Aquafine®

TROJAN technologies®

APPLICATION NOTE

APPLICATION: Monochloramine Reduction

Aquafine® Ultraviolet Treatment Systems for Chloramine Reduction

Chloramine vs. Chlorine

Chloramine - a mixture of chlorine and ammonia - is commonly used to treat municipal drinking water. Although it is a weaker disinfectant than chlorine, it is more stable, which extends its disinfectant benefits throughout a water utility's distribution system.

For more than 100 years, most public water supplies in the US have been treated with chlorine to satisfy the standards set by the Safe Drinking Water Act of 1974. However, over 40% of utilities today have made the switch from chlorine to chloramine, largely due to its advantages as a longer-lasting residual and that it produces fewer disinfection by-products.

Although chloramines can exist as mono-, di-, and tri-chloramine, dichloramine and trichloramine are less effective disinfectants and impart an unpleasant odor to the water. Therefore, chloramination processes are optimized for monochloramine production.

From a water treatment equipment optimization point of view, since chloramine remains active longer in the water and does not dissipate by itself, downstream membranes can be damaged by the oxidizing power of chloramines. For municipal water utilities now using chloramines rather than free chlorine to treat water, this reduces membrane performance and lifetime.

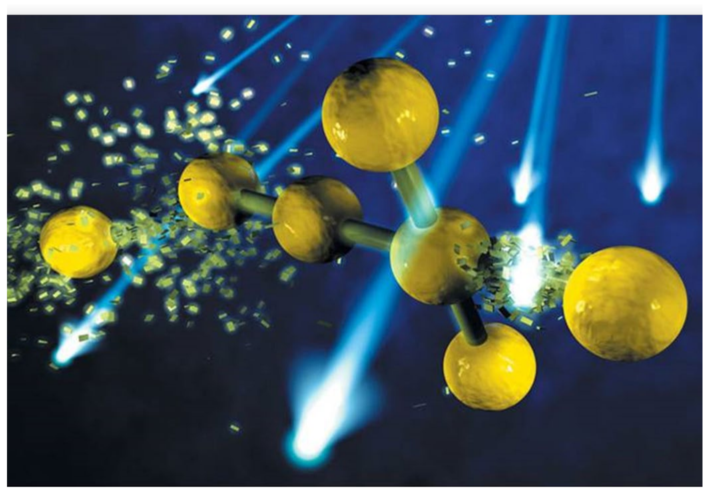
Unfortunately, chloramines come with many disadvantages. Though they help keep us safe from pathogens, they are also known to be challenging to remove and is a known irritant with corrosive properties.

Common Methods for Chloramine Removal

Ultraviolet Water Treatment

Ultraviolet (UV) technology using low-pressure lamps is a highly effective, versatile, and reliable method to address numerous requirements in industrial water applications, including chloramine reduction. Studies have demonstrated conclusively that chloramine residuals up to 4 ppm can be successfully reduced to < 0.02 ppm by the application of UV light.

Ultraviolet treatment using photolysis is rapidly growing in popularity. The breakdown products from treating monochloramine with UV are primarily nitrate, nitrite, nitrogen, and chloride ions which are non-hazardous. At typical pH and dissolved oxygen levels in municipal treated waters, ammonia formation is negligible.



Granular Activated Carbon (GAC)

Fixed-bed carbon adsorbers are designed to operate continuously and typically consist of two or more carbon beds where at least one regenerated carbon bed is always available for adsorption, thereby allowing continuous treatment. In a system with two carbon beds, each bed must be large enough to handle the entire flow while online. This means twice as much carbon must be provided (n+1 design) than for an intermittent system handling the same flow, leading to a large footprint.

Carbon has a limited capacity for organic removal. As the surface of the carbon becomes saturated with organics, the removal capability of the bed is diminished. At this point, the carbon bed must be replaced, or, alternatively, the carbon can be regenerated at very high temperatures to remove the organics.

With the high concentration of organics in the carbon bed, the surface of the carbon provides an ideal environment for the growth of microbiological contaminants. Most plants take precautions to control these populations in GAC filters via regular hot water or steam sanitization of the carbon bed. The frequency of sanitization is determined by factors including the raw water quality, intended used of the treated water, and overall operating experience with the system.

While well-known for its ability to remove chlorine, regular activated carbon is less effective for chloramine removal, requiring the water to have an extended contact time with the carbon bed.

The challenge of chloramine removal has led to the production of a modified carbon called catalytic carbon. Catalytic carbon is a higher-cost, specialty carbon designed to greatly enhance carbon's natural ability to remove chloramines. Although catalytic carbon is more effective than standard activated carbon for chloramine removal, the challenge of large footprint (n+1 design), biofouling, and regular carbon changeout remains. Regardless of the type of carbon used for chloramine removal, they require a larger physical footprint and water footprint (for backwashing and rinsing the carbon) than UV. Additional challenges arise when "Net Zero" directives need to be met with the use of carbon beds.

Dechlorination Chemicals:

To dechlorinate water, a reducing chemical such as sodium bisulfite is commonly used. Sodium bisulfite is a dechlorination agent that can remove or neutralize chloramine in water, and effectively eliminates chlorine residuals, preventing their adverse effects on downstream processes and ensuring the water meets desired quality standards.

Sodium bisulfite in solid form is mixed to form a solution, or as liquid form, is employed in industrial processes via chemical dosing pumps and metering skids where chloramine removal is necessary. Accurate process control and monitoring of sodium bisulfite delivery is critical, as significant overdosing leads not only to excess operating costs, but sulfate formation, suppressed dissolved oxygen content, and lower pH of the finished effluent. These can have an adverse effect on downstream processes. Furthermore, the addition of chemicals will burden the downstream membranes (if present) and reduce the membrane flux and potentially its longevity.

Summary:

When it comes to reducing chloramines in municipal supplies, there are a few options. UV technology has been successfully demonstrated in the industrial segment for being an ideal solution for chloramine destruction, given the following benefits:

- Small physical footprint
- Achieving chloramine levels down to parts per billion
- Meeting sustainable and/or "Net Zero" objectives
- Drastically reduced downtime
- Lower capex and opex compared to GAC

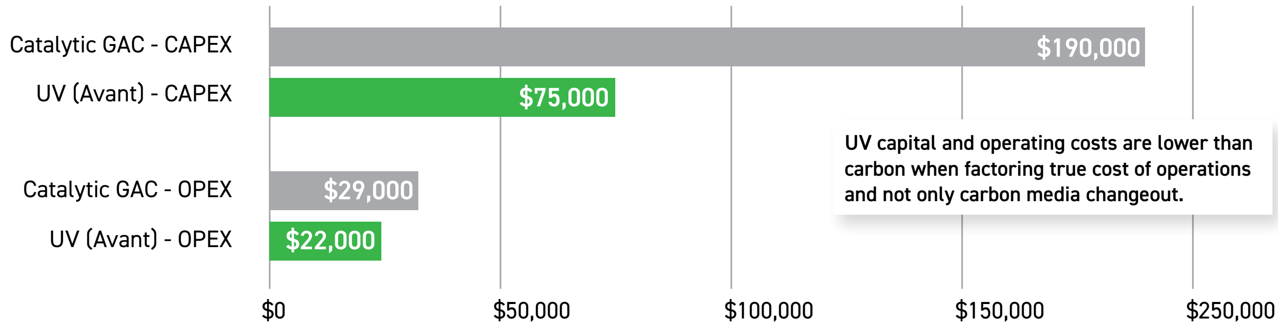
Economics of UV vs. Catalytic Carbon:

Assumptions:

- 25 gpm flowrate, city water
- 2 ppm down to <0.02 ppm chloramine
- 24 hr/d, 7 d/wk, 50 wks/yr operation
- Electrical power at $0.15/kWh
- Muni water at $11.50/1000gal; sewer charges at $16.70/1000gal
- Steam at $4.00/1000lb (saturated)
- Catalytic carbon cost at $300/ft3
- Carbon replacement: every 6 months; sanitization frequency: 1/week; backwash frequency: 1/week

CHLORAMINE REDUCTION

Catalytic Carbon vs. UV for Chloramine Reduction



Note: Carbon results from third party model developed with Pharmaceutical Water Specialists, LLC (Worcester, MA).
Note: GAC opex includes backwash water, rinse-to-drain water, media changeout, labor, steam for hot water sanitization, and cool down water displacement

The Trojan Technologies Solution

Aquafine, Trojan Technologies' brand of industrial UV water treatment systems, offers a portfolio of robust and flexible UV systems designed to meet the stringent requirements for Life Sciences, Food & Beverage, Microelectronics, and other industrial markets.

OptiVenn: Cost-effective and compact systems designed for low flows

The OptiVenn Series is used for low flow applications to break down chloramines while providing simultaneous inactivation of microbiological contaminants.

The OptiVenn is a robust and versatile solution that offers the following features and benefits:

- Multiple lamp configurations: Supports a wide flow rate range depending on lamp count.
- Flexible: Can be installed in different positions to adapt to existing pipes and layout constraints; available in ANSI flange or sanitary connection.
- Proven, Robust Components: UV sensors, lamps, drivers, and panels have demonstrated reliability worldwide in thousands of installations.

Avant: Advanced UV systems for mid/high flow applications

The Avant Series is a cutting-edge system that delivers efficient destruction of chloramine using a smaller footprint, saves energy and increases flexibility for skid-mounted designs, including the capacity to mount eight reactors in a 3/4 smaller footprint.

The Avant Series includes top-of-the-line components, which lowers the overall cost of ownership and dramatically reduces maintenance.

Features and benefits include:

- Intelligent Control System: PLC-based controller with 7" HMI touchscreen to display operating status, alarms, and enhanced lamp and driver diagnostics.
- Reduced Maintenance: The control system optimizes reactor operation and monitors the lamps individually while alerting plant operators to replace the lamp before failure, thereby decreasing unplanned maintenance and downtime.
- Multiple lamp configurations: Supports a wide flow rate range depending on lamp count.
- Compact installation: Multiple UV reactors can be stacked to minimize footprint; available in ANSI flange.

To learn more about the brands and affiliates of Trojan Technologies, please visit www.trojantechnologies.com

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