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OPERATION & MAINTENANCE

Plant Bowen

Evaluation of Long-Term Membrane Performance with Continuous Use of Hydro-Optic UV Dechlorination at Plant Bowen

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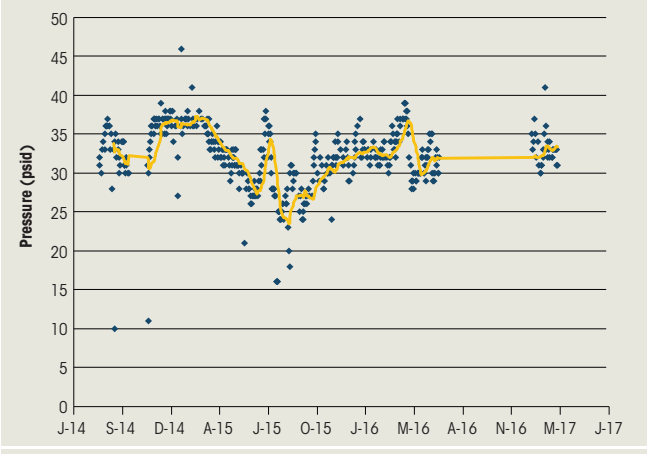
In 2014, Plant Bowen, a 3,160 megawatt coal-fired power station, in Cartersville, Georgia was facing frequent membrane and micron-filter maintenance and replacement as a result of biological fouling and oxidation despite their use of a sodium metabisulfite (SMBS) dechlorination process. Free chlorine compounds are removed from feed water with the dechlorination process; protecting the memebrane elements and other chlorine sensitive equipment.

The facility undertook a three month evaluation of a non-chemical dechlorination process, the Hydro-Optic (HOD) UV water treatment technology, manufactured by Atlantium Technologies, Inc., to improve the overall quality of reverse osmosis (RO) feed water at the Plant.

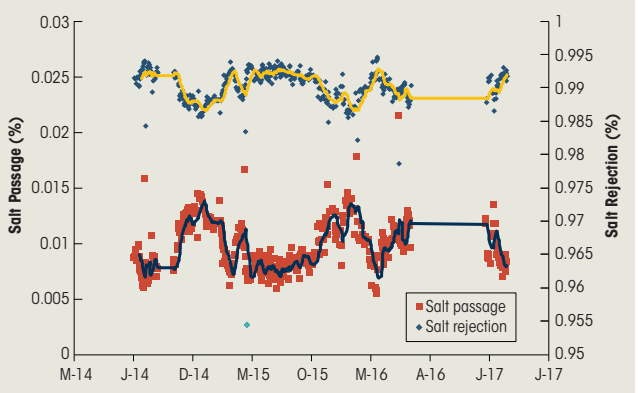
Three RZ300-13 HOD UV systems were provided to Plant Bowen in March 2014 to accommodate a flow rate of 680 gpm (154 m^3/hr) with 95 percent UV transmittance.

The units were installed in series on existing stainless steel piping after the media filters and before the micron and RO trains. At the conclusion of the evaluation period

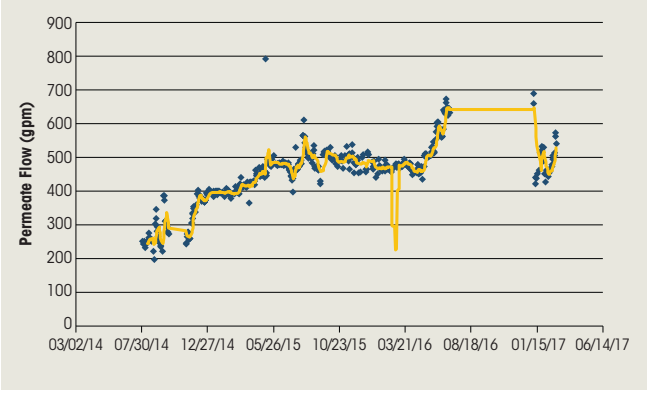
Train A Differential Pressure during 940 days of operation 1



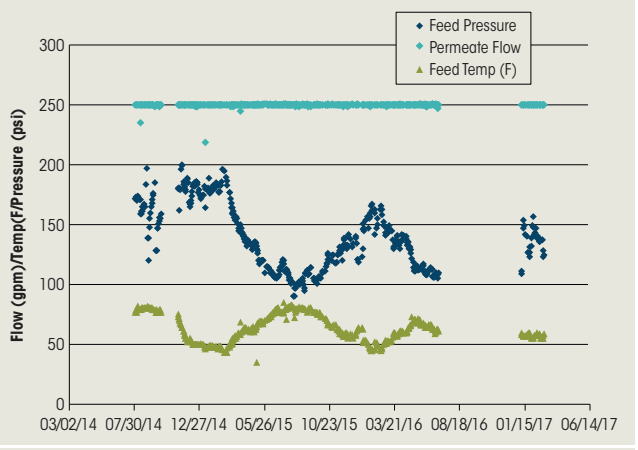
Train A Normalized Salt Passage and Rejection during 940 days of operation 2



Train A Normalized Permeate Flow during 940 days of operation 3



Train A Permeate Flow, Feed Pressure, and Feed Temperature during 940 days of operation 4



in May 2014, the technology had effectively removed free and total chlorine from boiler feed water to undetectable levels from inlet free and total chlorine levels above 1 ppm [1].

Following the successful demonstration of the technology, Plant Bowen incorporated the system into full-scale operations at the plant – a decision that has proved favorable for dechlorination efforts at facility.

PLANT PROCESS AND OPERATIONS

Plant Bowen receives its source water from the Etowah River. Following clarification and multimedia filtration, water passes through a two-stage micron filter process before entering the RO system. The two-stage micron filter process is composed of two trains, each containing a 3-micron filter followed by a 1-micron filter.

The RO system consists of two 250 gpm (114 m^3/h) trains (Train A, Train B) containing 72 membranes (DOW BWXFR-400/34i) per train. The RO system is arranged in a double pass configuration with 48 membranes in the first pass, followed by 24 membranes in the second pass.

The facility samples twice a week for feed water quality (pH and turbidity) and permeate and concentrate values of the RO system.

Given the Plant's problem with microbial growth and the creation of a biological matrix in the RO filters that restrict flow; differential feed pressure, effluent pressure, normalized flow, and chlorine residual are measured daily. A 10 percent increase in differential pressure alerts operational staff to undertake a cleaning of the membrane system with a caustic and acid solution.

The membrane cleaning process requires the facility to run at half capacity for 48 hours since each train is taken offline for a 24-hour period to have the membranes rinsed before being returned to service.

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Prior to the installation of new membrane elements in March 2014 an autopsy was performed on the existing elements and it was determined the facility had a sulfur reducing bacteria contributing to their microbial growth problems.

Operational staff felt that reducing the use of SMBS would lessen the biofouling potential since the bacteria's food source would be eliminated; enabling nature to take its course and cause the bacteria die off.

However, under the existing system design this reduction could not be achieved given that free available chlorine was above 1 ppm. Alternative dechlorination methods were then evaluated.

As a non-chemical approach to decompose the free chlorine oxidant and protect the RO membranes, the HOD UV technology provided the facility with the opportunity to reduce or eliminate the use of SMBS and reduce maintenance and associated costs.

HOD UV TECHNOLOGY-PRINCIPLES OF OPERATION

The HOD UV technology is a physical process for disinfection that exposes bacteria, viruses and protozoa to germicidal wavelengths of UV light, measured in nanometers (nm), to render them incapable of reproducing or further infecting a water system. Through UV oxidation, UV light can also destroy chemical contaminants.

The technology measures four critical parameters including percent ultraviolet transmittance (UVT%), flow rate, UV lamp intensity (kW) and apparatus (consisting of Total Internal Reflection and Dose Pacing) in real time to maintain a specified UV dose.

The system uses a proprietary Total Internal Reflection (TIR) based design that when coupled with the comprehensive monitoring of critical parameters allows the system to achieve and maintain the specified UV dose.

The system's patented TIR technology, which is similar to fiber optic science, recycles UV light energy within the HOD UV chamber.

This is especially important given that in traditional UV systems metal adsorbs or "detracts" the UV dose the closer it gets to metal, whereas the TIR enhances the UV dose. Simply put, the UV photons are effectively lengthened and provide a greater opportunity to inactive microorganisms and decompose the free chlorine.

The core of the technology is its water disinfection/chlorine-decomposing chamber made of high-quality quartz surrounded by an air block instead of traditional stainless steel. This configuration uses fiber optic principles to trap the UV light photons and recycle their light energy.

The photons repeatedly bounce through the quartz surface back into the chamber, effectively lengthening their paths and their opportunities to inactivate microbes.

LONG-TERM MEMBRANE PERFORMANCE WITH HOD UV DECHLORINATION

Plant Bowen uses a five-year replacement cycle for the RO elements, the last installation occurred in March 2014. The HOD UV system was also installed and placed into continuous operation in March 2014.

After three years of operation, the RO membranes are operating at the same level as new elements.

Data for the membrane system's differential pressure, normalized salt passage and rejection, permeate flow, and normalized permeate flow under the use of the HOD UV system was analyzed for a 940 day period from August 2014 to February 2017 (Figures 1-4 on pgs. 82-83). Normalized permeate flow is higher compared with a new membrane, while the quality of the permeate (salt passage and rejection) is similar to a new membrane.

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Prior to the installation of the HOD UV system the membranes were cleaned one to two times per month; with marginal improvement since 2014. However, what's most interesting is that the driver for cleaning the membranes has changed.

After three years of operation, the membranes are only up to 34 psi differential pressure from the original 28 psi when they were put into service; indicating a longevity of the membrane elements that didn't exist without the use of the HOD UV technology. Comparatively, the pre-2014 membrane elements were running at a 50 psi differential pressure after three years of operation.

Based on the 5-year replacement cycle for the RO elements, they are scheduled for a change out in 2019.

If performance remains positive, the facility will evaluate the possibility of increasing the life span another year. This would result in an additional cost savings of $100K.

Performance of the micron filtration system has also been enhanced with the use of the HOD UV technology. In 2015 the 4 pre-RO micron filters were changed six times, then reduced to four times in 2016, and two times in 2017. The reduction in cleaning frequency has resulted in a net savings of $160,000.

Since the installation of the HOD UV systems the chemical feed rate has decreased by 75 percent; whereas the facility was originally feeding SMSB at 4 ppm rate in 2014, the 2017 feed rate was 1 ppm.

The monthly chemical usage had been reduced from 44.2 gallons per month in 2013, to 7.6 gallons per month in 2017. The facility has realized an annual cost savings of $5,000 with the reduction in chemical usage.

Although the HOD UV technology has been proven to effectively remove free and total chlorine to undetectable levels from inlet free and total chlorine levels above 1 ppm; the facility maintains the 1 ppm SMBS feed rate as an asset protection method in the event of a power failure that would prevent the operation and delivery of dechlorination control from the HOD UV system.

Since SMBS is an oxygen limited chemical there is the option to alter the SMBS dose from continuous to periodic thereby enabling a constant change between an anaerobic and aerobic state to enhance the instability of any bacterial growth. This option has not yet been explored at Plant Bowen.

CONCLUSION

Incorporating the non-chemical HOD UV technology into full-scale operations at Plant Bowen has proven favorable for dechlorination efforts at the facility. In addition to reducing the use of SMBS, the facility has also minimized the frequency of micron filter replacement.

These operational efficiencies have resulted in a net savings of $175,000, providing a two-year return on investment. Moreover, there has been no reduction in performance to the RO membranes with the use of the HOD UV technology.

As a result, Plant Bowen has been able to maintain the integrity of their feed water for the boiler and steam cycle, ensuring production and quality levels necessary for the facility to operate efficiently. pe

REFERENCES:

[1] Boiler Makeup Water Dechlorination Using Advanced UV Technology

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Atlantium Technologies Ltd. is a global leader in UV treatment solutions for municipal and industrial applications. Atlantium's Hydro-Optic (HOD) UV system is a proven and effective alternative to chemically based treatment solutions. Facilities looking to achieve non-chemical disinfection, dechlorination, or oxidation will benefit from the use of the Hydro-Optic UV technology.