



# PURATE™ ClO<sub>2</sub> program improves environmental and productivity metrics in a hot rolling mill



## BACKGROUND

A large integrated steel producer was experiencing excessive corrosion at its hot rolling mill (HRM) resulting in shortened roll life and costly repairs. The elevated corrosion rate was largely due to high bleach usage (used for microbio control) required to overcome significant oil contamination from mill lubricants and to maintain good Legionella control. The large bleach usage resulted in elevated chloride levels in the system and generated high levels of Adsorbable Organic Halides (AOX), and Trihalomethanes - (aka Chloroform and related species - THMs) that resulted in significant environmental fees.

Nalco Water was asked to evaluate alternative microbio control programs that would maintain good *Legionella* control while lowering the hot rolling mill corrosion rate.

## SOLUTION

Nalco Water's PURATE™ Technology is a safer and more effective method of generating and delivering Chlorine Dioxide (ClO<sub>2</sub>) solution, which has been installed at numerous plants to improve microbiological and process control.

The PURATE solution was selected for use because of the advantages it has over Sodium Hypochlorite (Bleach):

- PURATE is highly effective and soluble in water and is not consumed by oil
- Microbes, including *Legionella*, do not develop immunity to PURATE as they do with non-oxidizing treatments

### CUSTOMER IMPACT



### ECONOMIC RESULTS

Reduced AOX by 43% Reduce TMH by 33%



\$11.5K USD/year

Reduced Roll changes by ~ 13 days



\$556K USD/year

Roll Life increased 16%



aligned with the above savings

eROI is our exponential value: the combined outcomes of improved performance, operational efficiency and sustainable impact delivered through our services and programs.

- PURATE is much more effective at penetrating biofilms, killing the mass, compared to bleach
- PURATE does not add chlorides back into the system
- PURATE is effective across a wide pH range and does not hydrolyze

The solution proposed was a step-wise control and monitoring evaluation of PURATE Technology.

## RESULTS

It was believed that many sites in the system were breeding locations for microbiological activity so the team wanted to be prepared to feed PURATE at various locations, adjusting feed rates as needed. The PURATE Generator is engineered to meet these requirements because it is customized to handle numerous injection sites and the PLC controller is able to dose eight different dosing rates per day.

The trial evaluated the effectiveness of the PURATE chemistry at different dosage levels and different dosing locations. Microbio effectiveness was measured by using Polymerase Chain Reaction (PCR), Adenosine Triphosphate (ATP) rapid microbiological testing along with weekly Legionella testing.

PCR test results (see Figure 1) increased during the early stages of the trial but then decreased to below the pretrial baseline required for good Legionella control. The early stage of the second dosing phase also showed an initial spike of PCR results which was not surprising as the PCR test measures all living and dead DNA, measured as Genomic Units per liter (GU/L). These higher spikes reflect the attack from PURATE on the system-wide biomasses. Concurrent to this increased "kill", was a resulting drop in ClO<sub>2</sub> residual.

	Early November	Mid-December	Mid-February
<b>Average PCR (GU/L)</b>	175,000	252,857	64,857

Figure 1: PCR data, average across 8 locations in the system

It's important to note, that in an HRM system, the levels of oils & grease and biofilm present in the system initially require more demand of PURATE (see Figures 2 and 3). This is because it effectively penetrates all biofilms and kills more microorganisms than traditional bleach treatment, thus the greater ClO<sub>2</sub> demand. This was expected and clearly confirmed in the trial results.

Ultimately, greater system-wide microbio activity (new colony formation) was controlled with PURATE as reflected in the very low levels shown at the end of the graph in Figure 2.

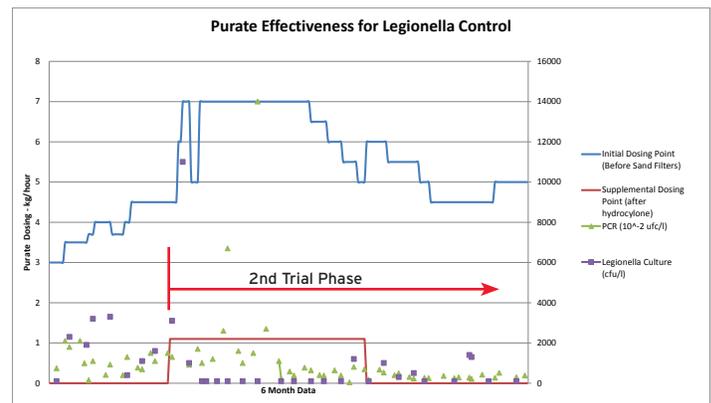


Figure 2

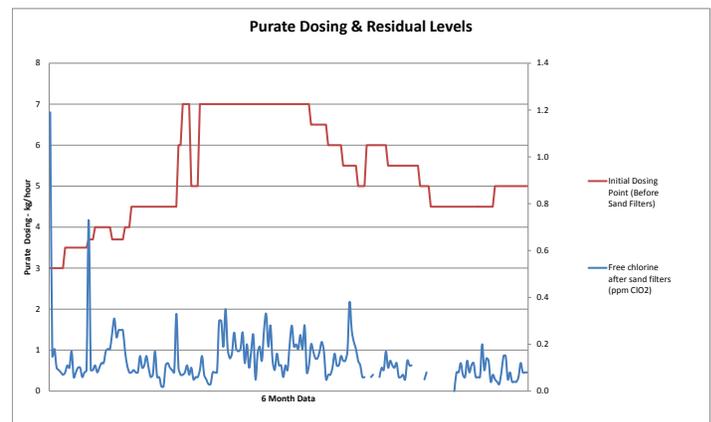


Figure 3 - Residual ClO<sub>2</sub> during the trial

During the trial it was noted that the backwash water exhibited significantly higher PCR levels. Because this water is high in oil, it was decided to inject bleach and bromine on the backwash water to help "kill" the oil and prevent it from returning to the system.

Prior to the PURATE System, the backwash water only had bleach injected, but due to the documentation of the PCR/ATP, it was found that the addition of Bromine resulted in greater system-wide effectiveness.

Results from the trial were used to develop a non-continuous dosing strategy that utilized the PURATE System's PLC to accurately dose the correct amount of ClO<sub>2</sub> to each feed point ensuring optimum system performance.

During this six-month evaluation, more than just microbiological activity was trended. The plant was also concerned that the continued use of bleach was generating higher than desired AOX and THM and the mill was concerned about in situ corrosion due to the higher levels of halogen that bleach put into the system.

As seen in Figures 4 & 5, the hazardous by-products began to immediately trend downward (Figure 4)... for the six-month trial; the AOX and THM were reduced by 43% and 33% respectively (Figure 5) from the measured levels prior to the PURATE solution.

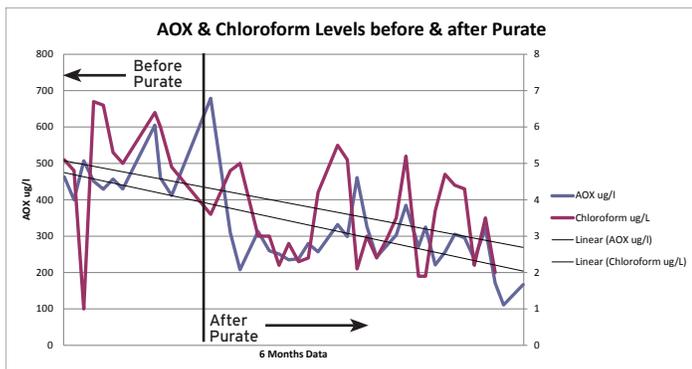


Figure 4 - AOX & THM trend

	AOX µg/l (average)	Chloroform µg/L (average)
Hypochlorite	481	5.0
Purate	273	3.4
<b>% Reduction</b>	<b>43%</b>	<b>33%</b>

Figure 5 - AOX & THM % reduction with Purate

Due to the increase of halogen in the system, the mill had an automatic blowdown when the chloride concentration exceeded 180ppm. As shown in Figure 6, the year before PURATE was introduced, the mill consistently reached this limit, thus forcing system wide blowdowns. This is not ideal from a sustainability standpoint as it increases water usage.

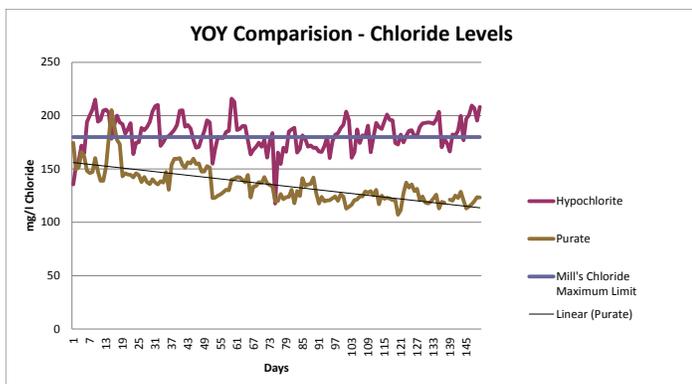


Figure 6 - YOY Chloride levels in the mill water - Before & after PURATE

Since the introduction of PURATE Technology, there has been a consistent and continued improvement in the mill's chloride level. The year-over-year (YOY) data shown in Figure 6 shows a reduction in chloride of 27%, but more importantly, bulk water corrosion, as measured by mild steel coupons for the same period decreased by 50%.

One of the most interesting findings with the reduced chlorides (from Bleach) and improved corrosion control of the water was the reduction in the reversal of rougher work roll changes (RM1) due to reduced chloride stress cracking. It was reported in November, 2015 issue of

AIST that the addition of free chlorine from bleach, in the presence of dissolved chloride ions, is a detrimental factor in work roll life and the findings at the client site confirmed the articles' laboratory findings†.

Typically, the roughing mill was changed every 120,000 tons. With the addition of PURATE Technology, the change was every 140,000 - 145,000 tons.

According to TCO discussions with the client the savings are estimated to exceed \$556,000 USD in production gains.

**These findings were significant. Lower system corrosion resulting from the PURATE System directly translated into operational enhancements of the work rolls and increased production time.**

## SUMMARY OF BENEFITS

After ten months of evaluation, Nalco Water and the customer agree on the following benefits:

- Legionella control was achieved with PURATE and proved to be a more effective alternative to bleach/ bromine
- Reduction in the AOX/THM taxes → ~ \$11.5k USD/ yr
- Productivity → Saving \$556k USD/yr
- Assets protection → increase in roll life ~16%

Critical to the success of the integration of PURATE Technology was the on-site service support of the Nalco Water and the ongoing monitoring of numerous variables from the onset of the trial as well as the knowledge and experience with the system to modify the program (feed rates, dosing locations, process data collection etc.) in order to optimize the program.

It is important to note that PURATE Technology is not just a ClO<sub>2</sub> injection product. It is a comprehensive, strategic program which combines a safer, unique, mixing technology that is integrated into a comprehensive monitoring, microbio mapping and service offering. Overall, the PURATE System has demonstrated much greater value to the end user than just "bug control".

† "Investigation on work roll corrosion and Oxidation Mechanisms in a Hot Strip Mill" - Iron & Steel Technology, November, 2015, page 81- A Publication of the Association for Iron & Steel Technology

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