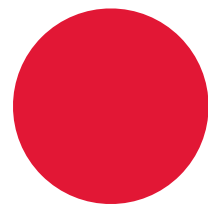


**UV-OXIDATION SOLUTIONS
FOR ENVIRONMENTAL CONTAMINANT TREATMENT**





Turn-key UV-oxidation water treatment

State-of-the-art solutions. One trusted source.

Our water resources are under stress due to increasing population, changing rainfall patterns, widespread pollution, and a variety of other factors. For this reason, water providers must strive to make the most of every available water source, even those that have been impacted by contamination. Trojan's Environmental Contaminant Treatment solutions continue our 25-year tradition of providing water confidence with proven UV technology and innovative solutions that help restore and preserve precious water supplies.

Trojan's turn-key UV-oxidation solutions are enabling water suppliers to cost-effectively treat chemical and microbial contaminants that affect the purity of water in drinking water, wastewater reuse and groundwater remediation applications. The revolutionary TrojanUVPhox™ and TrojanUVSwift™ECT provide reliable delivery of UV energy to safeguard water against microorganisms and catalyze the oxidation of chemical and environmental contaminants. These robust systems work in tandem with Trojan's sophisticated hydrogen peroxide (H₂O₂) delivery and storage equipment.

Service is an integral part of Trojan's UV-oxidation solutions. For example, our ChemWatch™ technology remotely monitors hydrogen peroxide use, enabling us to automatically schedule hydrogen peroxide deliveries or notify you of unexpected changes in usage. Trojan also oversees replenishment of hydrogen peroxide on an as-needed basis. From our Performance Guarantee of system sizing – to our maintenance, spare parts and lamps – Trojan delivers a level of confidence that can only come from one source.

Cover photo: Trojan is involved in a number of significant water reuse projects in Southern California that are using highly treated wastewater to prevent seawater from intruding into drinking water aquifers. These water reuse projects are helping to preserve and enhance drinking water supplies used by millions of people.

What are Environmental Contaminants?

A hidden danger exists in our water supplies



Environmental contaminants are:

- Harmful chemicals that have been detected in streams, lakes, rivers, and groundwater throughout the world
- The result of human activities, such as industrial manufacturing, agriculture, and wastewater discharge
- Also derived from natural sources, such as the taste and odor-causing chemicals generated by algae blooms in lakes and rivers
- Often not sufficiently treated by conventional water treatment facilities

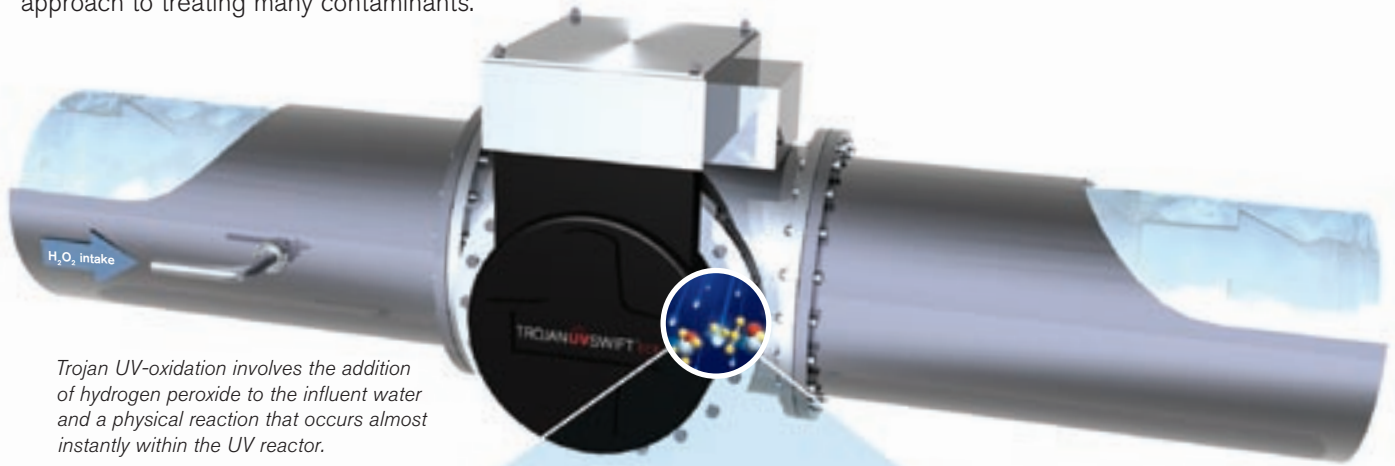
UV-Oxidation Applications

Indirect Potable Water Reuse	Municipal Drinking Water	Groundwater Remediation and Industrial Wastewater
<p>Part of the “gold standard” treatment train to purify wastewater to beyond drinking water standards</p> <p>UV treats recalcitrant organic contaminants such as <i>N</i>-nitrosodimethylamine (NDMA) while simultaneously disinfecting the water</p> <p>UV-oxidation acts as a barrier to:</p> <ul style="list-style-type: none"> ▪ NDMA ▪ 1,4-Dioxane ▪ Various pharmaceuticals and personal care products (PPCPs) ▪ Potential endocrine-disruptor chemicals (EDCs) ▪ Other unmonitored, unregulated organic contaminants. 	<p>UV disinfection capability satisfies USEPA LT2 disinfection criteria</p> <p>UV-oxidation is a barrier to wastewater-derived environmental contaminants introduced upstream of the drinking water facility</p> <p>UV-oxidation treats:</p> <ul style="list-style-type: none"> ▪ Seasonal contaminants such as taste and odor-causing chemicals resulting from algae blooms ▪ Volatile organic compounds (VOCs) ▪ NDMA ▪ 1,4-Dioxane ▪ Pesticides ▪ Other unmonitored and unregulated contaminants derived from upstream wastewater or other sources. 	<p>Applicable at Superfund sites, wellhead treatment systems, and in industrial wastewater discharge applications</p> <p>UV-oxidation effectively treats:</p> <ul style="list-style-type: none"> ▪ NDMA ▪ Hydrazine ▪ 1,4-Dioxane ▪ MTBE ▪ Various compounds that create toxicity ▪ Other environmental contaminants.

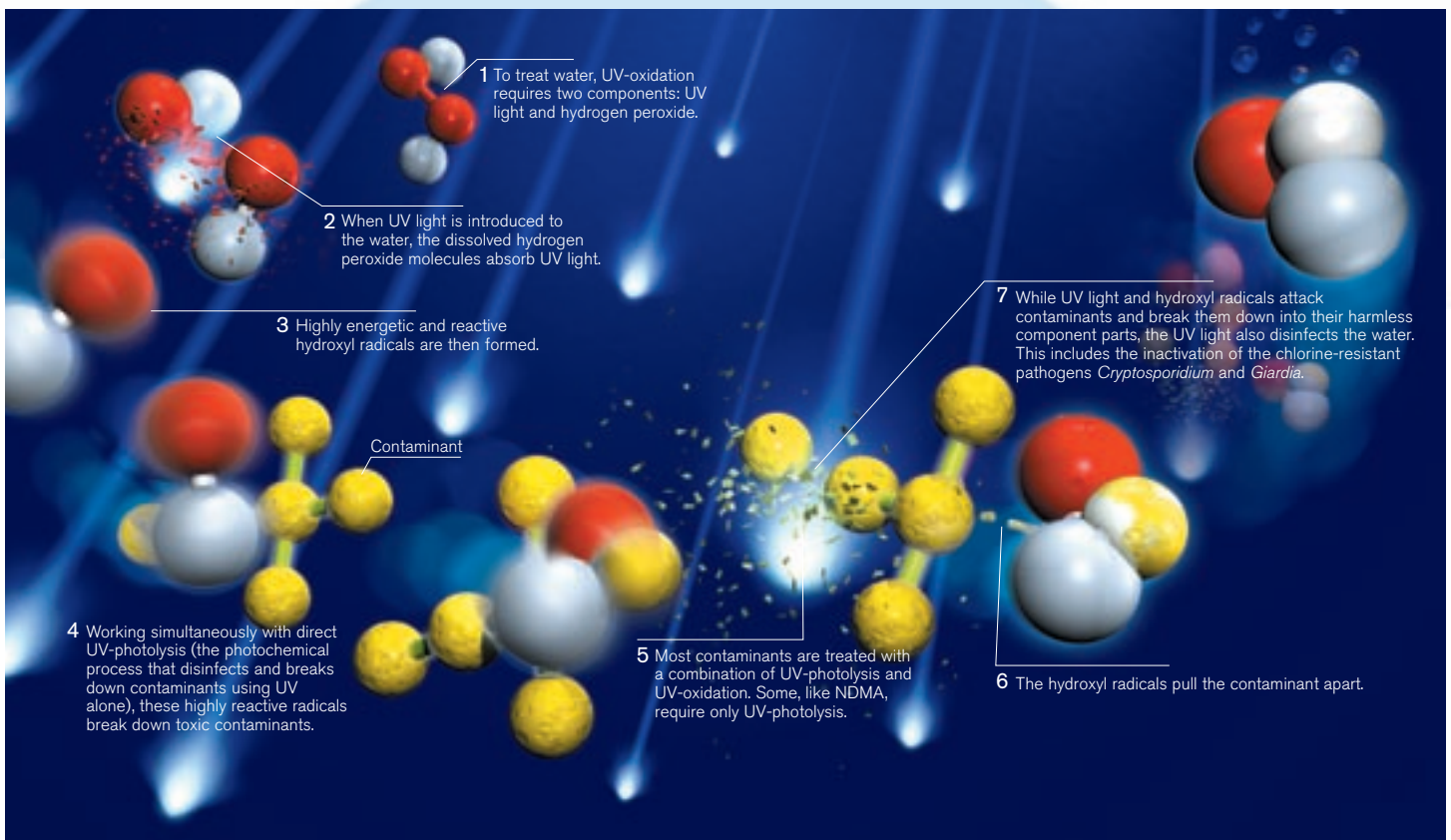
Trojan UV-Oxidation

An invaluable water treatment approach

UV-oxidation is a photochemical process that breaks down chemical constituents into their harmless component parts almost instantly within the UV reactor. Trojan has revolutionized UV-oxidation, making it an efficient and cost-effective approach to treating many contaminants.



Trojan UV-oxidation involves the addition of hydrogen peroxide to the influent water and a physical reaction that occurs almost instantly within the UV reactor.



How UV-Oxidation is quantified: The amount of energy required to reduce the concentration of a contaminant by 1 log (e.g. 10 ppb to 1 ppb) in 1,000 gallons of water is referred to as the **electrical energy per order** or **EE/O**. It is a measure of a reactor's hydraulic, optical and electrical efficiency. From a capital and O&M cost perspective, a lower EE/O is better.

Key Benefits

Trojan UV-Oxidation

Dual treatment action provides UV disinfection and contaminant destruction:

Innovative process delivers simultaneous microbial disinfection and elimination of chemical and environmental contaminants

Additional barrier of protection against contaminants in drinking water:

Safeguards against a wide variety of harmful contaminants, including industrial solvents, pesticides, pharmaceuticals, personal care products and other wastewater-derived contaminants

Concurrent disinfection meets EPA guidelines:

Provides simultaneous disinfection in accordance with the upcoming Long-term 2 Enhanced Surface Water Treatment Rule or LT2ESWTR (i.e. >2-log *Cryptosporidium* and *Giardia credit*)

Cost-effective:

Trojan's optimized reactor technology makes UV-oxidation cost-effective for a wide range of applications

Compact design reduces capital costs:

Small footprint relative to ozone and other technologies simplifies installation and significantly reduces building capital costs

Well suited to seasonal treatment:

Effectively treats taste and odor problems related to recurring algae blooms and pesticide contamination due to agricultural runoff

Eliminates difficult to treat contaminants:

Ideal for treatment of NDMA, 1,4-dioxane, and other currently unmonitored and unregulated contaminants in water reuse and groundwater remediation applications

Rapid, by-product-free treatment:

Single unit process treats water almost instantly, without forming bromate, other DBPs, or hazardous gases

Two UV solutions for application flexibility:

UV options include the medium-pressure lamp-based TrojanUVSwift™ECT and the low-pressure, amalgam lamp-based TrojanUVPhox™ – allowing Trojan the flexibility to propose the most economical option for each unique water treatment situation

Easy and safe to operate:

Designed for minimal operator involvement and maximum safety

TrojanUVSwift™ECT

Compact, medium-pressure design for high-volume performance with validated disinfection

Key Benefits:

- High intensity, medium-pressure lamps deliver significant levels of UV energy for microbial disinfection and UV-oxidation of contaminants
- Need for fewer lamps allows a smaller, space-efficient footprint that offers simplified integration into existing piping galleries
- Polychromatic light spectrum is more suitable for certain contaminants
- Useful when large amounts of UV light are required for treatment in a particular contamination situation
- Extensively validated disinfection performance under a wide range of flow rates and water parameters

Best Suited for:

- Applications in which contaminant treatment is intermittent (e.g. seasonal taste and odor treatment)
- Elimination of those contaminants that are more efficiently treated with a polychromatic light spectrum (e.g. some pesticides)
- Locations in which electrical power is relatively inexpensive
- Use in treatment plants where space is at a premium
- Treatment of large flow rates

Control Power Panel

Produces and distributes power to the UV lamps, UV sensor(s) and optional ActiClean™ cleaning system. Incorporates a programmable logic controller with input/output connection points and communication hardware.

Dual Action Automatic Cleaning



Chemical and mechanical cleaning system uses Trojan's patented, food-grade ActiClean™ gel to remove fouling and residue, ensuring the maximum amount of UV energy is available for UV-oxidation and disinfection.



Hydrogen Peroxide Storage Tank

Durable, double-contained, high-density polyethylene resists sun damage. Standard secondary containment provides 110 percent capacity of primary tank.

Hydrogen Peroxide Dosing System

Ensures consistent dosing. Fully maintained by Trojan. ChemWatch™ inventory management system provides usage monitoring, product delivery scheduling, and invoice tracking.

System Control Center

Programmable logic controller continuously monitors and controls UV system functions. Interfaces with control power panels, UV reactor(s), influent water temperature sensor, flow meter, hydrogen peroxide delivery system, and any valves (optional).

Hydrogen Peroxide Dosing Control System (Patent-Pending)

Optimizes hydrogen peroxide delivery in real time. During contamination events (e.g. a taste and odor event), UV reactor interfaces with the hydrogen peroxide dosing system, collecting flow rate, hydrogen peroxide concentration, UV transmittance (using Trojan's Optiview™ system), relative contaminant concentration, and other data. Delivers optimum hydrogen peroxide concentration and UV reactor energy distribution to minimize operational costs.

UV Reactor

Compact, flow-through design with lamps mounted horizontally and perpendicular to the flow. 316L stainless steel construction.

UV Intensity Sensor



Measures UV intensity within the reactor. Automated cleaning system prevents fouling of the photodiode sensor's quartz sleeve.



Compact, Hydraulically Efficient Reactor

Innovative design substantially reduces footprint and headloss



The TrojanUVSwift™ ECT was developed using advanced Computational Fluid Dynamics modeling, resulting in a compact, highly efficient system that minimizes space requirements and installation costs.

Benefits:

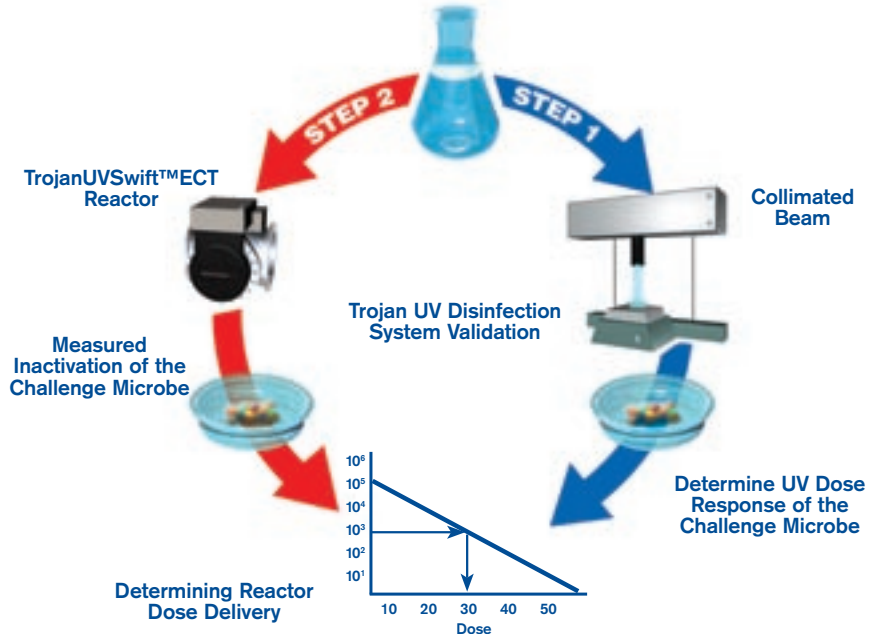
- Compact, in-line design minimizes reactor footprint
- Space requirements for taste and odor treatment are significantly less than ozone equipment/contact tanks – leading to significantly reduced installed capital costs
- Full serviceability from one side of the reactor allows installation in restrictive pipe galleries and against walls for maximum flexibility
- Hydraulically efficient, flow-through design developed through extensive computer analysis to minimize headloss and pumping requirements

Comprehensive Disinfection Validation

Exhaustive third-party testing

Benefits:

- The TrojanUVSwift™ ECT shares a platform with the widely successful TrojanUVSwift™ – a system with a significant installed-base for disinfection-only drinking water applications
- Disinfection performance of the TrojanUVSwift™ has been accurately documented through rigorous third-party validation
- The specific disinfection dose delivery of the system was determined in the field (bioassay) over a wide range of flow rates and UV transmittance values
- Disinfection performance is validated based on actual kill rate of microorganisms that flow through the reactor in a real world setting
- In the Trojan UV-oxidation process, disinfection occurs simultaneously with the treatment of contaminants



Simultaneous microbial disinfection is a key advantage of Trojan's UV-oxidation process. The disinfection performance of the TrojanUVSwift™ ECT in disinfection-only mode has been accurately documented through rigorous, third-party validation.

Sophisticated Hydrogen Peroxide Dosing Control System

Optimized dose delivery and cost-efficiency

Benefits:

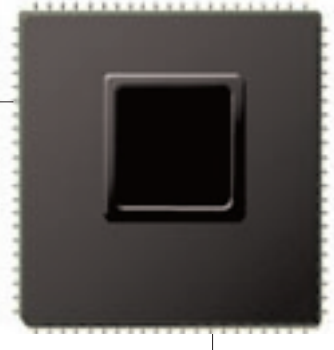
- Sophisticated, patent-pending control system optimizes the UV-oxidation process
- Controls the dosing of hydrogen peroxide, lamp power and on/off status in real time
- Collects and analyzes information on flow rate, hydrogen peroxide concentration, UV transmittance, relative contamination event strength and other data
- Minimizes ongoing operational costs while maintaining optimized UV energy distribution and hydrogen peroxide dosing

Inputs

- Flow rate
- UV transmittance
- H₂O₂ concentration
- Relative strength of the contamination event

Outputs

- Optimum H₂O₂ concentration
- Optimum lamp power
- Optimum number of lamps in operation
- UV energy output to minimize operation and maintenance (O&M) costs



Ideal for Seasonal Contaminants in Drinking Water

Addresses both disinfection and seasonal contamination

Recurring seasonal contamination events compromise drinking water supplies in many areas. Taste and odor events as a result of 2-methylisoborneol (MIB) or geosmin present in water, for example, can impact the aesthetic quality of drinking water. The TrojanUVSwift™ECT is ideally suited to this challenge, operating in two modes to address the dual needs of communities with seasonal issues:



Disinfection Mode: *Normal operating mode for year-round drinking water treatment. Runs at lower energy levels sufficient for elimination of any microorganisms. Reduces O&M costs for more efficient operation.*



Contaminant Control Mode: *Activated only during taste and odor/pesticide contamination events. Additional UV lamps/reactors are energized and hydrogen peroxide is dosed into the water upstream of the UV system. Initiates a powerful oxidation reaction that destroys contaminants and increases the level of disinfection.*

Benefits:

- Year-round disinfection and simultaneous elimination of seasonal contaminants
- Validated disinfection in accordance with upcoming LT2ESWTR (i.e. >2-log *Cryptosporidium* and *Giardia* credit)
- Provides disinfection barrier where activated carbon (powdered or granular) does not
- Produces no disinfection by-products (DBPs) such as bromate
- Lower capital and O&M costs relative to ozone
- Dual operating modes minimize O&M costs (approx. 1 cent/1,000 gallons in disinfection mode)
- Small footprint simplifies installation and significantly reduces building capital costs relative to ozone and other technologies
- Easily retrofitted into existing plants
- Safer than ozone systems

TrojanUVPhox™

Low-pressure, amalgam UV lamps maximize electrical efficiency for year-round treatment

Key Benefits:

- Highest electrical efficiency solution
- Capable of treating large flow rates
- Low-pressure, high-output amalgam lamps deliver lowest electrical energy per order (EE/O) and O&M costs
- Monochromatic light spectrum is more suitable for certain contaminants
- Provides simultaneous microbial disinfection
- Small footprint – vertically stackable, modular design allows for expansion without increasing footprint
- Available in multiple configurations with various numbers of lamps

Best Suited for:

- Water reuse, drinking water, and groundwater remediation requiring treatment of chemical contaminants and disinfection
- Areas where electrical costs are relatively high
- Elimination of NDMA or other contaminants that are more readily treatable with monochromatic lamps
- Year-round treatment applications

Hydrogen Peroxide Storage Tank

Durable, double-contained, high-density polyethylene tank is resistant to sun damage. Standard secondary containment provides 110 percent capacity of primary tank.

UV Reactor Chamber

Welded, electropolished 316L stainless steel. Contains one or two UV reactors – arrays of lamps operated together.

Hydrogen Peroxide Dosing System

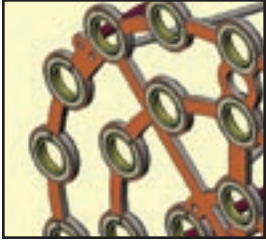
Ensures consistent dosing. Fully maintained by Trojan. ChemWatch™ inventory management system provides usage monitoring, product delivery scheduling, and invoice tracking.



Flanges

Available sizes range from 4 to 20 inches.

Optional Wiping System



Food-grade rubber wipers ensure maximum treatment efficiency by maintaining optimal transmittance of quartz sleeves.

Power Distribution Center

Houses the electronic ballasts and control board with local display. Each power distribution center provides power distribution for one UV reactor.

Control Board



Door-mounted interface displays the UV Intensity (mW/cm^2), Elapsed Time (hours), Lamp Status/Ballast Status and Alarm Conditions.

Optional System Control Center



Optional programmable logic controller continuously monitors and controls UV system functions. Interfaces with power distribution center(s), UV reactor(s), influent water temperature sensor, flow meter, hydrogen peroxide delivery system, and any valves (optional).

UV Intensity Sensor

Highly accurate photodiode sensor monitors UV output within the reactor. Mounted in the sensor port on the side wall of the reactor for easy access.

Modular Compact Reactor

Innovative design maximizes efficiency and minimizes footprint



The modular design of the TrojanUVPhox™ allows space efficient configurations capable of treating large flow rates.

Benefits:

- Energy-efficient lamps with high UVC-range UV light output
- Vertically stackable, modular design allows for system expansion without increasing footprint
- Proven reactor design – reactor configuration and components have demonstrated superior performance in thousands of installations
- Scalable system is available in multiple configurations and various lamps per reactor to handle virtually any flow rate
- Reactor designed using computational fluid dynamics modeling and other advanced computer simulation tools to ensure optimum lamp spacing, uniform flow field, and significant efficiency advantages
- Chambers constructed of electropolished 316L stainless steel for a smooth interior and exterior finish, long life, and durability

High-Output Amalgam Lamps

Advanced, energy-efficient lamps reduce electrical costs

Benefits:

- More energy-efficient – draw less power than competitive UV systems
- High-output amalgam lamps permit a compact reactor footprint
- Trojan amalgam lamps deliver even, stable UV energy output over a wide range of water temperatures
- Performance guaranteed to 12,000 hours for reduced maintenance requirements
- Single-ended lamp and sleeve design simplifies change-outs



Sophisticated Controls

Integrated, user-friendly systems ensure optimized operation



User-friendly, integrated control systems automate delivery of UV energy and hydrogen peroxide for efficient contaminant treatment and microbial disinfection with minimal requirements of operators.

Benefits:

- UV controls are integrated with hydrogen peroxide system to ensure smooth operation with minimal operator involvement
- Easy-to-use, digital interfaces are menu-driven for simple operation and comprehensive display of system status
- Optional control algorithm minimizes electrical consumption by dimming lamps automatically while maintaining performance
- Another optional control algorithm matches UV energy output to flow rate – a process called “flow pacing” – to minimize O&M costs
- Controls interface seamlessly with plant SCADA for full integration of facility operation and alarm systems

Operator-Friendly System with Optional Sleeve Wiping

Designed for maximum UV energy delivery and minimum maintenance

Benefits:

- Optional sleeve wiping system ensures lamps deliver maximum UV energy for disinfection and UV-oxidation of contaminants
- Sleeve wiping improves efficiency and minimizes operational EE/O values
- Automated wiping at preset intervals provides ongoing prevention of sleeve fouling
- Sleeve wiping takes place while the system is online and operating – so there is no need to shut down or bypass the reactor
- Single-ended lamp and sleeve design simplifies lamp change-outs and reduces maintenance time and expense
- Lamp change-outs can be completed without depressurizing or draining the reactor – the procedure takes only minutes per lamp, and does not require tools
- UV sensor is mounted on the outside of the reactor for easy access



Single-ended lamps and the optional sleeve wiping system of the TrojanUVPhox™ simplify and reduce maintenance requirements and their associated costs.

Hydrogen Peroxide (H₂O₂)

Safe, effective, and fully managed for worry-free water treatment

- Hydrogen peroxide (H₂O₂) is the oxidant used in UV-oxidation
- Trojan's integrated UV-oxidation offerings include full service and management of this consumable component and its related equipment
- H₂O₂ monitoring, replenishment, and equipment maintenance are done for you
- Installation and all maintenance is performed by experienced, highly trained professionals
- H₂O₂ is a liquid, so there is no potential for gaseous leaks that can endanger surrounding communities
- No requirement for hazard permit or evacuation plan
- No special handling or safety equipment required
- Any spills are localized and are cleaned up with water (decomposition by-products are water and oxygen)

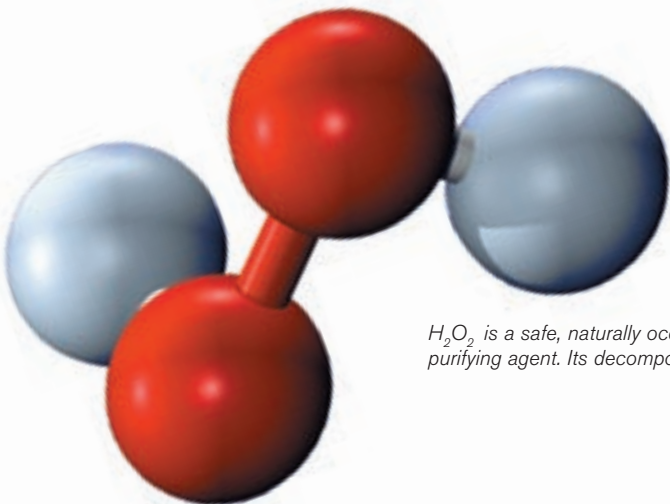
Automated H₂O₂ Supply and Delivery

NSF-grade Hydrogen Peroxide plus the benefits of complete support and logistics

- Reliable supply of technical grade or high-purity NSF-approved drinking water grade H₂O₂
- Remotely monitored H₂O₂ inventory and management
- All handling of H₂O₂ is done by Trojan – your plant operators never have direct contact with peroxide
- Automatically scheduled deliveries and customized usage reports
- Trojan UV-oxidation packages include a specified period of H₂O₂ supply, delivery, and proper maintenance and servicing of storage and dosing equipment
- Continuation of the H₂O₂ service package is available simply by continuing to purchase H₂O₂ from Trojan



Trojan's turn-key programs eliminate additional demands on plant staff. Our full service offering includes remote monitoring of H₂O₂ levels, automated delivery scheduling, and all peroxide handling and equipment maintenance.



H₂O₂ is a safe, naturally occurring compound and a very effective purifying agent. Its decomposition by-products are water and oxygen.

Comprehensive H₂O₂ Equipment & Services

Turn-key program eliminates training and handling requirements

Trojan UV-oxidation systems are fully integrated packages that include the UV equipment and control systems, as well as everything required to dose the water stream with H₂O₂ including:

Double Containment Tank Systems

- High density polyethylene construction with integral secondary containment
- Fully conform to the most stringent safety standards
- Includes fill line, inspection ports, overflow pipe, vent, and ultrasonic level sensor
- Available in a range of sizes

Metering Pump Assembly Skids

- Standard equipment includes ProMinent™ pumps for precise H₂O₂ metering
- Passivated 316L stainless steel suction and discharge piping ensures product quality
- Includes backpressure regulator, pressure relief valves, and calibration assembly for maximum safety
- Electrical control panel provides manual or automatic ON/OFF operation of either pump

Full Equipment Maintenance and Ongoing Service

- Comprehensive maintenance program and support
- Includes preventative maintenance, remote diagnostics, and process optimization support as treatment conditions change



Trojan UV-oxidation solutions include complete H₂O₂ storage, delivery and monitoring systems that meet the most stringent safety standards.

Trojan's Turn-Key UV-Oxidation Solutions

Trojan is your single-source solution for UV-oxidation systems. We provide everything needed to perform UV-oxidation, including our many years of technical experience in treating chemical contaminants and engineering expertise to handle the most technically challenging projects. Packages include:

- UV equipment:
 - TrojanUVSwift™ECT or
 - TrojanUVPhox™
- Storage tanks engineered specifically for hydrogen peroxide and with secondary containment standard
- Electronically controlled hydrogen peroxide metering pumps
- Performance Guarantee – Trojan guarantees sizing when a representative water sample is provided
- Ongoing supply and as-needed delivery of NSF- or technical-grade H₂O₂
- Remote monitoring, control, and inventory management of H₂O₂ using the ChemWatch™ system
- UV lamp supply and replacement

TrojanUVSwift™ ECT Product Specifications		
Reactor Model	L24	L30
Number of Lamps	4,6,8	8,16
Dimensions/Miscellaneous		
Approximate Dimensions		
Width (in/m)	52/1.3	66/1.7
Length (Flange to Flange) (in/m)	35/0.9	52/1.3
Overall Height (in/m)	40/1.0	48/1.2
Required for Service beyond End Cap (in/m)	24/ 0.6	48/1.2
Vertical Distance Required for Service (in/m)	44/1.1	52/1.3
Maximum Operating Pressure (psi /kPa)	150 / 1034	75 / 517 or 150 / 1034
Dry Reactor Wet Reactor Weight	1500 lbs/680 kg 2240 lbs/1016 kg	2182 lbs/990 kg 4050 lbs/1837 kg (75 psi model)
Electrical/Control Power Panel		
Electrical Supply	480, 575 or 600 V, 3 wire + ground, 60 Hz (575 and 600 V requires step-down transformer)	
Maximum Power Supply Range	4 lamp - 45.5 kVA unbalanced 6 lamp - 68 kVA balanced 8 lamp - 90 kVA unbalanced	8 lamp - 103 kVA unbalanced 12 lamp - 151 kVA balanced 16 lamp - 200 kVA unbalanced
Nominal kW Input per Lamp	10	11.7
Panel Rating	NEMA 12 Indoor	
Enclosure Dimensions (HxWxD)	87" x 95" x 26" max 2.2 m x 2.4 m x 0.6 m max	

TrojanUVPhox™ Product Specifications				
Single Reactor Model	12AL30	18AL50	30AL50	72AL75
Dual Reactor Model	NA		D30AL50	D72AL75
Number of Lamps (single reactor)	12	18	30	72
Number of Lamps (dual reactor)	NA		60	144
Dimensions/Miscellaneous				
Overall Length (in/m)	76/1.9	82/2.1	Single 86/2.2 Dual 148/3.8	Single 86/2.2 Dual 148/3.8
End Cap Diameter (in/m)	20/0.5	29/0.7	29/0.7	41/1.0
Required for Service Beyond End Cap (in/m)	72/1.8	72/1.8	72/1.8	72/1.8
Flange Size Options (in)	8, 4		12, 8	20, 16, 12, 8
Maximum Operating Pressure (psi/kPa)	100/690			65/450
Dry Reactor Wet Reactor Weight (lb/kg)	300/136 600/272	1400/635 2100/952	Single: 1600/726 2200/998 Dual: 3000/1360 4300/1950	Single: 2100/952 3700/1680 Dual: 3700/1680 7200/3270
Electrical/Power Distribution Center				
Electrical Supply	480V, 3 phase, 4 wire + ground, with 120VAC, single phase, 2 wire + ground for environmental			
Approximate Panel Power Draw (kW, Single Reactor)	3	4.7	7.8	18.5
Panel Rating	NEMA 12 Indoor, NEMA 4X Indoor, NEMA 4X outdoor (sun sheltered)			
Enclosure Dimensions (HxWxD)	48" x 40" x 12" 1.2 m x 1.0 m x 0.3 m		84" x 48" x 24" 2.1 m x 1.2 m x 0.5 m	

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