# NALCO Water Optimizes Performance and Operational Costs on Water Treatment (UF/RO) Plant at an Opencast Mining

NALCO Water
An Ecolab Company

CASE STUDY – MINING
CH-1887E

## INTRODUCTION

Cobre Las Cruces S.A. is an opencast mining complex located south west of Spain and is dedicated to the extraction and treatment of copper by a method called hydrometallurgy. On average, copper production amounts to 72,000 tons/year.

Water quality is very important in the mineral treatment process and makes water a vital resource for the mining industry. This, along with the environmental commitment of Cobre Las Cruces's mining project, has promoted the development of a complex system that will provide optimization of their treatment plant operation, maximize the water resources preserved through self-sufficiency and minimize the water discharged. This will ultimately increase operational efficiency while meeting Cobre Las Cruces's sustainability goals.

The water treatment process includes direct treatment of raw water ponds, physical-chemical treatments, sand filtration, ultrafiltration and reverse osmosis.

- The Mine Barrens Plant (Instalación de Estériles de Mina, IEM) and Barrens Treatment Plant (Instalación de Estériles de tratamiento, IET) ponds receiving leachates from tips where poor materials are collected. This is the area with more complex water quality.
- Water Contact Pond (Balsa de Aguas de Contacto, BAC-4) is an equalization pond receiving relatively good quality contact water (any surface or groundwater present at the mine site and in contact with the mineral) and some neutralized water from the Contact Water Emergency Pond (Balsa de Emergencia de Aguas de Contacto, BEAC).

| Customer Impact | eROI℠ | Economic Results |
|---|---|---|
| 40% reduction on water discharge | WATER | 331,000 €/year |
| 22 % reduction in energy required | ENERGY | 32,000 €/year |
| 2 additional years membrane life extension (from 3 to 5 years) | ASSETS | 761,300 €/year<br>Total 1,522,600 € in 2 years |
| Chemical reduction | | 87,000 €/year |

- Contact Water Emergency Pond, BEAC. Mixing point of leachates and water contact. Water is treated with lime and generated sludge is dewatered in filter press.
- Contact Water Conditioning plant (Plata de Acondicionamiento de Aguas de Contacto, PAAC) acts as a settler. Water pH is controlled with caustic (NaOH) and treated with coagulants. Sludge is also treated with filter press devices.
- Clarified water is sent to BAC-3, a 65,000 $m^3$ pond to fed Agua de Contacto (AC) water treatment plant including Planta de Filtración de Arenas PFAA sand filters, 2 UF lines and 3 RO lines, 2 of them with a 3 stages configuration and different membrane, spiral and flat.

Permeate water is sent to the hydrometallurgy plant obtaining copper. This process is demanding around 150 $m^3/h$ of permeate continuously. Water quality is the key for a good recovery copper extraction and final product quality.

Mass and chemical balances are important for the right management of large water volumes used in this industry. Seasonal variations of water volumes due to rainfalls, high variability in water quality including pH, conductivity and metal concentrations, among other pollutants, represent a constant threat to maintain flows and water quality but also for maintenance and plant operation or ultrafiltration (UF) and reverse osmosis (RO) membranes life.

Mining activity is another factor affecting water quality in the process as well as varying leachates composition when mineral extraction phases change.

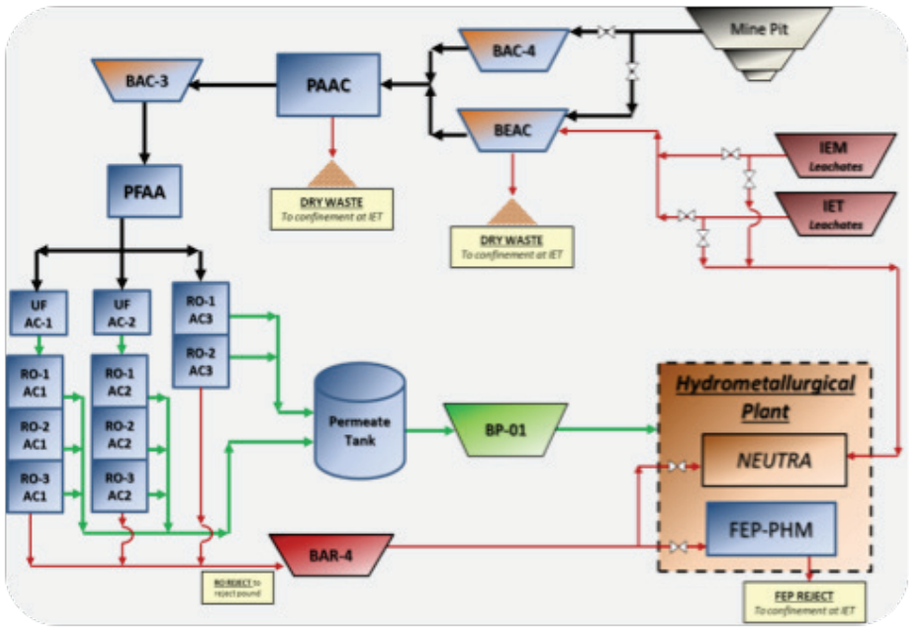


**Figure 1** – *Cobre Las Cruces water treatment plant schema*

Finally, and importantly, they must comply with environmental restrictions regarding generated water volumes, seasonal specific concentration limits in some pounds, volume and quality of water discharge to final media.

Due to the water process complexity and lack of resources, the customer asked NALCO Water for help on the water treatment management as a consultant and service provider.

## ACTION PLAN

The NALCO Water approach was to implement operational best practices, installing best available technologies including 3D TRASAR™ Technologies to have complete overview, monitoring and control of the process. Moreover, new treatment and water management strategies were put in place in order to adapt the plant operation to the changing water conditions, to optimize key parameters indicators (capacity, availability, quality and reuse) and reduce total operating costs.

The action plan implemented together by Cobre Las Cruces S.A. and NALCO Water included:

- A NALCO Water person on-site to follow up key operational parameters.
- NALCO Water expert recommendations:
  - System audits looking for maintenance and operational improvements.
  - Specific cleaning protocols with NALCO Water products (instead of commodities) adapted to different fouling events.
  - Specific chemical programs to different water and operational conditions.
  - Support from NALCO Water service department about specific RO system design questions.
  - Training.
- 3D TRASAR Technology implementation for a better antiscalant monitoring and control.
- Mindset change about water ponds management from just water reservoirs to regulation/ equalization elements.

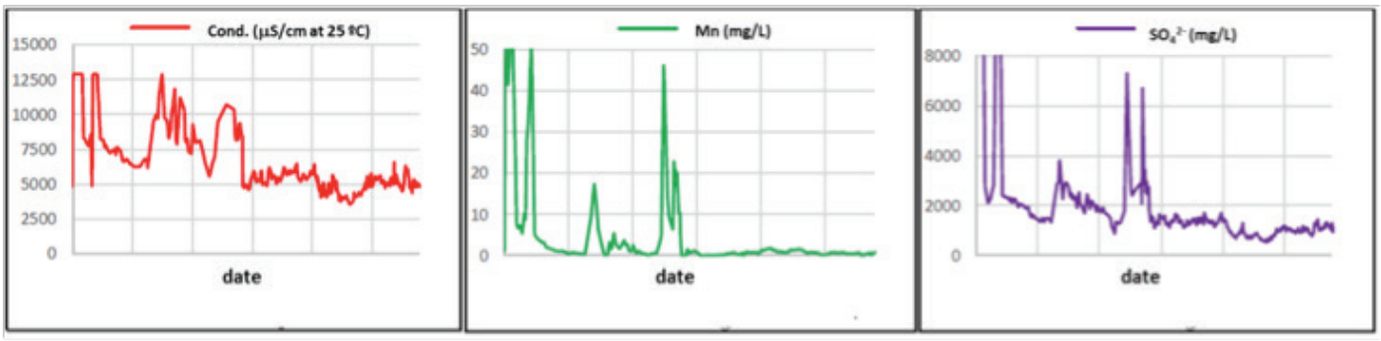


**Figure 2** – *Graphs showing better water stability achieved*

| Ba (%) | $HCO_3$ (%) | Cd (%) | Ca (%) | Cu (%) | Mg (%) | Mn (%) | $SiO_2$ (%) |
|---|---|---|---|---|---|---|---|
| 25,45 | 58,16 | 87,87 | 28,40 | 13,94 | 24,77 | 92,28 | 32,16 |

**Figure 3** – *Table showing average % removal of some species at PAAC after action plan implementation*

- Better control of mass balance and water flows arriving to BEAC. This follow up is critical to guarantee right performance of the system and permits maintain water quality required for next treatment steps.
- Convert PAAC initially designed as a sand trap into a physical-chemical treatment. Despite the operation in this way means a continuous and arduous monitoring it will permit remove important quantities of dangerous species for membrane system.
- Installation of sand filters to protect UF operation as a response to severe fouling events that reduce availability and performance of this membrane system.
- Recommend low energy membranes to reduce energy consumption.
- Flexibility about monitoring and programs to different conditions. For instance, increasing analysis frequency during rainy periods or using biocide to protect membrane systems in dry seasons.
- Daily evaluation of membrane system operation to adapt chemical programs and system operation to actual conditions. This includes water analysis and use NALCO Water RO Optimizer software.

## RESULTS

The NALCO Water water treatment manage-ment strategy has provided better water quality to be treated on membrane systems and assists in adapting the quality for required specifications.

The control of water flows arriving to first pond and the physical-chemical treatment implemented on the PAAC unit resulted in a more stable quality and higher percentage removal of the dangerous chemical species in UF/RO membrane systems.

The installation of sand filters before UF system and NALCO Water programs contributed to improved water quality reducing turbidity, obtaining SDI values as required (<3) and lowering, among other contaminants, Fe and Al which can foul UF and RO systems. Without sand filters UF availability and recovery was lower than designed due to frequent cleanings needed.

In terms of UF/RO systems, benefits achieved can be summarised as follows:

- Despite treating worst raw water quality due to mining extraction activity, the overall UF/RO system recovery have been increased to 85% (currently over design), while it was around 65% initially.
- Increase in an average around 27% water treatment capacity up to 4,400 $m^3$/day, being able to manage pics of 7,200 $m^3$/day maintaining close to 80% global recovery.
- Significant decrease of reject volumes around 40%, and related costs, around 331,000 €/year, compared with start-up period. This permit matching water discharge requirements.
- Use of NALCO Water chemical treatments and specific cleaning protocols UF trans-membrane pressure decreases to design values, meaning better operation and improved permeate quality feeding RO system with water SDI values <1 most of the time.
- Reduced UF cleaning frequency, from backwash every 15 minutes and CIP every 150-200 h in the past to backwash every 60 minutes and CIP every 1200 h currently. This means, besides lower chemicals for cleanings, a huge reduction in water losses due to cleanings, from > 17% to <4% currently. Estimated savings are 37,800 €/year.
- Lower RO cleaning frequency, from restorative cleanings every 200-300 h to the current preventative cleanings every 1,000-1,500 h.

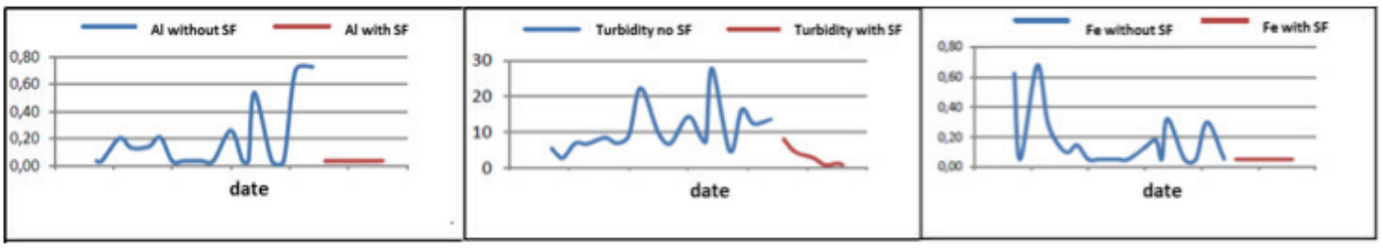


**Figure 4** – *Water quality comparison before and after sand filter installation*

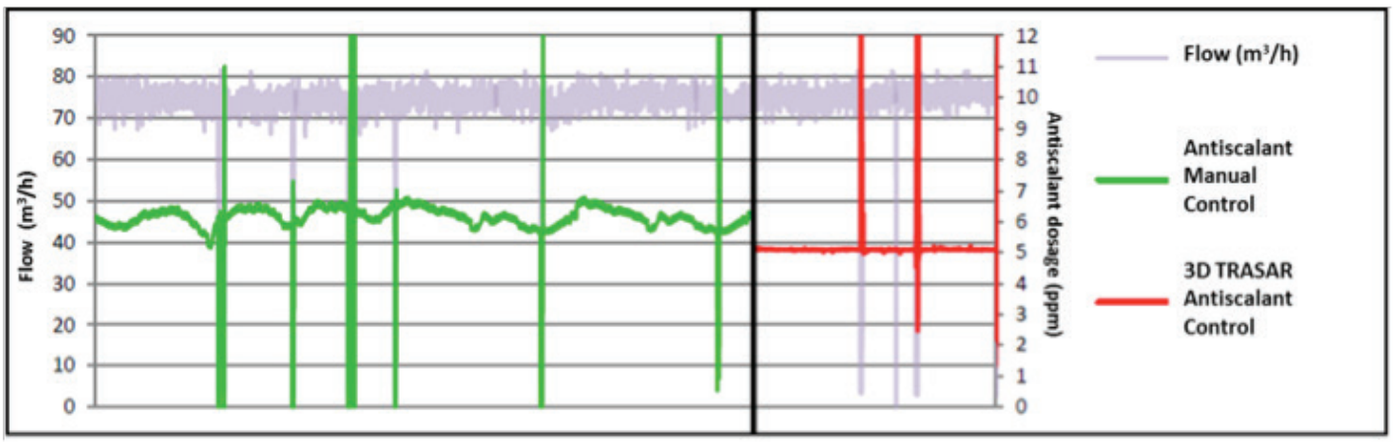


**Figure 5** – *Better antiscalant control from 3D TRASAR Technology*

| | UF | RO | | |
|---|---|---|---|---|
| | | 1st Stage | 2nd Stage | 3rd Stage |
| Estimated membrane life (years) | *3* | *3* | *2* | *1* |
| Current membrane life (years) | *> 5* | *5* | *4* | *3* |

**Figure 6** – *Membrane life improvement*

- NALCO Water antiscalant permitted operate RO system at > 92% recovery even when sulphate and calcium concentrations on final reject very high, while maintaining expected permeate quality.
- Compared with the start-up period, achieved 80% reduction on antiscalant needs (estimated in 50.000 €/year) thanks to 3D TRASAR Technology monitoring and control and adapting dosage just to the actual needs.
- 22% energy savings (32,000 €/year) in RO system by installing low energy high recovery membranes.
- Extended membrane life even running systems with worst raw water quality than expected. Since plant started-up cumulated savings of 1,169,000 € in RO membranes and 353,600 € in UF membranes.

## CONCLUSIONS

Water quality issues and potential process complexity in water treatment and management at mining sites can pose many challenges. The correct water treatment management is very important since it not only affects the entire copper production process but also has large impacts on the environment and communities surrounding the mining. A thorough and methodical control and follow up of water treatment parameters is the key to optimize systems and reduce operational costs while complying with copper process requirements as well as environmental legal restrictions.

Close cooperation between Cobre Las Cruces S.A. and NALCO Water has represented an outstanding combination of on-site expertise to meet water, energy and cost reduction. The NALCO Water solutions were able to help Cobre Las Cruces achieve both operational and environmental goals. The use of NALCO Water 3D TRASAR Technology to monitor and control risks correctly, has enabled significant contributions to water use efficiency and sustainability to meet Cobre Las Cruces S.A.'s key business drivers.

This has built a strong business partnership between Cobre Las Cruces S.A and NALCO Water, based upon a joint commitment to continuous improvement and sustainability.

NALCO Water would like to thank Cobre Las Cruces S.A for their permission to publish the information contained in this Case History.

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