer Backwash Frequency Reduction	80%
P15-VDU Heat Transfer Coefficient	22%
MED-Heat Transfer Coefficient	70%

FIGURE 4: IMPACT OF PURATE TECHNOLOGY ON CUSTOMER OPERATION

BEFORE PURATE TREATMENT



AFTER PURATE TREATMENT



Nalco Water, an Ecolab Company

Downstream: 11177 S. Stadium Drive, Bldg. 31 • Sugar Land, TX, 77478 • USA

North America: 1601 West Diehl Road • Naperville, Illinois 60563 • USA

Europe: Richtstrasse 7 • 8304 Wallisellen • Switzerland

Asia Pacific: 52 Jurong Gateway Road • #16-01 Jem Office Tower • Singapore 608550

Greater China: 18G • Lane 168 • Da Du He Road • Shanghai China • 200062

Latin America: Av. Francisco Matarazzo • nº 1350 • Sao Paulo – SP Brazil • CEP: 05001-100

Middle East and Africa: Street 1010, Near Container Terminal 3, Jebel Ali Free Zone, PO BOX 262015, Dubai UAE

Ecolab, Nalco Water and the logos are Trademarks of Ecolab USA Inc.

©2020 Ecolab USA Inc. All Rights Reserved 05/2020 CH-1924

NALCO Water
An Ecolab Company

ecolab.com/nalco-water