TROJANUV™

FACTSHEET

5 Reasons Why Wastewater Treatment Plants Convert from Chlorine to UV

Municipal Wastewater

Throughout the past few decades, growing awareness of the long-term public safety and environmental costs of chlorine wastewater disinfection has led to the adoption of inherently safer alternatives, such as UV. In fact, the first UV wastewater disinfection system in the U.S. was installed back in 1982 and now roughly 50% of the wastewater in North America is treated with UV. This includes new plants as well as existing ones that have converted from chlorine.

UV is the most effective, safe and environmentally friendly way to disinfect wastewater. Unlike chemical approaches to water disinfection, UV light provides rapid, effective inactivation of microorganisms through a physical process. When bacteria, viruses and protozoa are exposed to germicidal wavelengths of UV light, they are rendered incapable of reproducing and infecting. The process adds nothing to the water but UV light, and therefore, has no impact on the chemical composition or dissolved oxygen content of the water.

There are many reasons why plants make the switch from chlorine to UV – here are five of them.

1. Footprint/Contact Time

With chlorine disinfection systems, sizable contact chambers are required to allow sufficient contact time – typically about 30 minutes – for the chlorine to attack bacteria and other pathogenic microorganisms in the wastewater.

However, since the retention time for UV is measured in mere seconds or fractions of a second, a typical wastewater treatment plant actually reclaims additional space after converting from chlorine to UV.

Recent innovations in UV have led to much more modular and compact systems. The TrojanUVSigna™, for example, is designed to fit into an existing chlorine contact tank, often without any major modifications to the channel depth or width.

This TrojanUVSigna installation can treat 20 MGD (875 l/s) in only 250 ft^2 (23 m^2).

Stringent tolerances on concrete channel walls are not required, making chlorine contact tank and UV channel retrofits simple and cost-effective. Retrofits can accommodate existing water level profile and head loss.

2. Costs

Municipalities and wastewater treatment plants often hire engineering firms to conduct a comparative analysis of disinfection alternatives.

If a new treatment plant is being constructed, the analysis is relatively quick and straightforward. Many new wastewater treatment plants in North America install UV disinfection systems because the safety and cost benefits are so compelling.

For existing treatment plants, there is more variability in costs since there is already treatment equipment in place. The cost to expand or upgrade the equipment to meet current regulatory requirements is what must be calculated.

- **Capital Expense:** This includes the physical installation of equipment, or in the case of an existing facility, the upgrade/expansion of the current processes. The initial capital expense of the disinfection alternatives is relatively straightforward to quantify. Capital expenditures are required for contract management, design engineering, land and equipment purchase, and construction and installation. The required capital expenditure will vary based on the size of the facility and scope of the upgrade. Cost estimates are prepared following an engineering evaluation to allow direct comparison between disinfection options.

- **Operating Expense:** The annual operating expenses can be more challenging to estimate since there are many contributing factors, variable components and some hidden costs. Costs to operate a chlorine disinfection system can be grouped into several categories, including chemical supply, labor, training and certification, emergency response planning and administration. For UV disinfection, the bulk of operating costs are attributed to electricity and replacement lamps.

At-a-glance Cost Comparison

Ongoing Expense	Chlorine Gas	Sodium Hypochlorite	UV Disinfection
Disinfection/ Dechlorination Chemical Supply	**$$$** Purchase and delivery of chlorine gas cylinders.	**$$$$$$** Purchase and delivery or on-site generation of hypochlorite.	**None** No chemical supply is required.
Electricity	**$** Relatively low power requirements for chlorine gas disinfection.	**$** Power is required for operating chemical feed pumps and aeration equipment (if applicable).	**$$$$** Electricity is required to power the UV lamps.
Replacement Parts	**$** Replacement parts are minimal with chemical disinfection systems.	**$** Replacement parts are minimal with chemical disinfection systems.	**$$$** Replacement parts associated with UV disinfection systems consist primarily of UV lamps.
Operator Labor	**$$$$$$** Labor required for changing chlorine cylinders, maintaining lead detection and emergency equipment, maintaining on-site chemical distribution and storage equipment.	**$$$** Labor required to maintain pumps, generators, storage tanks, water conditioning equipment, de-scaling equipment, on-site chemical distribution piping.	**$** Labor includes replacing UV lamps periodically and ensuring that quartz sleeves that house the UV lamps are kept clean.
Leak Response Requirements	**$$$$$$** Costs for responding to and repairing leaks are very high.	**$$$** Since hypochlorite is less toxic than chlorine gas, costs in this area are reduced. However, there are costs associated with containment and leak protection of the hazardous chemical.	**None** UV lamps contain a very small amount of mercury. Leak response and emergency preparedness plans are not required, however, local guidelines must be adhered to. Trojan offers a complimentary recycling program in which used lamps are picked up and shipped to an approved recycling facility.
Administration for Ensuring Regulatory Compliance	**$$$$$$** Time-intensive administration for compliance with regulated risk management plans, emergency response plans and community right-to-know programs.	**$$$** Although sodium hypochlorite is exempt from “hazardous” designation, it is unstable and corrosive. As such, procedures must be in place to ensure proper transportation, handling, storage and spill protection.	**$** Administration costs for UV are low. No special safety programs or risk mitigation plans are required.
Training	**$$$$$$** Employees must be trained on process safety management, risk management plans, and evacuation procedures in addition to routine operation of the system.	**$$$** Training programs must be in place to ensure chemicals are properly transported, stored and handled.	**$** UV equipment is simple and straight-forward to operate. No special training or certification is required for operators.

3. *Safety*

Chlorine gas is typically delivered to wastewater treatment plants in large cylinders mounted on trucks or trains. It is a highly toxic chemical that must be transported and handled with extreme caution. Training programs, certifications and emergency preparedness must be in place and routinely practiced, and a seemingly minor incident or lapse of attention can have significant safety implications and costs. Even a small leak can result in thousands or millions of dollars spent on evacuations, system upgrades, inquiries and insurance claims.

Sodium hypochlorite is a diluted liquid form of chlorine. It is corrosive and harmful if ingested or inhaled. It too must be handled and stored with caution, and containment and leak protection equipment must be in place.

In contrast, UV disinfection systems are straightforward and inherently safe to operate. Operation of a UV treatment system requires no special training or certification, beyond the manufacturer's start-up training program. Standard maintenance tasks typically include changing out the UV lamps, cleaning the quartz tubes that house the lamps (though many UV systems now have automatic sleeve cleaning), and routine monitoring of treatment performance.

4. *Disinfection By-products*

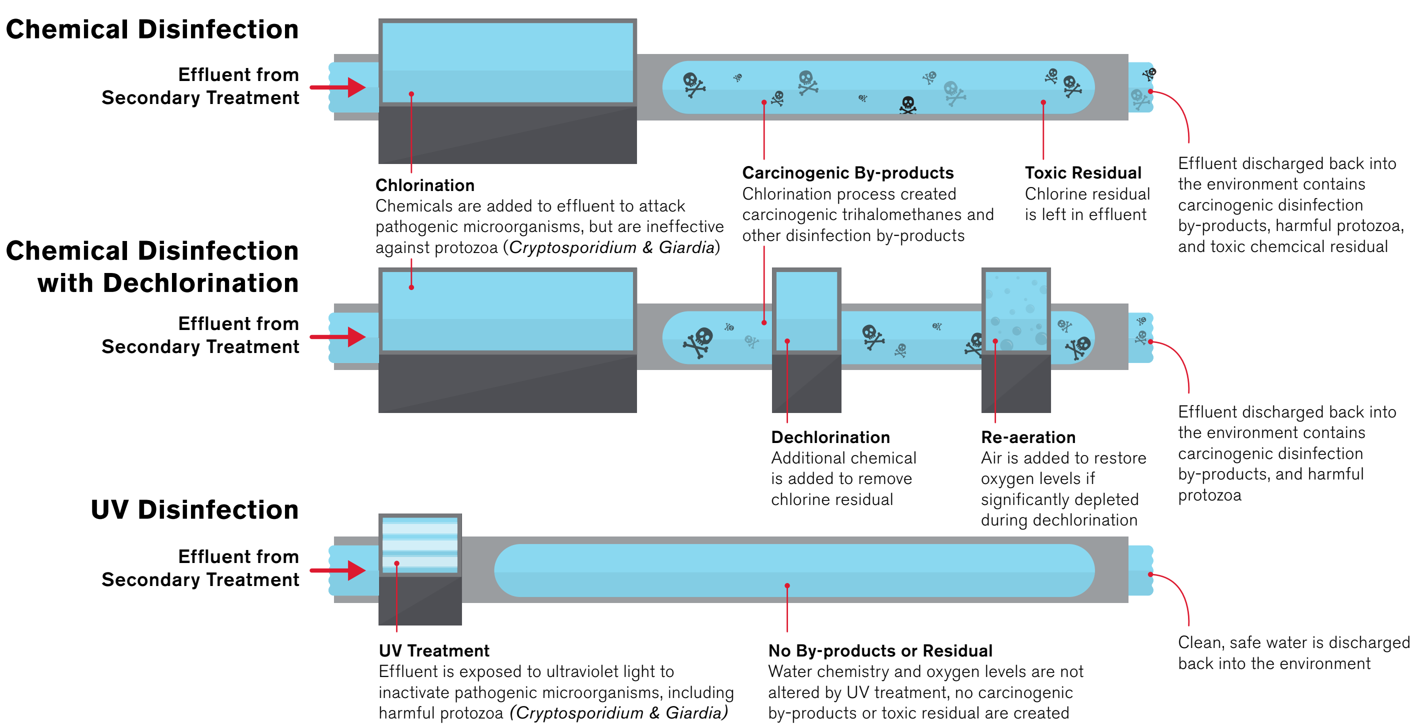
There are a number of organic and inorganic constituents found in wastewater. When chlorine is added to wastewater, the chemical alters and binds to the organic matter, forming what is called a disinfection by-product (DBP). The quantity of DBPs created is a function of the amount of organics in the water and the amount of chlorine added.

Disinfection by-products are known to be dangerous and, as such, have been studied in depth over the past few decades. Of most significant concern are the DPBs proven to be cancer-causing. Regulations in place today center around limiting the formation of these DBPs, particularly trihalomethanes and haloacetic acids. Even in small concentrations, these by-products have been proven to be carcinogenic.

Treatment plants must continuously attempt to balance the amount of chlorine added, and subsequent DBPs produced, with the need to adequately destroy the microorganisms in the wastewater. Regulations are in place simultaneously limiting concentrations of DBPs and bacterial levels, contributing to the complexity and cost of chemical-based disinfection systems.

5. *Dechlorination*

In response to the dangers posed by chlorine disinfection, regulators have imposed increasingly stringent limits on the levels of residual chlorine that can be released into receiving waters. For some wastewater treatment plants, this has prompted the need for an additional process – dechlorination – to remove residual chlorine in the effluent before it can be returned to the environment.



The dechlorination process typically involves the use of sulfur dioxide (SO_2), a corrosive gas that can cause eye and throat irritations at small concentrations, and potentially more dangerous effects at higher exposure levels. As a result, it too requires special safety provisions for handling, storage, and emergency response training. Increasingly, sodium bisulfite ($NaHSO_3$) is being used as an alternative to sulfur dioxide.

In this final step, gaseous sulfur dioxide is injected into the wastewater in a dechlorination basin. To adequately eliminate residual chlorine, it must be thoroughly mixed, and requires contact time with the effluent of approximately one minute.

Precise dosing of sulfur dioxide is essential to achieve the desired result. Overdosing can result in the formation of sulfites, and lower the dissolved oxygen content and pH level of the effluent. If too much oxygen is depleted, the water must be re-aerated prior to discharge.

Let's Discuss Chlorine Conversion

We hope this article has answered some of the questions you had about converting from chlorine to UV disinfection. As mentioned earlier, thousands of wastewater treatment plants have converted to UV and are now enjoying the benefits that this environmentally responsible disinfection method has to offer. In fact, with the world's largest municipal UV installation base, we here at Trojan have been involved in several of these chlorine conversion projects.

Are you ready to start evaluating your options? Would you like us to prepare an economic evaluation based on a net present value analysis? To get started, simply visit trojanuv.com/contactus and let us know more about your plant.

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