AquaScience Research Group, Inc.

ClorAm-X®

Ammonia, Chlorine & Chloramine Remover

PURPOSE AND BENEFITS

ClorAm-X® is a unique, dry powder, water conditioner that has been scientifically formulated to remove, and thereby detoxify, ammonia, chlorine and chloramines from water for use in all types of fish and aquatic invertebrate culture. **ClorAm-X®** should be used (1) when conditioning new water for aquariums, tanks, ponds, and live-haul containers, (2) after or during water additions, (3) before adding new plants, invertebrates, fishes or amphibians to an existing aquarium, tank, or pond, and (4) to live-haul containers, during transportation of live fishes, amphibians, or aquatic invertebrates, to control and eliminate ammonia in the shipping water.

WATER CONDITIONING; GENERAL CONSIDERATIONS

Water conditioning is the process of altering water so that aquatic life can survive and thrive in it. Municipal water sources are treated so that the water delivered to the tap is free of viable disease-causing bacteria, viruses and other organisms as well as appearing clean and clear and being free of disagreeable odors and flavors. While such water is typically suitable for human consumption with no further treatment it is almost always quite deadly to aquatic life.

In broad terms, a water conditioner must remove or mitigate those substances which are toxic to aquatic life and add those substances which promote the health and well being of aquatic life. **ClorAm-X®** is just such a water conditioner and continues the long tradition of powerful and safe water conditioners developed and distributed by AquaScience Research Group, Inc..

WATER CONDITIONING; SPECIFIC CONSIDERATIONS

Water from different sources will have different problems which need to be corrected before it can be safely used for aquariums and ponds.

CHLORINE: This is the most commonly used disinfectant substance found in tap water in the world. This is because it is highly effective and inexpensive and the technology, in water treatment, is well documented and understood. The chlorine content of any water sample can be easily determined with available chlorine test kits. The best kind of kit is one which will give two different, but related, measurements: (1) "free, available chlorine" and (2) "combined available chlorine".

In the United States the federal Environmental Protection Agency (EPA) and various federal, state and local public health agencies have required that for overall human health that the amount of trihalomethanes (mostly as chloroform, $CHCl_3$) be significantly reduced or totally eliminated from drinking water. The source of trihalomethanes in drinking water comes mainly from the reaction of "free, available chlorine" with low levels of dissolved organic substances in the treated water.

The obvious problem with reducing "free, available chlorine" is that disease-causing organisms (e.g. polio virus, typhoid fever bacteria, and fecal coliform bacteria) would likely make it through the water treatment process and arrive at the customers' taps.

"Free, available chlorine" is known, chemically, as "hypochlorite". The hypochlorite ion, OCl^-, is the same ion that is found in common, household bleach products. As every homemaker knows, bleach is one of the best disinfectants available. Some small water treatment companies even "batch treat" their water supplies by adding the required amount of industrial bleach solution to a large tank of water before it gets distributed through the water supply system. The larger water treatment companies simply add chlorine gas directly to the water treatment stream and thereby produce the hypochlorite *in situ*.

The actual concentration of hypochlorite in the delivered water will vary from day to day and from season to season depending upon the conditions of the feed water and how the chlorine is added to the water.

The removal of chlorine; called "dechlorination" is relatively simple and can be achieved by a number of chemical substances. In addition, when water contained almost exclusively "free, available chlorine" it could be strongly aerated for a few days at room temperature and most (but usually not all) of the chlorine would dissipate. This was called "aging" the water.

The actual chemical reaction that occurs between hypochlorite ions and **ClorAm-X™** is illustrated in the following chemical equation:

$$OCl^- + HOCH_2SO_3Na \rightarrow H_2NCH_2SO_4Na + Cl^-$$

This results in the formation of chloride, Cl^- and sulfate, SO_4^{-2} ions. As natural water sources around the US and, indeed, around the world became more and more polluted it became necessary to more aggressively treat water to insure a healthy product. This also meant adding increasing amounts of chlorine so that the water treatment agencies could insure that the chlorine residual being delivered to the customer was sufficient to maintain safe water throughout the ever aging distribution systems.

As chlorine content (as "free, available chlorine") increased so did the trihalomethane content. Trihalomethanes are known cancer-causing agents (carcinogens). To counteract the trihalomethane threat and still provide safe water is was known that by increasing the "combined, available chlorine" content one could both make the water safe and eliminate the carcinogens. "Combined, available chlorine" is better know as "chloramines".

CHLORAMINES: These substances are formed from the reaction between chlorine (or hypochlorite) and ammonia or ammonium compounds in water. There are three substances which can be called chloramines. These are (1) monochloramine, NH_2Cl, (2) dichloramine, $NHCl_2$, and (3) trichloramine, or nitrogen trichloride, NCl_3. The formation of these compounds are relatively easy to understand if one looks at the ammonia molecule, NH_3, which consists of a central nitrogen atom, N, with three hydrogen atoms, H, attached. Any or all three of the hydrogens can be removed in a chemical reaction and each can be replaced by a chlorine atom, Cl.

The chemical reaction between monochloramine and **ClorAm-X®** is illustrated by the following chemical reaction:

$$NH_2Cl + HOCH_2SO_3Na \rightarrow H_2NCH_2SO_3Na + H^+ + OCl^-$$

The OCl^- is hypochlorite. This ion then reacts with the sulfonate end of the **ClorAm-X®** molecule to form harmless chloride ions, Cl^- (see the previous section "**CHLORINE**").

In water treatment the first such compound, monochloramine, is the most desirable due to its stability in solution and its ability to kill viruses, bacteria and other microorganisms. In actual practice, there is always a small percentage of the total chloramine content present as dichloramine, but never any trichloramine. The trichloramine is very unstable and rapidly decomposes to free nitrogen and chlorine (that's why one should never mix bleach and household ammonia (or ammonia-containing cleaners)).

When dechlorinated with ordinary dechlorinators the chloramines release the bound ammonia into the water. In addition, the chloramines are resistant to dissipation, even when the water is strongly aerated. The removal, or destruction, of chloramines is called "dechloramination". There is only one substance which not only dechloraminates water, but is also stable in solution, is nontoxic and has been determined by the United States Food and Drug Administration (FDA) that it does not come under their regulation. **ClorAm-X®** is, therefore, suitable for use on fishes and aquatic invertebrates intended for human consumption. This substance is found in **ClorAm-X®** and is protected by US and foreign patents.

AMMONIA: Ammonia comes from many sources in aquariums and ponds. These include accumulated and decomposing feces, uneaten food and dead plants. In aquariums, however, it has been shown that the majority of the ammonia in the water comes from the living fishes. Fishes expel ammonia directly into the water from exchange sites on their gills. This means the ammonia enters the water directly without having to be first mineralized from feces, etc. This is why starved fishes will still pollute their water with ammonia even though little or no fecal matter is produced.

The actual molecular or ionic form of the ammonia present in the water is directly dependent upon the pH, temperature and salinity. The pH is the most important factor affecting the equilibrium between molecular (= "free"), NH_3, and ammonium ion (="ionic ammonia"), NH_4^+. As the pH increases the percentage of molecular ammonia increases, and as the pH decreases the percentage decreases. Another way of understanding this is to remember that at acid pH's (pH < 7) the ammonia becomes less toxic to the fishes and at alkaline pH's (pH >7) it becomes more toxic. **ClorAm-X®** reacts with ammonia in is free, or unionized form. **ClorAm-X®** will not only remove the "toxic ammonia" but due to the concentration present in standard dosages it will also remove all the ammonia as the equilibrium between ammonia and ammonium ion shifts as the NH_3 is consumed in the reaction. At low pH's this reaction proceeds slower than at pH's above 7, but in practical terms the reaction proceeds quickly enough to provide complete ammonia removal in an hour or less.

The actual chemical reaction between ammonia and **ClorAm-X®** is shown below:

$$NH_3 + HOCH_2SO_3Na \rightleftharpoons H_2NCH_2SO_3Na + H_2O$$

The reaction product, $H_2NCH_2SO_3Na$, an aminomethanesulfonate salt, is nontoxic and is capable of being metabolized by ammonia-oxidizing (nitrite) bacteria. If the **ClorAm-X®** is dosed at levels higher than needed to react with the ammonia present in the treated water, the excess may react further with the aminomethanesulfonate salt. This secondary reaction, however, will proceed slower than the initial reaction, and dosing with excess **ClorAm-X®** to react with anticipated ammonia levels, such as in shipping bags or tanks, over a long period is recommended. The aminomethanesulfonate salt is stable at pH levels less than 9.0; at higher pH levels the compound will start to react with hydroxide ions, OH^-, and some free ammonia may be produced.

Unlike other water conditioner which claim to remove toxic ammonia, **ClorAm-X®** will do so even if the pond, tank, or aquarium is not cycled, is overstocked or is improperly filtered (this is why **ClorAm-X®** can be used in live-haul tanks and shipping bags where there is no filtration and where the number of fishes per volume of water is typically several times that found in an aquarium, tank or pond). Additionally, when using **ClorAm-X®** to remove ammonia there is no need to do water changes nor to vigorously aerate the water to facilitate is action. This does not mean that **ClorAm-X®** should be used instead of proper water maintenance, but when **ClorAm-X®** is used water management is made more efficient and effective.

SPECIFICATIONS

ClorAm-X® is a single-phase, dechlorinating (chlorine removing), deaminating (ammonia removing), and dechloraminating (chloramine removing) agent. It is a white powder that is essentially odorless (upon long-term storage the product may develope a very slight odor) and completely soluble in water.

Dosage: use 1 teaspoon (~ 5 mL) per 10 gallon of water.

FOOD FISH USE

ClorAm-X® may be used on fishes intended for human consumption. The United States Food & Drug Administration (FDA) has determined that the use of the chemical that constitutes **ClorAm-X®** (sodium hydroxymethanesulfonate) in water with fishes, intended for human consumption, does not come under FDA jurisdiction. For a copy of the FDA's "letter of determination" please write or fax us.

USE WITH CRUSTACEANS AND MOLLUSKS (SHELLFISH)

As with fishes intended for human consumption, **ClorAm-X®** may be used on shellfish intended for human consumption. In the FDA's "letter of determination", the agency states that the use of the chemical that constitutes **ClorAm-X®**, in water with aquatic invertebrates (e.g. lobsters, shrimp, crabs, clams, oysters) intended for human consumption, does not come under FDA jurisdiction. Our double blind toxicology studies were conducted on *Homarus americanus*, American lobsters, by Dr. Paul Cheung of the Osborne Marine Institute (Brooklyn, NY) and by Leberco Laboratories (NJ). The results of these studies were a part of the materials submitted to the FDA when we requested a determination of the product's legal status with regard to its use on aquatic animals intended for human consumption. For a copy of the FDA's "letter of determination" please write or fax us.

MARINE INVERTEBRATES: During the development of **ClorAm-X®**, successful shipping tests were conducted with a wide variety of marine invertebrates: shrimp (e.g. penaeids and *Stenopus hispidus*), *Octopus bimaculoides*, American lobster, *Turbo* and *Conus* snails, *Aplysia*, various squid species, tropical and cold-water sea stars and sea cucumbers, *Metridium* and *Condylactis* anemones, and hermatypic corals (e.g. *Trachyphyllia geofroyi*). Additionally, over the years that **ClorAm-X®** has been on the market, it has been used commercially by soft-shell crab distributors to prevent ammonia accumulation during the period the crabs are held before and during their molting.

FRESHWATER INVERTEBRATES: ClorAm-X® has also been extensively tested with freshwater mollusks and crustaceans. These have included species of snails, shrimp and crayfish. The product is routinely used for ammonia control in the shipments of both freshwater and marine invertebrates intended for the aquarium and bait trades.

LIVE FISH FOODS: ClorAm-X® is routinely used in the packaging and shipping of live aquatic invertebrates sold as live fish feeds. Brine shrimp (*Artemia* spp.), glassworms, bloodworms, blackworms, *Daphnia* spp., etc., have been, and currently, are being held, shipped and packaged in water treated with **ClorAm-X®**.

ACADEMIC AND RESEARCH USE

ClorAm-X® is used extensively by researchers doing remote field research where the collection, holding and transportation of live fish and invertebrate specimens is both necessary and difficult. When collected animals are held in water treated with **ClorAm-X®** the effects of ammonia are eliminated. When used in shipping water the effects of ammonia and shipping stress are eliminated or mitigated. For shipping, the used of breathable bags greatly enhances the

survivability (during and after shipping) of both fishes and invertebrates. For more information on the use of **ClorAm-X®** on collecting expeditions please contact our scientific staff.

STABILITY

ClorAm-X® is stable for an indefinite period if kept in its original container. **ClorAm-X®** should be kept dry, but if the powder forms lumps from having been exposed to humid air, the lumps can be pulverized, as necessary, and the product can be used as before. Do not return unused portions to the original container; do not introduce any water or other chemicals into the container.

COMPATIBILITIES AND CONTRAINDICA-TIONS

ClorAm-X® is not a medication, chemotherapeutic agent nor an economic poison and is not indicated for the treatment or control of any specific or general disease condition in aquarium organisms nor for the control of any pests.

WITH OTHER WATER ADDITIVES: ClorAm-X® is compatible with most other water conditioners. It is incompatible with strong oxidizing agents such as potassium permanganate ($KMnO_4$) and its solutions. Due to its ability to reduce certain dyes **ClorAm-X®** should not be used with treatments containing malachite green or methylene blue or related dyes. **ClorAm-X®** is compatible with most antibiotics. **ClorAm-X®** can be added directly to recirculating systems with active biological filtration; it will not interfere with, nor short-circuit, the nitrification process.

USE IN WATER PREVIOUSLY TREATED WITH CHLORITE-CONTAINING DRUGS: It has been confirmed that chlorite-containing drugs, used to treat and control "ich" and other diseases in pond and aquarium fishes, will inhibit normal nitrification and ammonia levels can increase significantly. **ClorAm-X®** will react with chlorite in a manner similar to its reaction with hypochlorite. Unfortunately, the reaction with chlorite, ClO_2^-, may not go to completion (at which point nontoxic chloride ions, Cl^-, are formed). Instead, if only enough **ClorAm-X®** is added to remove the measured ammonia it may react with the chlorite only to the extent that the chlorite is partially reduced and hypochlorite is formed. Even extremely low concentrations of hypochlorite are more toxic to pond and aquarium inhabitants than similar levels of chlorite. The result of this partial reduction of the chlorite in the treated water can be that the animals are poisoned by the resulting hypochlorite (small, nearly undetectable, concentrations of hypochlorite can significantly increase the toxicity of even low concentrations of ammonia). To prevent this occurrence one must measure the "available chlorine" concentration in the water before and immediately after treatment with **ClorAm-X®**. Additional product must be added to completely dechlorinate the treated water as well as enough to eliminate the unwanted ammonia.

Since there are areas where the use of chlorite-containing drugs is standard practice, the inhibition of nitrification and the subsequent increase in ammonia levels is a well-known and expected reality. Since **ClorAm-X®** is the world's best product for the removal and detoxification of ammonia its use in waters treated with chlorite drugs must be thoroughly understood.

WITH TEST KITS: Water treated with **ClorAm-X®** will give false (high), off-scale readings with ammonia test kits that use Nessler's reagents. Water treated with **ClorAm-X®** is compatible with most salicylate and phenol/hypochlorite test kits. Contact AquaScience if there is a question about ammonia test kit compatibilities.

Water treated with **ClorAm-X®** is compatible with all known nitrite and low-range nitrate test kits.

Water treated with **ClorAm-X®** is incompatible with Winkler and modified Winkler dissolved oxygen (DO) test kits. These kits will give false, low, or zero, readings. However, water treated with **ClorAm-X®** is compatible with indigo/carmine dissolved oxygen test kits and with dissolved oxygen meters.

WITH COLORIMETERS: Refer to the information above about test kit reagent compatibility. AquaScience has valuable information about ammonia testing using colorimeters and methods which require the use of a blank determination; please contact us for details.

WITH ELECTRONIC METERS AND ISE'S: When testing treated water with an ammonia ion-specific electrode (ISE) and electronic meter omit the step where 10*N* sodium hydroxide solution is added. Instead, dilute the electrode's picric acid filling solution with deionized water (to increase the electrode's sensitivity) at a ratio of 1 (filling solution) : 9 (deionized water), by volume, and measure the free ammonia directly. Refer to available charts to calculate the total ammonia from the free ammonia value determined and the known temperature, pH and salinity. Contact AquaScience for more information about how to do measurements with an ammonia ISE in water treated with **ClorAm-X®**.

USE IN LOW ALKALINITY WATER: If used to remove large concentrations of ammonia (>1.0 mg/L as NH_3) in water with little (<50 mg/L as $CaCO_3$) or no alkalinity the pH should be monitored. If the pH declines (by more than 0.3 units) simply add sufficient sodium bicarbonate (baking soda) to boost both the pH and the alkalinity.

TOXICITIES

ClorAm-X® is not known to be toxic to any fishes, amphibians, aquatic invertebrates or aquatic plants.

Solutions containing approximately 21% **ClorAm-X®** have been shown to be nontoxic and nonirritating to humans. Acute mammalian toxicity tests were performed on rats and skin and eye irritation (Draize tests) were performed on rabbits. The tested solutions of **ClorAm-X®** were found to be nontoxic at oral doses of 5,000 mg/Kg or less.

Double blind toxicities studies were performed on American lobsters to determine if toxic metabolites accumulated in the edible tissues of the lobsters. No significant differences were found, in aqueous and ether extracts of the lobsters' edible tissue, between exposed and unexposed (control) animals.

PACKAGING

ClorAm-X® is packaged in five different convenient sizes: 5 lb, 5 Kg, 10 lb, 10 Kg and 25 Kg. All packages are plastic bags in boxes.

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