

KLARIX™ 4000 Algicide for Industrial Cooling Water Systems

Description

Why Use KLARIX 4000 Microbicide?

As a Service Company committed to meeting the needs of your customers, you need the best technology and products available to be successful. The newest member of our microbicide family, KLARIX 4000, was developed to provide you and your customers with a solution to persistent algal contamination in industrial cooling waters. Its unique blend of efficacy and human and environmental safety makes KLARIX 4000 microbicide the perfect addition to your product line.

With KLARIX 4000 you can offer your customers a more effective solution to algal contamination and prevention. In the field, KLARIX 4000 has demonstrated superior performance. In 1996, a Rohm and Haas Company product, based on the same active ingredient in KLARIX 4000, was awarded the "U.S. Presidential Green Chemistry Challenge Award" for excellence in environmental achievement. By offering your customers KLARIX 4000, you deliver on their need for better-performing, safer products.

In the current regulatory climate, where increasing amounts of data are required by customers, regulatory authorities and ecolabel associations, it is important to choose not only the right product, but also the right supplier. Rohm and Haas Company, the inventors and leaders in isothiazolone chemistry, maintain extensive regulatory, toxicology and environmental fate databases. Our extensive technical expertise on isothiazolone chemistry, coupled with our support and commitment, enables you to market KLARIX 4000 with confidence.

Features

- Clear liquid microemulsion
- Physically stable product
- Chemically stable active ingredient
- Completely soluble at use concentrations
- Extremely effective against algae, cyanobacteria, mold and yeast at low use rates
- Also effective against bacteria
- Compatible with oxidizing biocides and other commonly used additives
- Compatible with most materials of construction
- Low viscosity
- Low, nonpersistent foam
- Odor-free
- Complete environmental package

Benefits

- Easy-to-dose product, eliminates the dosing issues (e.g. pumping and adequate mixing) associated with terbutylazine-based products
- Superior algicidal activity vs. competitive products reduces dosing frequency
- Rapid loss of "green" color in obviously fouled towers is a visual reminder of KLARIX 4000's efficacy
- Excellent environmental fate package (does not bioaccumulate in the environment, readily biodegrades to nontoxic byproducts)
- Cost effective

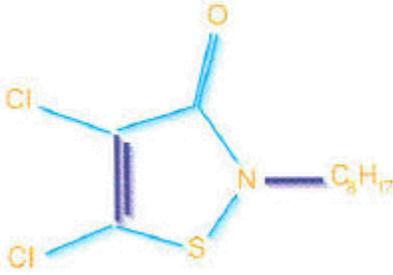
Physical and Chemical Properties

Typical Physical Properties

These properties are typical but do not constitute specifications.

% Active (nominal)	4.25
Appearance	Clear light amber liquid Free from foreign matter
pH @ 25°C	4.0 - 6.0
Flash Point	155°C (seta-flash)
Viscosity (21°C)	60 cps
Specific Gravity @ 22°C	1.020 - 1.035 g/ml

Structure

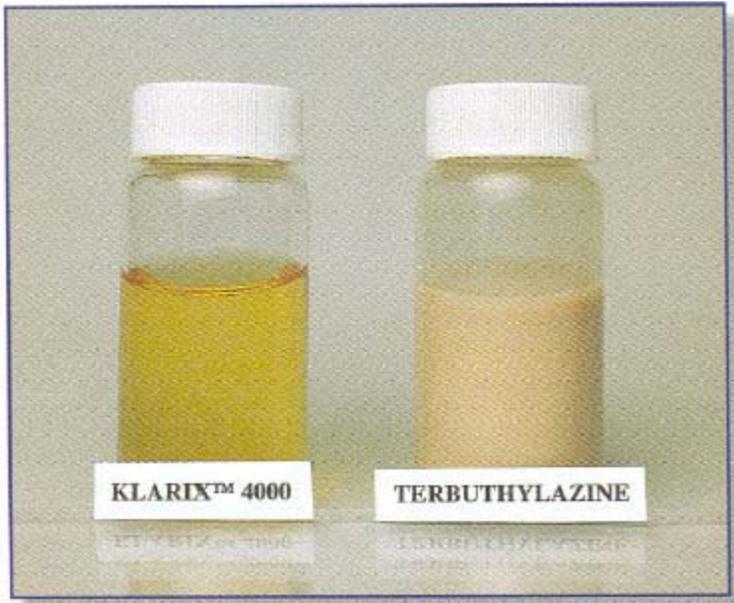


Molecular Formula: C₁₁H₁₇Cl₂NOS

Molecular Weight: 282.2

Active Ingredients	KLARIX 4000
4,5-dichloro-2-n-octyl-4-isothiazolin-3-one	4.25%

Inert Ingredients	
Solvent	8.50%
Surfactant	28.00%
DI Water	59.25%
Total	100.00%



The superior clarity of KLARIX 4000 microbicide is evident in this photograph of KLARIX 4000 (4.24% active ingredient) and a commercial formulation of terbuthylazine (4.0% active ingredient).

Suggested Applications

- Recirculating Cooling Towers
- Closed-Loop Cooling Water Systems
- Air Washers

Recommended Use Directions

KLARIX 4000 microbicide kills algae, fungi and bacteria in recirculating cooling towers, closed-loop cooling water systems and air washers.

The recommended use level for KLARIX 4000 microbicide is 6 - 141 ppm product as supplied (0.25 - 6 ppm active ingredient, 0.05 - 1.2 pounds or 0.74 - 18 fluid ounces per 1000 gallons of water). Repeat until control is achieved. Badly fouled systems should be cleaned before treatment is begun.

Application	Sites of Addition	Dose Levels			
		lb/1000 gal	oz/1000 gal	ppm Product	ppm ai
Cooling Water	Tower basin, distribution box, or other point for uniform mixing	0.05 - 1.2	0.74 - 18	6 - 141	0.25 - 6
Closed Loop	Reservoir, recirculating line, or other point for uniform mixing	0.2 - 1.2	2.95 - 18	24 - 141	1 - 6
Air Washers	Air washer sump or chill water sump for uniform mixing	0.1 - 1.2	1.58 - 8	12 - 141	0.5 - 6

General Dosing Recommendations

- Dose once or twice a week using a slug treatment of 6 - 47 ppm product (0.25 - 2 ppm ai) depending on the amount of algal growth.
- For heavily fouled systems, dose 47 ppm product (2 ppm ai) twice per week for 2 - 3 weeks to gain control.
- Once control is achieved, dose 6 - 24 ppm product (0.25 - 1 ppm ai) as needed.

Minimum Inhibitory Concentration (MIC)

Organism	As Supplied (ppm)	Active Ingredient (ppm)
Green Algae		
<i>Chlorella pyrenoidosa</i>	2	0.1
<i>Scenedesmus quadricauda</i>	28	1.2
<i>Chlorococcum oleofaciens</i>	23	1.0
<i>Ulothrix fimbriata</i>	14	0.6
<i>Ulothrix acuminata</i>	14	0.6
<i>Selenasirum capricornunim</i>	59	2.5
Cyanobacteria		
<i>Anabaena fios-aquae</i>	7	0.3
<i>Phormidium luridum</i>	14	0.6
<i>Oscillatoria prolifera</i>	7	0.3
<i>Synechococcus leopoliensis</i>	14	0.6
<i>Nostoc commune</i>	14	0.6
<i>Scytonema bofmanni</i>	14	0.6
<i>Microcystis aeruginosa</i>	14	0.6
<i>Calothrix parientina</i>	14	0.6
<i>Schizothrix calcicola</i>	14	0.6
Filamentous Bacteria		
<i>Sphaerotilus natans</i>	31	1.3
<i>Beggiatoa alba</i>	<5	<0.2
<i>Leptothrix discophora</i>	<1	<0.05
Bacteria		

<i>Pseudomonas aeruginosa</i>	118	5.0
<i>Enterobacter aerogenes</i>	89	3.8
<i>Klebsiella pneumoniae</i>	59	2.5
Fungi		
<i>Aspergillus niger</i>	14	0.6
<i>Rhodotorula rubra</i>	<1	0.03

Algae and cyanobacteria were tested in Modified Allens Medium, pH 7.5, 25°C. Filamentous bacteria were tested in Lactate-Hepes Medium, pH 7.2. Bacteria were tested in enriched synthetic process water, pH 8.0. Fungi were tested in enriched synthetic process water, pH 8.0.

Microbiological Properties

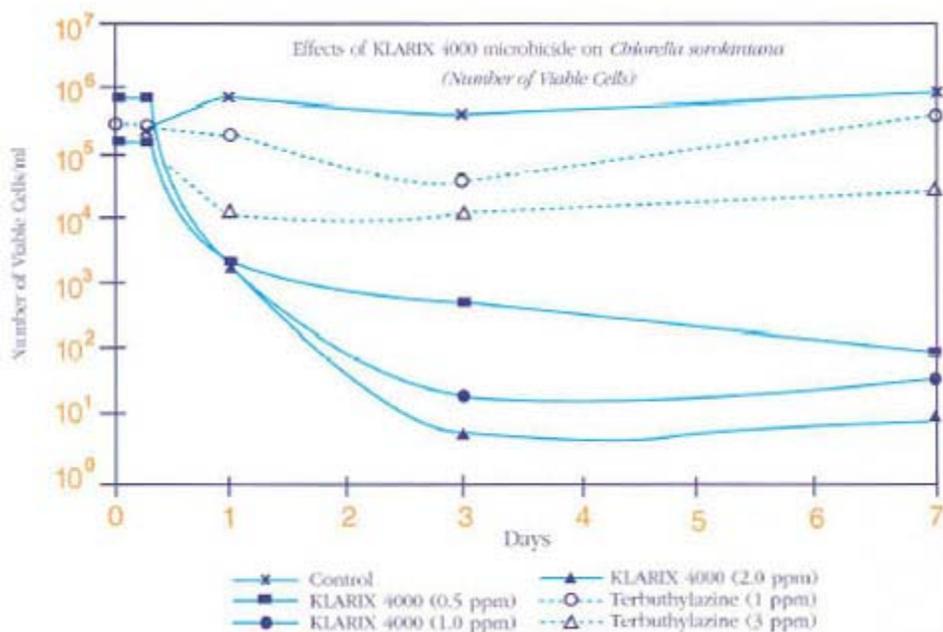
KLARIX 4000 microbicide exhibits outstanding antimicrobial activity against a wide range of green algae and cyanobacteria. KLARIX 4000 microbicide also is effective against fungi and bacteria. The table above gives the minimum level in ppm active ingredient that inhibited the growth of various microorganisms. The data demonstrate the broad activity of KLARIX 4000, but should not be taken as recommended use concentrations.

Conclusions:

KLARIX 4000 exhibited low MIC values against green algae, cyanobacteria, filamentous bacteria and fungi (generally <1 ppm ai). KLARIX 4000 also demonstrated activity against bacteria (MIC = 2.5 - 5 ppm ai). These data suggest that KLARIX 4000 is active against a broad spectrum of green algae and cyanobacteria, as well as other problem organisms.

Speed-of-Kill of KLARIX 4000 vs. Terbutylazine Against Algae

The speed-of-kill of KLARIX 4000 against the green algae, *Chlorella sorokiniana* UTEX 1230, was assessed in synthetic cooling water at pH 8.0, 28°C. KLARIX 4000 was evaluated at 0.5, 1 and 2 ppm ai versus terbutylazine at 1 and 3 ppm ai. The inoculation level was 10^5 cells/ml of sample. Contact time was 0.25, 1, 3 and 7 days. The algae were enumerated using the most probable number technique. The level of chlorophyll pigments in the algal cultures was determined spectrophotometrically.

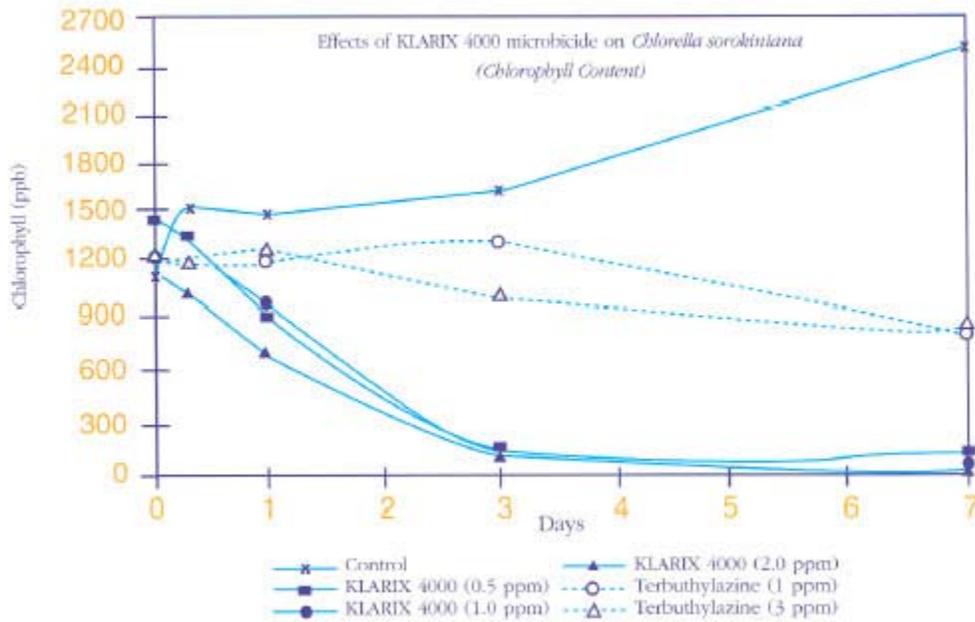


Conclusions:

In the shake-flask tests, treatment of *Chlorella sorokiniana* with KLARIX 4000 microbicide caused a rapid decline in the number of viable cells. With a single 0.5 ppm ai dose of KLARIX 4000, a 3-log reduction in the cell viability was observed after three days and a 4-log reduction was observed after seven days. Higher levels of the algicide were even more effective. For example, within three days, treatment with 1 or 2 ppm ai of KLARIX 4000 yielded a 4-log reduction in the level of viable algae compared to the control.

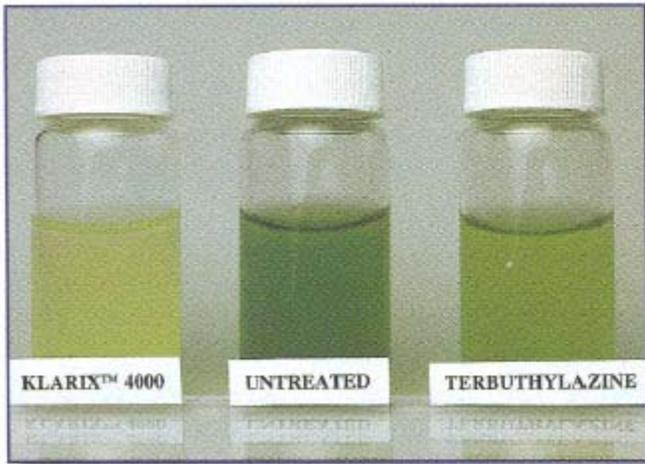
In contrast, treatment of the algal cultures with 3 ppm ai of terbuthylazine resulted in a *ca.* 2-log decrease in the number of viable cells after one day. Within three days after dosing, the viability of the cultures began to increase. Treatment with 1 ppm ai of terbuthylazine marginally affected the number of viable algae.

Effects of KLARIX 4000 vs. Terbuthylazine on Algal Chlorophyll Levels



Conclusions:

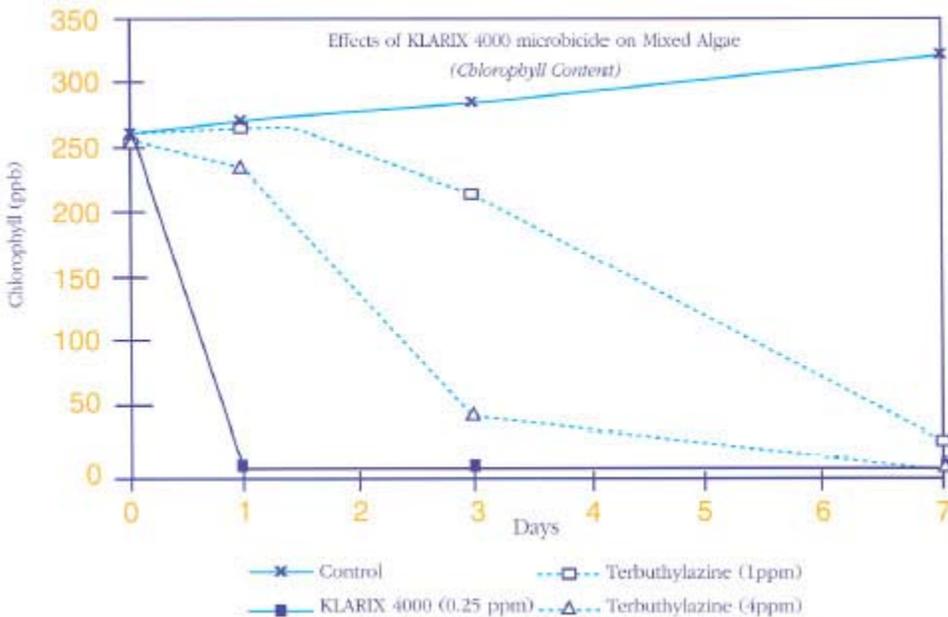
The chlorophyll levels in cultures treated with 0.5 - 2.0 ppm ai of KLARIX 4000 decreased dramatically after one day. After three days, the levels of chlorophyll in the cultures treated with 1.0 ppm ai of KLARIX 4000 were reduced by 92% compared to the level in the untreated culture. The effect of KLARIX 4000 on chlorophyll levels persisted for at least seven days. The terbuthylazine product inhibited the growth of the algal cultures at 1 and 3 ppm ai, but the levels of chlorophyll remained relatively unchanged from the level at the beginning of the experiment. These results demonstrate one of the unique benefits of KLARIX 4000: rapid loss of green color associated with fouled cooling towers. Treatment of the tower with low levels of KLARIX 4000 turns the color of the fouled tower surfaces from green to pale green to off-white. With KLARIX 4000, you can see the difference.



Loss of green color from a mixture of green algae and cyanobacteria after treatment with 2.0 ppm ai of KLARIX 4000 microbicide or a commercial formulation of terbuthylazine. The photograph was taken 3 days after dosing.

Effects of KLARIX 4000 vs. Terbuthylazine on Chlorophyll Levels (Mixed Algae)

The effects of KLARIX 4000 microbicide on algal chlorophyll levels also were assessed against a mixed population of green algae and cyanobacteria in synthetic cooling water at pH 8.0, 28°C. KLARIX 4000 was evaluated at 0.25, 0.5, 1 and 2 ppm ai versus terbuthylazine at 1, 2 and 4 ppm ai. The test organisms used in this study consisted of two green algae, *Chlorella sorokiniana* UTEX 1230 and *Scenedesmus quadricauda* UTEX 1450, and two cyanobacteria, *Anabaena flos-aqua* UTEX 1444 and *Phormidium luridum* var. *olivace* UTEX 426. The inoculation level was 10^4 cells/ml (combined) of sample. Contact time was 1, 3, and 7 days. The level of chlorophyll pigments in the algal cultures was determined spectrophotometrically.



Conclusions:

The shake-flask test was repeated with a mixed inoculum of green algae and cyanobacteria. The concentration of the mixed inoculum was lower (10^4 cells/ml combined) than the previous experiment (10^5 cells/ml). Both of the algicides tested performed better against the inoculum level.

Within one day, treatment with levels of KLARIX 4000 as low as 0.25 ppm ai quickly reduced the levels of chlorophyll to below detectable limits. The level of chlorophyll also was reduced by treatment with terbuthylazine, although the effects were not observed until three and seven days after dosing.

KLARIX 4000 Outperformed Terbuthylazine in Laboratory Studies

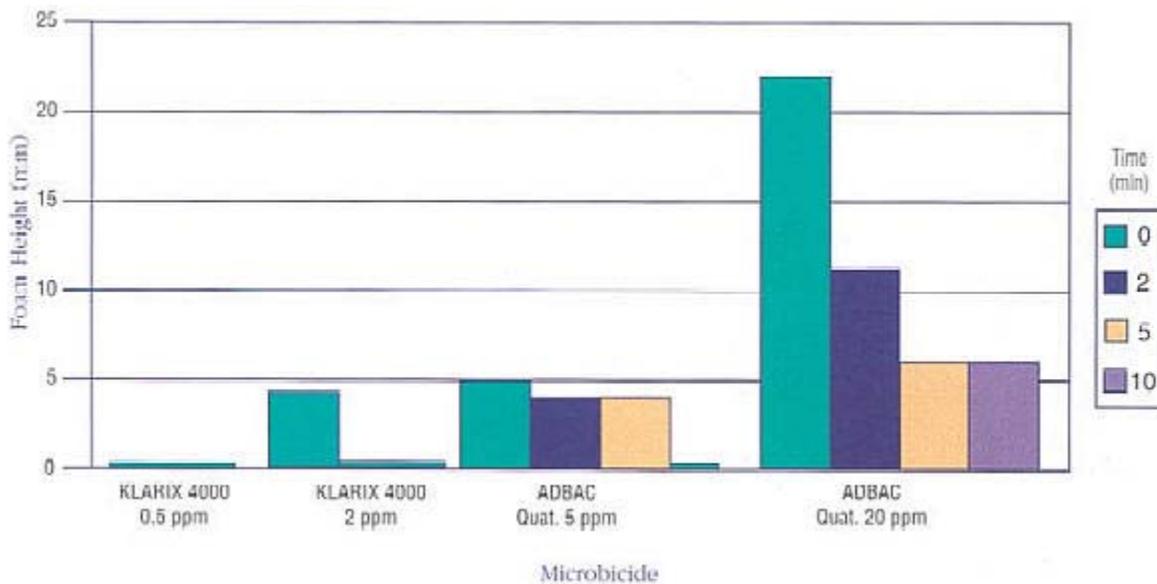
- Faster kill at 2 - 6x lower use rate after 1 - 3 days
- Faster reduction of chlorophyll at 2 - 6x lower use rate after 1 - 3 days
- Bleaching effect (reduction in chlorophyll content) was observed with KLARIX 4000 at levels as low as 0.25 ppm ai
- Algicidal effects of KLARIX 4000 seen in both laboratory studies and in field trials

Foaming Properties

We assessed the foaming properties of KLARIX 4000 in the laboratory vs. a quaternary ammonium compound. The comparison is presented in the table below. KLARIX 4000 exhibited significantly lower foam than the quaternary ammonium compound. In the field, we have observed initial low foam (especially if dosed near points of agitation and in heavily fouled systems). However, any foam generated rapidly dissipates.

KLARIX 4000 is a Low Foaming Algicide

Foaming in Synthetic Cooling Water
(Hardness - 650 ppm)



* Foam generated in 100 ml graduated cylinder
* ADBAC Quat. = n-alkyl dimethyl benzyl ammonium chloride

Materials of Compatibility

KLARIX 4000 is compatible with most materials of construction except carbon steel. Please contact Rohm and Haas Company for recommendations and information on materials not listed below.

Material	Corrosion Rate	Comments
Carbon Steel	40 mpy	
Stainless Steel		
304	0 mpy	
304t.	0 mpy	
316	0 mpy	

316t.	0 mpy
Aluminum	
Al 1100	OK
Al 3003	OK
EPDM	NR
Viton™	OK
Butyl	NR
Neoprene™	Marginal
Kynar™	OK
Plasite™ 9570	OK
Plasite 4300	OK
Atlac™ 382	OK
Derakane™ 411	OK

Regulatory Status

U.S. EPA Registration

KLARIX 4000 is registered for industrial recirculating water cooling systems, closed-loop systems, air washers, brewery pasteurizers and can warmers. The EPA registration number is 707-259.

Toxicological Summary

The toxicology of the active ingredient of KLARIX 4000 microbicide has been assessed in a number of clinical and nonclinical studies, including acute, subchronic, genotoxicity, and dermal sensitization studies. Results of these studies have demonstrated that KLARIX 4000 microbicide does not present a mutagenic or teratogenic risk to humans.

Acute Toxicity

Oral LD ₅₀ (rat)	>5000 mg/kg (product as sold)
Dermal LD ₅₀ (rat)	>2000 mg/kg (product as sold)
Inhalation LC ₅₀ (rat), 4 hrs	1.3 mg/L air (product as sold)
Skin irritation	Slightly irritating (product as sold)
Eye irritation	Corrosive—severe corneal damage (product as sold)
Sensitization	Skin sensitizer

Like practically all biocides, at higher than recommended use-level concentrations, KLARIX 4000 microbicide can cause contact dermatitis (skin irritation and/or skin sensitization) in susceptible individuals. The use of KLARIX 4000 microbicide at recommended use levels is safe. This is supported by our extensive toxicological and clinical databases, and our more than 25 years' experience with the safe use of industrial biocides.

For further details on the complete toxicological profile of KLARIX 4000 microbicide, please contact your local Rohm and Haas sales office.

Environmental Information

We have conducted extensive environmental fate studies on the active ingredient in KLARIX 4000. The results demonstrate that it does not bioaccumulate in the environment ($\log P_{ow} < 3$) and readily biodegrades to nontoxic by-products.

Physical, Chemical and Biological Degradation

Aqueous Hydrolysis

half-life = 9 days at pH 5
half-life = >21 days at pH 7
half-life = 12 days at pH 9

Photolysis

half-life = 13 days

Seawater

half-life = <24 hours for natural sample
half-life = >30 days in sterile water

Seawater/Sediment

aerobic half-life = <1 hour anaerobic
half-life = <1 hour

Degradation Products

N-octyl malonamic acid is the initial by-product
Toxicity = 10,000 - 100,000 times less toxic than parent molecule

Waste Treatment

no active ingredient (<0.04 ppb)
recovered in treatment plant
effluent at field trial site

For more information, please contact your local Rohm and Haas sales office.

Award-Winning Chemistry

KLARIX 4000 microbicide contains the same active ingredient as SEA-NINE™ 211 marine paint antifoulant. In 1996, SEA-NINE 211 received the Presidential Green Chemistry Challenge Award in the category of Designing Safer Chemical Products. This award was established by an alliance of the chemical industry, the EPA and the Clinton Administration to recognize and promote fundamental breakthroughs in chemistry that accomplish pollution prevention through source reduction and are useful to industry.

Storage

KLARIX 4000 microbicide is corrosive to mild steel. Do not store or transport in unlined metal containers. Do not contaminate water, food or feed by storage, disposal or cleaning of equipment.

Store above +5°C, 45°C maximum. Keep KLARIX 4000 from freezing. Contact Laurie Vanarsdale at (281) 474-8586 or your local technical representative for recovery procedures.

Safe Handling Guidelines

Experts in the handling of isothiazolinones for 25 years, Rohm and Haas personnel are available to give advice and assistance on safe handling of KLARIX 4000 preservative in your plant.

The following handling precautions should be observed with the product as supplied.

Personal Protective Equipment

- **Material is CORROSIVE.** Do not get in eyes, on skin, or clothing. Causes eye damage and skin burns. May cause allergic skin reaction. May be harmful if swallowed or absorbed through the skin. Keep away from children.
- **Wear appropriate safety equipment when handling.** Wear goggles or safety glasses, face shield and gloves (butyl rubber or nitrile) when handling. Avoid breathing vapor or mist. Avoid contamination of food. Do not take internally. Wash thoroughly after handling.

First Aid Measures

After contact with eyes: FLUSH IMMEDIATELY with copious amounts of water for at least 15 minutes, with the eyes held open. Get prompt medical attention but FLUSH FIRST.

After contact with skin: Wash thoroughly with soap and plenty of water. Remove and launder contaminated clothing. Wash thoroughly, even if no skin burns are present, since they may become apparent only after long contact time following inadequate washing. Get medical attention if irritation persists.

If inhaled: Remove casualty immediately to fresh air. If not breathing, apply artificial respiration. If breathing is difficult, give oxygen. Call a physician immediately.

If ingested: Wash mouth thoroughly with plenty of water and give water or milk to drink. Call a physician at once. Never give anything by mouth to an unconscious person.

NOTE TO PHYSICIAN: Corrosive material. Probable mucosal damage may contraindicate the use of gastric lavage. It is inadvisable to induce vomiting. Measures against circulatory shock, respiratory depression, and convulsions may be needed.

For more information, please contact your local Rohm and Haas sales office.

Deactivation of KLARIX 4000 Active Ingredient

Rohm and Haas personnel are available to give advice and assistance on KLARIX 4000 in your plant.

Deactivation and Cleanup of Equipment and Containers

Reagents Required:

- Sodium Thiosulfate (STS), or
 - Sodium (meta) Bisulfite, or
 - Sodium Bisulfite (SBS)
 - Methanol or 2-propanol
1. Wear appropriate personal protective equipment (chemical suit/apron, gloves, goggles, respirator, etc., as called for by site practices).
 2. Make up the fresh 10% deactivation solution: Dissolve 10 parts of the selected deactivation reagent into 90 parts of a 50:50 water/methanol mixture (or a 50:50 water/2-propanol mixture).
 3. Estimate amount of residual product in the equipment/container to be deactivated.
 4. To this, add methanol to dilute the product to <10% active ingredient.
 5. Mix the above mixture, and gradually add 5 lbs of 10% aqueous deactivation solution per lb of mixture in Step 4.
 6. Agitate for 30 minutes, if possible.
 7. Allow to stand for 1.5 hours.
 8. Drain contents to chemical sewer or dispose of contents as called for by local, state and federal regulations.
 9. Rinse the equipment/container twice with plenty of water.
 10. Drain to chemical sewer.

See Insert for Modified Deactivation Procedure 1/99

Cleanup of Spills

Reagents Required:

- Sodium Thiosulfate (STS), or
 - Sodium (meta) Bisulfite, or
 - Sodium Bisulfite (SBS)
 - 50:50 Water/Methanol (or 2-propanol) Solution
1. Wear appropriate personal protective equipment (chemical suit or lab coat, rubber overshoes, gloves, goggles, and respirator as needed).
 2. Prepare the selected deactivation solution away from the spill area in a polyethylene gallon container with a screw cap lid: 10% of selected deactivation reagent in 50:50 water/methanol (or 50:50 water/2-propanol).
 3. Dike and absorb as much of the spilled material as possible using spill pillows or inert solid absorbents (such as Vermiculite, paper towels or rags).
 4. Transfer absorbed material to a 5-gallon plastic pail for disposal.
 5. Thoroughly wipe the spill area at least twice with methanol- (or 2-propanol-) soaked paper towels or rags and dispose of the towels in the above container.
 6. Rinse hands with gloves on, then carefully peel the contaminated gloves off by pulling on the outside of the glove sleeve, turning the gloves inside out as you remove them. Place them into the container (Step 4) for disposal.
 7. Wear clean gloves and apply the deactivation solution (Step 2) to the spill area at a ratio of 10 volumes deactivation solution per estimated volume of residual spill to deactivate any residual active ingredient.
 8. Let stand for 30 minutes.
 9. Flush the spill area with copious amounts of water to chemical sewer (if in accordance with local procedures, permits and regulations).
 10. Remove and dispose of gloves as in Step 7 above.
 11. Dispose of this waste container as "Waste Contaminated with Pesticide," in accordance with local, state and federal regulations.

Disposal of Spilled and Waste Material

KLARIX 4000 microbicide as sold is toxic to fish and wildlife. Spills and runoffs from cleaning should not be discharged where they can drain into sewage treatment plants, lakes, streams, ponds, or other public water. Follow the disposal methods provided on the package label, and observe all federal, state, and local regulations.

KLARIX 4000 microbicide-containing wastes must not be discharged into public waters or sewage treatment systems. As described above, such wastes must be deactivated and adequately diluted before discharge into any public water or sewage treatment facility. When considering disposal of any waste, observe all federal, state, and local regulations.

Please contact CHEMTREC, (800) 424-9300, in the event of a major accidental spill.

Material Safety Data Sheets

Material Safety Data Sheets (MSDS) are available for all Rohm and Haas products. These sheets contain pertinent information that you may need to protect your employees and customers against any known health or safety hazards associated with our products.

We recommend that you obtain copies of our MSDS from your local Rohm and Haas technical representative on our products before using them in your facilities. We also suggest that you contact your suppliers of other materials recommended for use with our products for appropriate health and safety precautions before using them.

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These suggestions and data are based on information we believe to be reliable. They are offered in good faith, but without guarantee, as conditions and methods of use of our products are beyond our control. We recommend that the prospective user determine the suitability of our materials and suggestions before adopting them on a commercial scale.

Suggestions for use of our products or the inclusion of descriptive material from patents and the citation of specific patents in this publication should not be understood as recommending the use of our products in violation of any patent or as permission or license to use any patent of the Rohm and Haas Company.



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