xylem
Let's Solve Water

WEDECO AQUACULTURE SOLUTIONS

INDUSTRIAL-STRENGTH
THINKING
SOLVES MORE THAN WATER

UV and Ozone for Aquaculture Water Treatment

ENSURING BIOSECURITY AND HYGIENIC WATER CONDITIONS

Water Treatment and Disinfection Play a Crucial Role in Aquaculture

Rearing fishes and other commercial species are sensitive to pathogens, water quality and toxic substances. The use of advanced systems and technologies allow aquatic farmers to meet increasing demands for fish welfare, fish health, sustainable production and consumer requirements.

In aquaculture it is essential to reduce the transmission risk of infectious diseases and invasive species. Two key methods used in aquaculture are UV irradiation and oxidation by ozone.

UV irradiation is one of the most effective and efficient methods for disinfection because it inactivates pathogens by disrupting their genetic material. Due to this mode of action, UV poses a significant advantage in aquaculture, since it does not use chemicals that produce by-products which can adversely affect fish stock or humans.

Ozone oxidation, or ozonation, is also a highly effective treatment method for water quality improvement and disinfection of all contact equipment. In addition to pathogen elimination, it is ideally suited for removal of nitrite, color, taste, and odor.

Ozonation and UV irradiation are often combined in series, as they provide back-up systems and different modes of action. UV irradiation also has the advantage of removing ozone residues from treated water.

Recirculating Aquaculture Systems (RAS)

RAS is the most sophisticated form of aquaculture and provides several advantages when properly set up, including good biological control, water quality control, and temperature optimization.

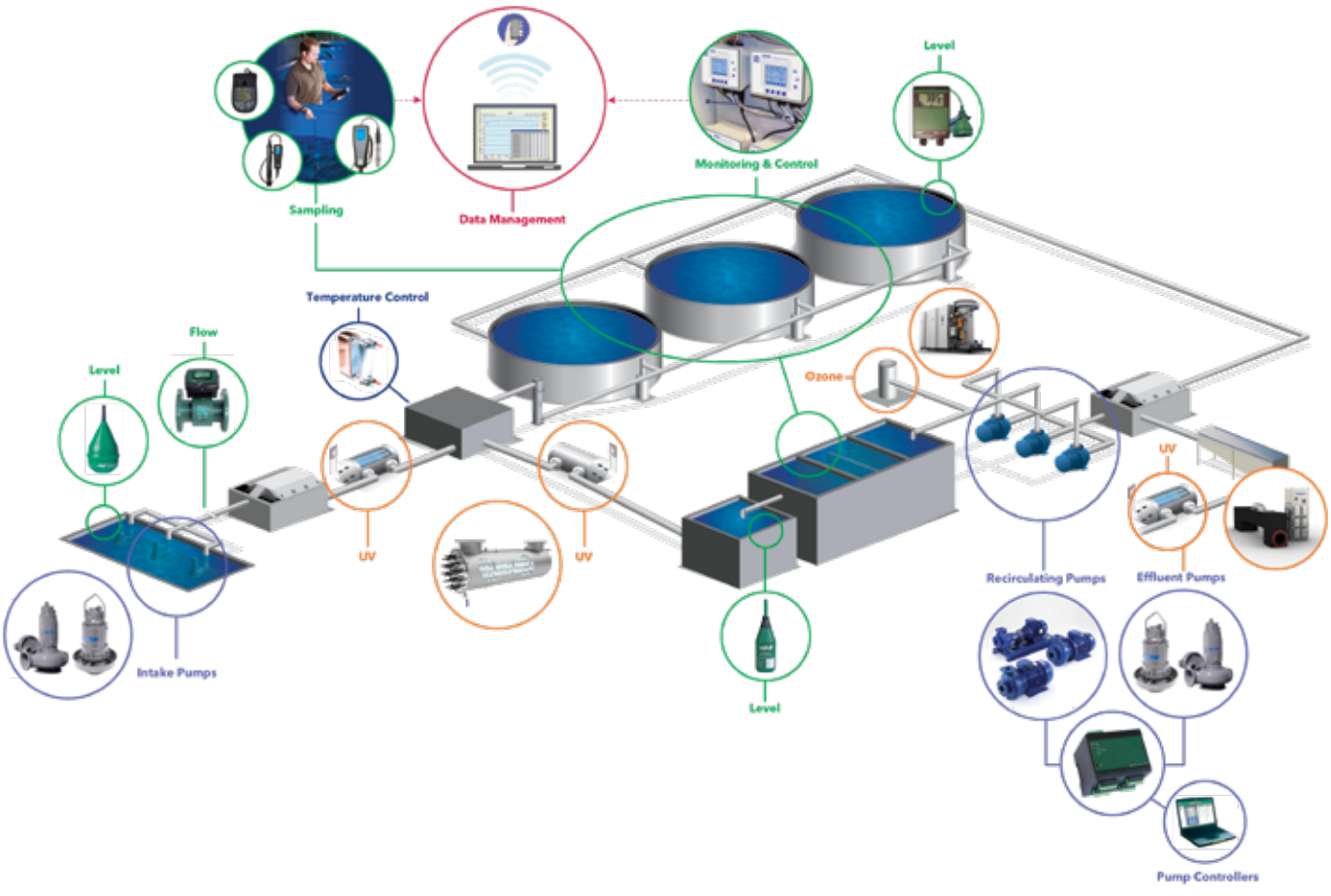
Recirculating Aquaculture Systems (RAS) rear fish and other species at high densities and within a controlled environment in indoor tanks while recirculating systems filter and recycle the water back through the tanks. Treatment is necessary to maintain clean water and to provide a habitat suitable for fish because disease outbreaks can more readily occur within the high stocking densities typically employed in RAS.

RAS provides consistent high fish production while remaining functional in varying environmental conditions (i.e. inlet water quality), which also allows for its use in areas not typically suited for aquaculture.

Also, it generates lower wastewater volume compared to open flow and land-based flow-through systems, thereby lessening environmental stress.

The treatment steps in the RAS recirculating system typically include solids removal, ammonia removal, CO_2 removal, oxygenation and disinfection. Here, drum filters for filtration and UV for disinfection are typically utilized and, ozone is used for particle removal, oxidation, and color removal. New water is added to make up for evaporation and water losses in treatment steps. In addition to treatment of recirculate water, the treatment of makeup water is also necessary before it enters the recirculation loop.

In addition to providing disinfection along with UV, ozone generation systems significantly reduce total suspended solids (TSS) and dissolved organic carbon (DOC) in recirculating aquaculture systems, and diminish off-taste-causing compounds such as 2-Methylisoborneol (MIB) and Geosmin, while decreasing color due to humidic substances in the water.



Well Boat

It is critical that live haul units during transport and operation are kept clean and free of pathogens at all times. The risk of outbreak can transpire frequently during live transport.

Well boats transporting live species from land-based smolt facilities to open cages at sea, sorting fishes on the boat during grow-out, and transporting the harvest back to shore for processing, require proper treatment. This includes treatment of the boat's storage system and intake water to ensure less biosecurity risk to nearby locations, lower fish mortality rate and high quality stock, as well as to treat for parasites such as sea lice.

Here, ozonation and UV irradiation are used during fish transportation to protect fish and break the routes of disease transmission by disinfecting the wells, pipes, valves, pumps and all equipment in contact with the transport water during the different transports. Both ozone and UV maintain hygienic conditions for water intake, preventing growth of pathogenic bacteria, fungi and viruses.

In well boat operations, storage system and intake water treatment is critical to ensure high quality stock, pathogen reduction, and less biosecurity risk.

Open-flow and Land-based flow-through systems

Open-flow systems typically refer to fish farming in natural water bodies: oceans, bays, estuaries, lakes or rivers. In Flow-through aquaculture systems, culture water makes a single pass through the system and is discharged.

Such systems commonly take the form of raceways or tanks, with water either gravity fed or pumped. Raceways are relatively shallow and rely on a high water flow in proportion to their volume in order to sustain aquatic life. Flow-through fish culture systems pass water through the systems once and is then discharged. In intensive flow-through systems, aeration systems are installed to provide a number of benefits, including carbon dioxide removal and increased dissolved oxygen.

There are varying input and output treatment methods in these systems. It is important to provide good control of the water intake to minimize pathogens, suspended solids and organic pollutants. In addition, treatment of wastewaters from flow-through land-based aquaculture facilities is a necessary practice. In many systems, incoming water is filtered and UV disinfected. Effluent water is also filtered, UV treated and nitrogen wastes are removed.

Commercial Fish Hatcheries

In the incubation process, treatment systems must significantly reduce pathogen counts to ensure no harmful pathogens enter the hatchery.

Fish hatcheries, like rearing facilities, are increasingly adopting the use of recirculating water systems to incubate fish eggs. Although these systems provide many benefits, the continuous reuse of water makes it increasingly susceptible to various types of bacteria, virus and parasites harmful to many fish species.

Here, UV systems are typically installed as the final treatment step, just prior to water contacting the fish eggs. In addition to its use in hatchery recycle loops, UV is also being increasingly utilized in hatcheries' effluent treatment systems. Often, ozone injection is also made into the recycling loop for further disinfection just prior to UV treatment.

Depuration Facilities

Effective depuration requires shellfish to be properly handled during harvest, and pre-depuration transport and storage. It also requires proper design and operation of the depuration system to meet the requirements for removal and separation of contaminants.

Typically, seafood depuration is performed in segregated physical tanks using treated seawater that has been sterilized. UV depuration procedures reduce pathogen levels to ensure the shellfish are safe for human consumption.

Ozone is also being increasingly used at depuration facilities to clean seawater and shellfish. Ozone significantly reduces pathogens and also promotes an increase in the dissolved oxygen level of the water. Neither ozone nor UV treatment affects the taste or smell of the shellfish.

Aquaria

Aquarium water technologies are very similar to that used in fish aquaculture, but a key difference remains: the purpose in aquaria is not to rear some species for food production, but to keep valued species alive and healthy and under good conditions for exhibition or decorative purposes.

Fish density is lower in aquaria, compared with fish farms. Consequently, contamination and biomass concentrations are kept at lower levels. These differences also influence the demands on the water treatment system. Biofilters for aquaria are typically smaller than those used for fish farms. Due to the lower biomass levels, the UV transmittance will generally be higher than for fish farms, allowing for UV installations in a side stream despite low water treatment turnover rates. Thus, a more economic UV system can be selected.

Maintaining crystal clear water at all times is essential for zoos and aquaria. Here, ozone oxidation can provide your visitors with a clear, optimal visual experience. Ozone, in addition to UV, is often used in large-scale aquariums to keep tanks clean and reduce odors while inactivating bacteria and virus populations. This creates healthier environments for the fish inside and an optimum experience for visitors outside.

Partnering with Xylem helps you achieve your water treatment goals, and more

Xylem engineers design and manufacture the highest quality UV and ozone generation systems available. That's not all, however. We apply the same dedication and expertise to every aspect of our relationship with you. Our people – and how they partner with you – are what makes Xylem the right choice for your aquaculture water treatment solutions.

We've been partnering with fish farmers, OEMs, integrators, well boat manufacturers, and processing plants for decades. From hatcheries to market, we understand the challenges facing the aquaculture industry to help you control costs while enhancing your operations.

Excellent disinfection capacity at lower energy consumption. Our efficient UV treatment and ozone oxidation technologies provide excellent disinfection capacity. Our advanced UV lamp and control technologies help provide optimal aquaculture water conditions while saving you energy.

Reduced capital expenses. Both our UV and ozone systems allow for reduction of construction and installation costs, creating less footprint due to the optimum arrangement of pipework and cabinets. In addition, our open-channel UV systems require less channel depth and our ozone generators' electrodes are manufactured from inert, highly corrosion resistant materials, making them practically maintenance free.

Assured compliance to strict disinfection and biosecurity requirements. Disinfection and biosecurity are today vital to the health maintenance of aquatic species. Wedeco UV and ozone systems are certified to the highest standards, so you can be confident that the design of your treatment system will meet your most demanding disinfection requirements.

Future-proof flexibility. By installing efficient, sustainable Wedeco disinfection technologies, we future-proof the disinfection and oxidation treatment of your operations and provide flexibility of critical control systems, spare parts, retrofits and services. Our systems may be integrated to your SCADA system and are smart technology ready.

3-,4- and 5-log reduction. Proven Wedeco UV disinfection technologies protect both the health of your fish, and your bottom line. Wedeco ozone generation systems, in addition to providing excellent disinfection, help maintain Total Suspended Solids TSS and Dissolved Organic Carbon (DOC) levels while controlling Biological Oxygen Demand (BOD). This leads to a reduction in effluent volumes, greater productivity, and higher levels of biosecurity.

Rugged performance to meet the demands of harsh environments. Our water management engineers and aquaculture experts are constantly developing smarter technologies with rugged, robust performance to meet the demands of harsh aquaculture environments. Our ozone and UV systems and ancillary equipment are built to last.

Increased operation time and uninterrupted disinfection processes. Due to their rugged performance plus our easy replacement and installation capabilities, downtime is minimized, allowing for greater productivity through uninterrupted disinfection.

Easy installation, facility integration, retrofitting and mounting regardless of piping conditions. A standard feature across the Wedeco UV is a proven engineered feature that promotes easy mounting and ideal hydraulics with very low headloss regardless of inlet piping conditions, while our plug-and-play ozone systems have little foot print and deliver high ozone output.

UV Disinfection in Aquaculture

Proper UV system design for an aquaculture system determines the effectiveness of the treatment. System design is influenced by many factors, including: 1) type and quality of raw, recirculated and discharge water, 2) type of water treatment scheme (open flow or RAS), 3) the reared species and its growing stage, 4) the targeted pathogens to be inactivated and targeted reduction rate, and 5) compliance with government and organizational regulations

UV in Open Flow Systems
The goal is to reduce as much bacteria and viruses as possible before the water enters the system.

The UV system must be installed in full-flow, prior to the holding tank but after passing a filtration step that removes suspended solids.

UV in Recirculation Aquaculture Systems (RAS)
The goal is to achieve both inlet and outlet disinfection to maintain the bacteria population at equilibrium and prevent cross contamination between tanks

Depending on the fish species reared in an aquaculture scheme, the target pathogen(s) that need to be reduced may vary. Accordingly, also the UV dose requirements will differ from site to site.

UV installed after the bio-filter protects the entire rearing system from bacteria and viruses, including those originating from the bio-filter.

UV in Well Boats
The goal of using UV in well boats is to effectively disinfect the intake water during smolt transport and the discharge water during the transport of market-sized fish. There are multiple UV system designs for well boats, including installation on the water intake after a prefilter step (typically 150 micron), and installation on the water discharge after a prefilter (also typically 150 micron). Mostly UV systems on well boats are designed according to a minimum UV dose. Although the required minimum dose varies by location, a minimum UV dose of 25 mJ/cm^2 is the Norwegian standard.

Wedeco UV Systems

The Ideal Choice For Today's Aquaculture Facilities

Most Wedeco UV systems have received approval from the Norwegian Veterinary Institute (NVI), which validates UV systems for aquaculture applications in Norway and other parts of the world. This guarantees that our UV systems perform in compliance with current regulations to prevent organisms that are detrimental to fish health and water quality.

The UV-C output of Wedeco UV lamps can be up to five times higher than conventional low-pressure lamps, and they are three times more efficient than medium-pressure lamps. Many Wedeco models provide sensor-controlled monitoring in real time, plus control logic dosing that adjusts energy consumption to the minimum needed to meet dosing requirements. Operator-friendly system controllers unify all sensor signals, alarms, SCADA connectivity, and closed loop control for easy monitoring and control. Plus, dimmable lamps provide wide dosage control and energy efficiency capabilities.

For all Wedeco closed vessel systems, we can offer a separate, overarching Programmable Logic Controller (PLC) for control and and monitoring of several UV reactors.

Wedeco Spektron UV Series

With highly efficient UV lamps and advanced flow distribution technology, the Spektron UV Series is a cost effective, reliable solution for aquaculture. It has a capacity of more than 6,000 m³/h (25 MGD) per unit and is validated by the UVGDM, DVGW and ÖNORM, for guaranteed microbiological performance. Spektron is NVI approved for use in aquaculture.

Wedeco Duron UV Series

Wedeco Duron is a modular open channel UV disinfection system that combines intelligent control with the most advanced UV lamp and ballast technology - giving the right dose with minimal energy consumption to effectively inactivate 99.99% of pathogens and save energy without harmful by-products. The Duron Series is approved by the Norwegian Veterinary Institute (NVI) for treatment of aquaculture, DVGW, UVGDM and ÖNORM.

Wedeco Acton PE UV Series

Wedeco Acton PE is a closed UV disinfection reactor made of high quality polyethylene (PE100) material, perfectly suited for the corroding elements of aquaculture farms, aquaria, saltwater thermal pools, and well boats.

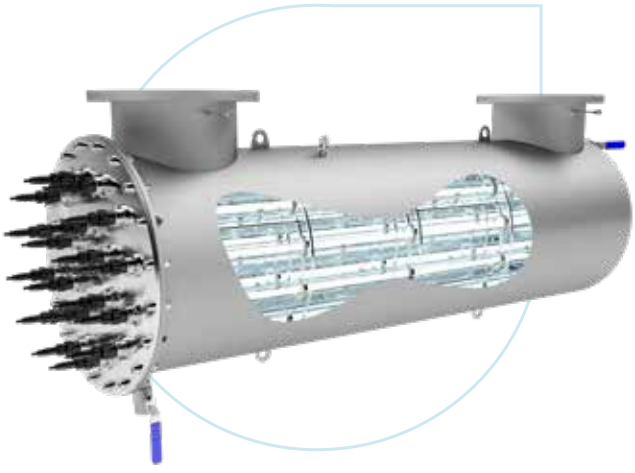
For high ambient temperature applications, the electrical cabinet can be equipped with an air conditioning unit, and the reactor is equipped with temperature monitoring to assure operating in the adequate range. NVI approval for Wedeco Acton PE is in process.

Wedeco Quadron UV Series

Wedeco Quadron is a powerful medium-pressure UV disinfection system with unique hydraulic design features to weather all site conditions, for flexible installation in areas requiring a minimum footprint. Quadron is approved by NVI for use in aquaculture, and is DVGW and UVDGM validated.

Wedeco BX UV Series

This is an extremely compact and versatile UV system for flow rates of up to 530 m^3/h (1.25 MGD). The Wedeco BX UV Series combines maximum disinfection performance and minimum energy use to best suit recirculation system intake water. For low UVT applications, Wedeco BX Series units also provide a proven, energy-efficient UV solution and has been validated by the NVI.



UV Comparative Chart for Aquaculture





Model	Duron	Acton PE	Spektron	BX	Quadron
UV Transmittance, Flowrate and Certifications					
UV transmittance range in % (1cm)	<20% to >80%	>70%		≥ 80%	≥ 65%
Maximum flow rate (m^3/h) *	>750	829	6,032	2,120	4,100

UV Lamps and Monitoring Systems					
Lamp Technology	Ecoray® Low Pressure UV Lamp				Multiray™ Medium Pressure UV Lamp
Power per Lamp (W)	600	350 and 600	50 to 600	70 and 290	6000
Number of Lamps per Module or Per Reactor	12 to 20 (in 2 staggered rows per module)	1 to 6 (per reactor)	1 to 6 (per reactor)	2 to 8 (per reactor)	3 to 5 (per reactor)
Lamp Life (hrs)	14,000				8,000
Performance Approvals	USEPA's UVDGM,NWRI, DVGW, NVI	NVI in process	USEPA's UVDGM, DVGW, ÖNORM, NVI	NVI	USEPA's UVDGM, DVGW, ÖNORM, NVI
Individual Lamp Monitoring	Germicidal, ÖNORM Compliant				

UV Reactor				
Protection Class	IP 67	IP 65		IP 54 (Nema 12)
Cleaning System	Standard: OptiWipe Optional: OptiBrush	Manual Optional: Automatic Mechanical Wiper, CIP System		
UV Module or Reactor Material	Stainless Steel	High Quality HDPE (PE100)	Stainless Steel	
Maximum Operating Pressure bar PSI		6 87	10 145	

Electrical Cabinets		
Ballast Type	Electronic, High-efficiency, Constant or Variable Output	
Control Philosophy	Fix power or dose-pacing	
Controller	EcoTouch, Optional with PLC	
Material Construction	Painted Sheet Steel Optional: Stainless Steel or Duplex Steel	
Electrical Standards	CE, UL/cUL*	
Common Outputs	System Status, Lamp Status, Alarm Messages, Process Values	
Scada Communication	Optional: via Bus Interface	
Protection Class	Standard: IP 54 Optional: IP 55	IP 54 / cUL type 12
Cooling	Ventilated: IP 54 / cUL type 12; Optional: A/C	

*UL/cUL not for BX

Ozone Oxidation in Aquaculture

The use of ozone in aquaculture has a number of benefits that are mostly related to improvement of water quality, resulting to increased production performance of various fish species.

During the species' growth stages, stocking density, food utilization and amount of feces increase and have a significant impact on the water quality. This in turn influences the ozone design and implementation. Some of the important technical parameters in the design include point of use, amount and quality of recycled water, and the existing treatment technology.

OZONE IN AQUACULTURE SYSTEMS

Ozone is mainly used for rearing of trout, salmon, sturgeon, gilthead, seabass or turbot. But not all described benefits are applicable for all fish species.

For pathogen control, the goal of ozonation is to kill pathogens, bacteria and viruses and reduce fish mortality rate.

For the abatement or elimination of organic and inorganic compounds, the goal of ozone oxidation is to remove nitrite, which is toxic to fishes. Nitrite is a transformation of ammonia created as a product of metabolism during the production process. Ozonation transforms nitrite to nitrate, which is not harmful to fishes

Ozonation also can be used to reduce taste and odor (i.e. geosmin and MIB) and improves the quality of the fish, thereby increasing its value. Ozone also breaks down refractory organic molecules, making them digestable for treatment in the biofilter. Ozone also reduces colors and supports micro flocculation, resulting in very clear water.

Ozone is very effective for suspended solids removal. It enhances fine solid removal by changing particle size (i.e. micro-flocculating fine particulate matter) and surface properties, which allows particle to settle, filter or float easier. This removal of fine suspended solids is beneficial to fishes by preventing gill damage.

OZONE USE IN WELL BOATS

In well boats, ozone disinfects the wells, pipes, valves, pumps and all equipment in contact with the transport water during the different transport operations. The goal is to prevent disease transmittance from fishes in one transport to others in the succeeding transports - breaking the routes of disease transmission.

Ozone is produced on-site with ozone generators and is injected into the recirculation loop when running its circulation pumps.

Ozone reacts with bromide, and after an initial ozone demand, starts building a disinfection residual (total residual oxidants = TRO), which inactivates fish pathogens.

TRO concentration and contact time should be designed according to approvals from regulatory authorities, typically at least TRO 1 mg/l for three hours.

Wedeco Ozone Systems

The Ideal Choice For Today's Aquaculture Facilities

Xylem's Wedeco Ozone Systems provide compact and plug-and-play equipment for aquaculture applications. Along with the ozone generator, our systems come with control cabinets, dosage control based on water flow, a pump-venturi system, and oxygen supply, if necessary.

Wedeco GSO 18 Series

Xylem's Wedeco GSO 18 Series generators are compact ozone generators designed to produce ozone more effectively at high concentration yields with very low energy demand. The unit can be quickly installed and operated as a turn-key packaged ozone system. Equipped with the unmatched reliability of our Intelligent Electrode Protection technology, the GSO18 Series yields high ozone concentration, low energy demand and optimized operating cost.

Wedeco SMOevo^{PLUS}

A compact, plug-and-play ozone system that maximizes ozone production for medium to large capacities, and achieves up to 60% lower cooling water consumption at high energy efficiency and low lifecycle costs. The Wedeco SMOevo^{PLUS} has the ability to feed as a centralized unit into various ozone application points, such as multiple parallel lines or various rearing stages

It is equipped with state-of-the-art semiconductors technology (IGBTs) for improved system control, while the air conditioning system allows it to operate under high temperature (up to 35°C) and high humidity (up to 90%) conditions, eliminating the thermal power loss of electrical components.

Options

A number of options and ancillary equipment are available to complete your Wedeco ozone systems, such as instrumentation, PLC logic, feed gas supply, cooling water supply etc., so that you are ensured that you get optimum results for your ozonation requirements.

Containerized systems	Insulated, lighted and painted container Complete alarm and safety concept according to international standards Electric heating and ventilation fan
Instrumentation and control	Ozone concentration control Ozone residual in water Alarm monitoring and indication System control based on process signals monitoring
Feed gas supply	Liquid oxygen On-site generated oxygen Air preparation comprising air compressor, desiccant dryer, filtration
Ozone mixing and contacting	Side stream injection systems Fine bubbles diffusers Closed reactors Degassing tanks Demistors
Electronic process control	Operation panel Overall process control
Ozone destruction in off gas	Catalytic ozone destructor
Cooling water supply	Air / water cooled chiller units Heat exchangers

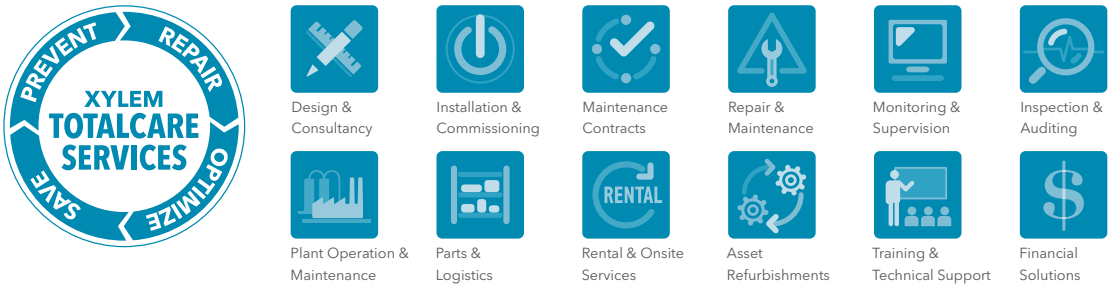
Ozone Technical Data Summary

Model	SMOevo^{PLUS}	GSO 18
Ambient Temperature °C °F	10 - 35 50 - 95	5 to 35 41 to 95
Cooling Water Inlet Temperature °C °F	5 to 35 41 to 95	
Ozone Production, Nominal g/h or [ppd]	Air: 1,291 -12,976 or [68 to 687] Oxygen: 2,137 to 23,810 or [126 to 1260]	Air: 3 to 215 or [0.16 to 11.4] Oxygen: 12 to 420 or [0.6 to 22.2]
Ozone Concentration Range Air Oxygen	1.5 to 5 wt% 6 to 15 wt%	1.5 to 4 wt% 2.3 to 12; 7 wt% (nominal)
Feedgas	Air; LOX; PSA	
Feedgas Inlet Pressure bar(g) PSI(g)	3 to 6 44 to 87	2.5 to 3.5 36 to 51
Outlet Pressure Feedgas: Air Feedgas Oxygen	2.0 1.2	
Dew Point Feedgas °C °F	< -70 < -94	
Feedgas - Total Hydrocarbons (THC)	≤ 60 ppmV	
Dimensions L x H x W (mm) - Smallest unit: Biggest unit L x H x W (in) - Smallest unit Biggest unit	3100 x 2275 x 950 4840 x 2280 x 1550 122.1 x 89.6 x 37.4 190.55 x 89.76 x 61.02	850 x 800 x 350 910 x 1615 x 540 33.4 x 31.4 x 13.7 35.8 x 63.6 x 21.3
Max Cooling Demand Water m³/h gpm	2.6 to 26.5 11.4 to 116.6	0.08 to 0.70 0.35 to 3.10
Standard & Remote Control & Alarms		
PLC	Siemens	Proprietary controller
HMI	SIMATIC HMI Comfort Panels	Proprietary display
Bus System	Profinet; Ethernet	None
Common Outputs & Alarms	System Status; Alarm Messages; Process Values	Alarm Message; Set Point
Electrical Standards		
Electrical Requirements	3x400 V / N / PE ±10%; 50/60 Hz (TN-C or TN-S-net)	Models (20-40): 230V Models 50: 400V 50/60Hz
Electrical Standards	EN; IEC; ISO	
Installed Capacity (kVA)	21.8 to 184.0	0.6 – 4.5, 0.95 to 0.99
Power Factor	0.95 to 0.99	
Protection Class	IP54	Models (20-40): IP30; Models 50: IP32
Materials of Construction		
Enclosure	Powder Coated Steel	
Painting	RAL 7035	
In Contact with Ozone	SS316 , SS304	
In Contact with Water	SS 316	
Options		
PLC	Siemens, Allen Bradley, Schneider	Optional PLC: External
Scada Communication	Available	None
Measurement	Ozone in Water, Redox	
Reaction Tank	Available	480L, 1000L, 1500L, 2000L
Air preparation	Available	
Cooling Systems	Open loop cooling; Closed, loop cooling; Chiller	
Ozone Destructor	Catalytic	
Oxygen Generator	Available	
Ozone Contacting	Diffusors; Pump-Injection (venturi)	
Gas Distrubution System	Automatic; Manual	None
Demistor	Available	None

TotalCare
Secure, Optimal Operations

Water quality directly influences the health of rearing fish, which makes maintaining trouble-free water treatment equipment operation especially crucial. Xylem's global service network helps to ensure equipment is properly installed, maintained and regularly checked – whether on land or on a boat. Xylem TotalCare offers Preventive Maintenance Agreements customized to the individual needs of each customer's system, ensuring fast response to any equipment issues requiring immediate resolution.

Accessing the deep system expertise and know-how built into Xylem product brands ensures these systems and equipment always perform at their best. Xylem TotalCare gives you operational security and more time to focus on your core business. Our standardized service packages let you use our service and support on your terms. With Xylem TotalCare services, you're just one phone call away from integrated service and support that you won't find anywhere else.



Xylem TotalCare is a comprehensive, integrated portfolio of services that ensures your business keeps running at its best. Our portfolio comes backed by deep systems knowledge and expertise in water and wastewater applications. Xylem TotalCare gives you operational security and more time to focus on your core business.

xylem
Let's Solve Water

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