



Ballast Water Management System



Frequently Asked Questions

Ecochlor was founded in 2001 to provide a simple, reliable, cost effective, easy to use ballast water treatment system to the maritime industry. In 2004, Ecochlor obtained United States and International patents for the use, generation and control of chlorine dioxide (ClO_2) for the elimination of aquatic invasive species in ballast water. Since then, our team has been dedicated to developing a product line that utilizes ClO_2 to provide effective, robust BWMS that can stand up to the most stringent regulations in the world.

Ecochlor Treatment Technology

What is chlorine dioxide (ClO_2)? ClO_2 is a powerful biocide. It has been used in a wide variety of land-based treatment applications, including drinking water, municipal waste processing, food, pulp and paper production for over 70 years. It has now been proven as a powerful treatment technology for ballast water. ClO_2 offers a number of advantages over other disinfection methods and techniques; it is effective on all aquatic organisms, including bacteria and other pathogens.

How is the Ecochlor ClO_2 treatment technology different from BWMSs that use chlorine to treat ballast water? Chlorine (bleach) and ClO_2 are both oxidizing agents. However, they work in fundamentally different ways.

ClO_2 reacts with living cells by first penetrating the bacterial cell wall and then reacting with the material within the living cell in order to kill the organism. ClO_2 has very limited reactions with organic matter present in ambient water and works exceptionally well where high levels of organic materials ("dirty" or turbid waters) are anticipated to be present. This greatly reduces the formation of disinfection by-products and means that ClO_2 treatment effectiveness is not affected by turbidity or temperature.

On the other hand, chlorine reacts with almost any organic material (living and non-living) such as oil, algae, sediments, etc. This means that waters with high levels of organic matter can increase the demand for chlorine, leaving less of the chemical available to treat living organisms; thus, requiring an increase in dose. Due to the types of reactions that chlorine has with both organic and inorganic compounds, chlorine has a greater potential to form undesirable by-products in water. These by-products can pose toxicity risks to both aquatic organisms and humans.

The high levels of chlorine required to treat ballast water comes with operating limitations — neutralization is required to ensure chlorine can be discharged safely. Because ClO_2 is more selective in its reactions (with 2.6 times the oxidative power than chlorine) this makes it effective at lower concentrations. ClO_2 does not require neutralization or re-treatment of the ballast water prior to discharge because it naturally decays to a safe discharge concentration.

How does the Ecochlor BWMSs work? Ecochlor offers three different products to the BWMS market to provide shipowner with the flexibility they need when it comes to selecting a BWMS.

Each of these BWMSs rely on the same core, ClO_2 technology. Within all Ecochlor Systems, ClO_2 is generated on demand and is not stored onboard the vessel. To generate the ClO_2 , two precursor chemicals are pumped into a small mixing chamber, which then combines to automatically produce the ClO_2 . An eductor then draws the ClO_2 from the mixing chamber and mixes with the motive water supply to form the ClO_2 solution. This solution is injected into the main ballast water stream. When ClO_2 is no longer required, the treatment system is thoroughly flushed with water to remove all residue so that it is ready for the next ballast uptake.

What are Ecochlor's line of products? Ecochlor's three product lines incorporate ClO_2 technology in different ways to provide the shipowner

flexibility regarding the installation and operation of their BWMS.

- Ecochlor® BWMS (Filtration & ClO_2): This system treats ballast water by filtering the water to 40 microns and then injecting a dose of 4.25 mg/L of ClO_2 . The system includes a generator cabinet, tanks, injection components, and main and aft peak tank filter(s) if required. Vessels operating this system can operate anywhere in the world with no restrictions when it comes to temperature, salinity, or turbidity.
- EcoOne™ BWMS (ClO_2 alone): This system treats ballast water by injecting a dose of 4.6 mg/L of ClO_2 . The system includes a generator cabinet, tanks, and injection components. Vessels operating this system can operate anywhere in marine and brackish waters (i.e., ≥ 1 PSU) and with no restrictions on temperature or turbidity.
- EcoOne™ Hybrid BWMS (Dual mode filtration & ClO_2 or ClO_2 alone): This system will allow shipowners to operate their BWMS either with or without a filter. This option will be suited for shipowners who wish to have the flexibility of unrestricted operation globally, with the convenience of a no-filter system.

Why is the ClO_2 disinfectant particularly well-suited as a filterless BWMS option? ClO_2 is not affected by suspended sediments or turbidity.

This means that ClO_2 disinfection is effective regardless of changes in turbidity. Filtration is not necessary to remove sediments prior to treatment with ClO_2 , in contrast with UV or similar technologies

Additionally, ClO_2 primarily reacts with living organism, rather than reacting with other organic matter. Due to its limited reaction with non-living organisms ClO_2 works exceptionally well in "dirty" water.

Large increases in ClO_2 are not necessary to ensure effective treatment, unlike with electro chlorination (EC) or similar hypochlorite-based treatment technologies. As a result, power consumption remains extremely low and vulnerable tank coatings are still protected.

Can I convert my standard Ecochlor® BWMS to an EcoOne™ BWMS?

Yes! The EcoOne™ BWMS is a standard Ecochlor® BWMS with a few minor additional components and a change in software. If you have a standard Ecochlor® BWMS and wish to convert it to an EcoOne™ BWMS, please contact Ecochlor for details and pricing.

What about TRO sensors?

TRO sensors are typically used in Electro Chlorination and similar chlorine-based BWMS technologies to regulate both the chlorine dose on uptake (in response to varying water conditions) and the neutralizing dose required during discharge. These sensors can be troublesome in operation, leading to disruption to ballasting and deballasting processes.

Because the Ecochlor system uses a fixed dose of ClO_2 , regardless of water conditions, and because there is no requirement for neutralization on discharge there are no TRO sensors within the system.

Technical Considerations (Applicable for all of Ecochlor's Product Lines)

Are there any hold times for treated ballast water discharge? The Ecochlor system's minimum hold time is 24 hours. Prior to discharge of treated ballast water, the ClO₂ residual must be verified to ensure the maximum allowable discharge concentration (MADC) of 0.2 mg/L ClO₂ is not exceeded. Using a simple test, the crew collects two independent in-tank ballast water samples at different depths representing the middle and bottom of the tank to confirm the ClO₂ residual is less than 0.2 mg/L prior to discharge.

What is the chemical storage temperature range? The recommended temperature range for the space in which the precursor chemicals are stored is 5 °C – 40 °C. The low temperature is based on the temperature required to prevent the possibility of water lines freezing within the BWMS dedicated space and to maintain the quality of the chemicals. ClO₂ is generated on demand and is not stored onboard the vessel.

Will the use of chlorine dioxide have any effect on ballast tank coatings or increase corrosion inside the ballast tanks? There should be no effect on tank coatings or corrosion rates when utilizing the Ecochlor system. This was confirmed through tests on four different epoxy coatings and bare steel panels conducted by independent laboratories with samples analyzed by 3rd party experts, including a marine coatings supplier. At

the conclusion of the study, International Paint also provided a letter indicating that the Ecochlor® BWMS is unlikely to have a detrimental effect on epoxy ballast tank coatings approved to IMO Resolution MSC.215 (82).

What is the system's inbuilt safety measures? The Ecochlor system provides methods of preventing the accidental release of ClO₂. The generation of ClO₂ is equipped with numerous fault interlocks that prevent the operation of the generator without the prerequisite motive water flow and proper vacuum in the mixing chamber. The BWMS is also equipped with a flow deviation alarm which reconciles the flow of motive water entering the generator to the flow of the ClO₂ solution at the injection points. In the event that the flow deviation alarm is activated, the system will automatically shut down. If a chemical leak is detected, the system will automatically shut down and the system ventilation will increase to 30 air exchanges per hour.

Additionally, the system includes a ClO₂ gas detector mounted on the generator cabinet skid, and a redundant unit within the treatment system deckhouse, which will trigger a system warning upon a one-time detection of 0.3 ppm ClO₂. The system will shut down if there is a detection of 0.3 ppm ClO₂ for a continuous 15 minutes and / or if there is a one-time detection of 1.0 ppm ClO₂.

Vessel Compatibility with Ecochlor Systems

What are the key advantages of the Ecochlor® BWMS to a vessel or the ship operators? Ecochlor's powerful treatment technology meets or exceeds regulatory requirements from IMO & USCG: International Maritime Organization (IMO) Type Approval – BWMS Code (2020) & G9 (2010); and, USCG Type Approval (2017).

Benefits include:

- The BWMS is engineered for reliability and low maintenance
- Minimal crew involvement during system operation
- Small footprint even for vessels with high flow rates
- Low power requirements, possibly the lowest in the industry
- Option for no-filter operation
- Installation flexibility: Treatment System can be placed in any convenient location as modular components. The Ecochlor System allows for the flexibility to design a skid-mounted system
- No ballast water treatment or neutralization required at discharge

Can the Ecochlor system be installed in a Tanker with hazardous zones?

The system is approved for installation in both U.S. Flag and foreign flag vessels in hazardous zones rated Zone 1 or Zone 0. The treatment system equipment must be installed within an enclosed, non-hazardous area, typically a deckhouse or dedicated space. In some situations, the deckhouse or dedicated space can be installed in a hazardous

zone in accordance with the vessel's Classification Society's rules. The main ballast filtration system (if provided), consisting of the filters and associated equipment, can be installed within a Zone 1 or Zone 0 hazardous zone requiring the use of properly-rated equipment.

Can filters be installed on the Main Deck without a deckhouse?

The fabrication and installation of an enclosure for filtration system equipment on the main deck is required for an Ecochlor System. A deckhouse is typical, however, any major components installed on the main deck can be installed within a weather-protected enclosure to protect it from the elements.

What are the advantages to installing an Ecochlor system on a Bulk Carrier with gravity-discharge top side tanks? The normal operation on a bulk carrier with gravity discharge top side tanks is to discharge the ballast tanks directly overboard without using pumps or transferring the ballast water back through the pump or engine room. This discharge method would not be possible with any treatment technology that needs to treat or neutralize the ballast water at discharge without modifications. Adjustments to a bulk carrier to allow for this ballast water to be retreated or neutralized can be extremely costly and, more importantly, could lead to operational difficulties of the vessel. There are no treatment or neutralization requirements during the discharge of ballast water treated with the Ecochlor® BWMS making it a superior option for bulk carriers with gravity-discharge top side tanks.

Installations Service Options

What additional services do you offer shipowners to assist with the installation? Ecochlor offers a full range of ad-on options to facilitate system installations:

- Door to door shipping including assistance with ocean or air shipping, customs clearance and storage
- Installation supervision / commissioning testing attendance (with Class approval)
- Purchase and shipment of Alloy 20, 316L, GRE and other stainless-steel piping using U.S. high-grade steel to support the installation
- Spare parts and delivery savings

Equipment

What type of tanks are used to store the precursor chemicals on board a vessel? The two precursor chemicals are stored at atmospheric conditions onboard in storage tanks that are engineered, designed and fabricated for installation on the vessel main deck or above. One tank is a vented carbon steel tank lined with Halar (ECTFE). The other tank is a vented 316L stainless steel tank. Each tank is mounted inside a secondary containment system made from carbon steel coated with a chemical resistant coating and designed to hold 100% of the tank volume at a 37° vessel list. The secondary containment is equipped with sensors to detect the presence of fluid with an alarm condition to shut down the system and alert the crew.

What is the lead time for production of an Ecochlor System? Ecochlor has short lead times. Contact your local sales representative to discuss specific details.

Training

How is your commissioning training and first ballast operation set up? Training is provided at the end of the BWMS installation period and includes both classroom training as well as hands-on operational training. Classroom training is usually held sometime within the first 15 days of dry dock and runs approximately two hours. The operational training is typically run during the BWMS manufacturer's commissioning. In addition, Ecochlor can also offer hands-on training at the ship's first full ballast operation, allowing for a more realistic, stress-free learning experience with the engineers on board the vessel.

Do you offer computer-based training? After shipboard hands-on training at commissioning, the Ecochlor installation team provides an interactive computer training program, produced by MARPOL Training Institute, Inc., to the vessel. This software training program, with classification society DNV GL certification, can be installed on the ship's computer network or given to an owner's facility for access on their server during corporate training sessions.

Resupply and Service Support

Will the vessel's crew be responsible for chemical resupply? Chemical resupply is quick, easy and handled exclusively by our Chemical Operations Team.

Using the FMDS provided by the crew after each ballasting operation, Ecochlor tracks chemical use and arranges chemical resupply to the vessel at the appropriate time and location. Working with the vessel's nominated agent, the Chemical Operations Team will coordinate the delivery of chemicals to the vessel at berth or anchor. During chemical resupply there is no direct human contact because the entire process is closed, using special equipment and only Ecochlor trained personnel. Resupply takes approximately a ½ day to complete; this includes the clean-up and the removal of empty IBCs and submission of a detailed service report.

Chemical resupply will be performed approximately two times annually (dependent upon the number of ballasting operations) which allows for the Ecochlor technicians to offer new crew training and service maintenance on the Ecochlor® BWMS.

The Ecochlor service team provides logistics and technical support for chemical resupply at most major ports and harbors around the world

Operations & Maintenance

What is the life cycle of the main treatment components? The major components of the Ecochlor system include a generator and chemical storage tanks that are designed for the life of the vessel.

What are the maintenance requirements? The Ecochlor® BWMS requires very little periodic maintenance. During commissioning a preventative maintenance schedule is provided to the crew in the Operation Maintenance Safety Manual (OMSM).

Maintenance activities are scheduled in a frequency ranging from 12 to 60 months and involve routine inspection activities. It is recommended that the ships have some key spare parts on board. Chemical resupply will be performed approximately two (2) times annually (dependent upon the number of ballasting operations), which allows for the Ecochlor technicians to attend the vessel regularly and identify maintenance requirements early.

Do you offer training at shipowner facilities? A portable Human Machine Interface (HMI) training kit is available for onsite training at the Owner's training facilities. The portable simulator allows familiarization with the Ecochlor's system operation utilizing process replication and a full size [HMI] panel. Various operating and alarm conditions can be simulated to provide initial introduction to the system as well as responses to normal and abnormal variations in operating conditions.

Do you have a training facility where we can send our management and/or crew? The Training Center is located at Ecochlor's Corporate Headquarters in the USA. The facility includes classroom training on operation, safety, troubleshooting and maintenance as well as the use of an HMI training simulator that replicates the experience of using an Ecochlor system in a real-world situation. During the hands-on part of the training there will be an operating Ecochlor BWMS, both a wet and dry filter allowing for the equipment to be disassembled to view inner workings and functions.

Locations are continually expanding to align with the needs of the client base. Contact the chemical support team at chemops@ecochlor.com for the latest update on supply locations.

How do I reach your service team if I have any problems during ballasting? Ecochlor has service engineers located throughout USA, Europe and Asia. We continue to strengthen our in-house team supported by carefully selected Ecochlor Authorized Installation and Service providers. Contact ecochlorservice@ecochlor.com for service support.

What service support do you offer the crew after the installation? Our spare parts and service networks are positioned globally to respond quickly to our customer's requests; thereby, ensuring maximum system operation with minimum downtime.

The Ecochlor® BWMS is simple, with only a few major components. It requires very little periodic maintenance. Since chemical resupply is performed twice a year, it allows Ecochlor technicians to regularly attend the vessel and identify maintenance requirements early. Shipowners state that this frequent review by our technician provides them with "regulatory piece of mind."

Regulatory Compliance

Are there any compliance requirements associated with the Ecochlor system? Ecochlor has BWMS Code (2020) and G9 Type Approval (2010) as well as USCG Type Approval (2017) for the Ecochlor® BWMS. Ecochlor is pending IMO and USCG Type Approval for the EcoOne™ and EcoOne™ Hybrid BWMS. Below is the summary of approved or pending approval operational parameters.

Operating Parameters:

Operational Parameters (Approved or Pending)	Ecochlor® BWMS with Filter Operation Only	EcoOne™ Hybrid System With or Without Filter Operation	EcoOne™ System Without Filter Operation Only
Salinity	N/A	With filter: N/A Without filter: ≥ 1 PSU	Without filter: ≥ 1 PSU
Temperature	N/A	N/A	N/A
Filter Pressure	> 0.4 bar	With filter: > 0.4 bar Without filter: N/A	N/A
Hold Time	24 hours*	24 hours*	24 hours*
ClO ₂ Dose	4.25 mg/L	With filter: 4.25 mg/L Without filter: 4.6 mg/L	4.6 mg/L
Power Requirements	Flow Rate: 500 - 3,000 m ³ /hr. Typical <7 kW; Maximum of < 30 kW Flow Rate: 3,000 - 10,000+ m ³ /hr. Typical < 14 kW; Maximum of < 50 kW	With filter: Ranges 6 to 50 kW Without filter: Ranges 4 to 6 kW	Ranges from 4 to 6 kW regardless of system type or flow rate

* 24 hours plus confirmation that the residual ClO₂ concentration has degraded to below the MADC of 0.2 mg/L