



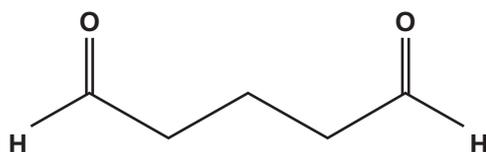
AQUCAR™ GA 25 Water Treatment Microbiocide

For use in Oilfield and Pulp and Papermaking operations

General

AQUCAR™ GA 25 Water Treatment Microbiocide is an aqueous solution of glutaraldehyde (CAS Reg. No. 111-30-8) containing 25% active ingredient. AQUCAR GA 25 is effective over a wide range of pH and temperature conditions.

Structure



Physical Properties

The following are typical properties of AQUCAR™ GA 25 Water Treatment Microbiocide; they are not to be considered product specifications.

Appearance:	Transparent, colorless
Active, % Glutaraldehyde (w/w):.....	25
pH @ 25°C/77°F:.....	3.1 to 4.5
Solubility in water, 20°C/68°F:	Miscible
Boiling point:.....	100.5°C/213°F
Freezing point:.....	-10°C/-14°F
Specific gravity, @ 20/20°C (68°F):.....	1.064
Vapor pressure @ 20°C/68°F:.....	0.3 mmHg based on glutaraldehyde (0.27 hPa)

Applications/ Directions for Use

AQUCAR™ GA 25 Water Treatment Microbiocide is well suited for use in the following applications.

Water Flood Injection Water

Glutaraldehyde exhibits excellent stability in oilfield injection waters, which ensures that its antimicrobial activity will not be diminished in long pipelines. Hard waters or brines do not adversely affect its biocidal efficacy, and glutaraldehyde is non-ionic so it won't interfere with the action of demulsifiers, corrosion inhibitors, or surfactants. AQUCAR™ GA 25 Water Treatment Microbiocide is typically slug dosed into the injection water on a daily or weekly basis at 50 to 2500 ppm active for up to 4 hours, although the exact treatment regimen will depend on the condition of the system, the amount of water being treated, etc.

Drilling, Completion, Workover, and Fracturing Fluids

Glutaraldehyde functions as a biocide over a broad pH range and its efficacy is much faster at neutral to alkaline pH's than at acidic pH's. Therefore, AQUCAR™ GA 25 Water Treatment Microbiocide is an excellent choice for use in preserving drilling muds and other oilfield fluids that are typically alkaline in pH. The combination of rapid alkaline efficacy at the typical use rates of 25 to 500 ppm as active, and proven stability and effectiveness in high salinity matrices ensures microbial protection of these important fluids.

Produced Waters

Most oilfield systems contain sulfate reducing bacteria (SRB's) and acid producing bacteria (APB's). The presence of SRB's and APB's presents a serious challenge for effective

control of microbial contamination in a production system. For a biocide to be effective against these problematic organisms, it must be stable in the presence of sulfides or organic acids that are produced by these organisms. Glutaraldehyde, unlike some other biocides (formaldehyde, acrolein, and isothiazolone) does not react with, and is not deactivated by, H₂S or other organic acids. This ensures that all of the glutaraldehyde added is available to act as a biocide. Like its use in waterflood injection systems, glutaraldehyde is typically added in slug doses on a daily to weekly basis at concentrations of 50 to 2500 ppm as active.

Oil and Gas Transmission lines

Biofilms are a major problem in oil and gas production systems and pipelines are often afflicted with biofilm related problems. Microbiologically influenced corrosion (MIC) is often associated with the presence of a biofilm. The control of biofilms is therefore crucial to ensuring that corrosion events, due to microorganisms, are minimized. Glutaraldehyde has been shown to penetrate a biofilm and kill the microorganisms that are contained within it. The penetrating ability of glutaraldehyde, along with its long-term stability in oilfield waters, makes it an effective product to control established biofilms in pipelines and prevents the formation of new ones.

Gas Storage Wells and Hydrocarbon Storage Facilities

The water bottoms in hydrocarbon storage tanks and gas storage wells can often be contaminated with SRB's and serve as hosts to biofilms. This, in turn, can lead to the formation of H₂S in the gas storage facility and the corrosion of hydrocarbon storage tanks.¹ Glutaraldehyde preferentially partitions into the water phase in a mixed hydrocarbon/water system and so would attack any microorganisms that are present in these water bottoms.

Production Wells

The injection of scale and corrosion inhibitors into production wells can introduce microorganisms into the production equipment and the formation. The addition of glutaraldehyde during these injections (squeeze treatments) can help to control these microorganisms and may help reduce the occurrence of MIC in production equipment.

Paper Mills and Paper Mill Process Water Systems

AQUCAR™ GA 25 Water Treatment Microbiocide should be added to a papermaking system at a point of uniform mixing, such as the head box, beaters, broke chest, pump, save-all tank, or white water tank.

Initial Treatment: When the system is noticeably contaminated, add 1000 to 6000 ppm of AQUCAR GA 25 (as Product) per dry ton of pulp or paper as a slug dose. Repeat until control is achieved. Heavily fouled systems should be boiled out prior to initial treatment.

Subsequent Dose: When microbial control is evident, add 600 to 4000 ppm of AQUCAR GA 25 (as Product) per dry ton of pulp or paper as a slug dose as necessary to maintain control.

Pigments and Filler Slurries for Paper and Paperboard

Use from 200 to 1200 ppm of AQUCAR GA 25 Water Treatment Microbiocide (as Product) in the mixed slurry.

Water-Based Coatings

NOTE: For use in non-food contact coatings only.

Use from 200 to 1200 ppm of AQUCAR™ GA 25 Water Treatment Microbiocide (as Product) in the mixed slurry.

Food Additive Regulations

The product meets the requirements of the Food Additive Regulations listed below. Uses are subject to good manufacturing practices and any limitations which are part of the regulations. The information given here is for use as a general guideline. The regulations should be consulted for complete details. In some cases a product formulation may meet an FDA clearance and the use is not on the product label.

21 CFR 172.230(a)(3) Cleared for use as a cross-linking agent

21 CFR 173.320(b)(6) Chemicals for Controlling Microorganisms in Beet-Sugar Mills (max. 250 ppm active)

21 CFR 173.357(a)(2) Fixing agent in the immobilization of glucose isomerase enzyme preparations for use in manufacture of high fructose corn syrup.

21 CFR 175.105 (c)(5) Adhesives

21 CFR 176.170 (a)(5) Cleared for use as antimicrobial agent in pigment and filler slurries used in manufacture of paper and paperboard (max. 300 ppm active)

21 CFR 176.180 (b)(1) Components of Paper and Paperboard in Contact with Dry Food (max. 300 ppm active)

21 CFR 176.300 Slimicides

Efficacy of Glutaraldehyde Against Oilfield SRB's

The efficacy of glutaraldehyde is demonstrated by the following experiments. Field isolates of seawater and produced water SRB's were grown to high levels in the laboratory and then challenged with glutaraldehyde. The following results were obtained.

Efficacy of Glutaraldehyde vs. Seawater SRB's

Biocide (ppm a.i.)	Log Reduction (hours)		
	1	2	4
GA*, 25	4	4	7
GA*, 50	6	7	8
GA*, 100	8	8	8
Control	10 ⁸	10 ⁸	10 ⁸

Efficacy of Glutaraldehyde vs. Produced Water SRB's

Biocide (ppm a.i.)	Log Reduction (hours)		
	1	2	4
GA*, 25	4	6	5
GA*, 50	5	6	5
GA*, 100	5	8	8
Control	10 ⁸	10 ⁸	10 ⁸

*Glutaraldehyde

The experimental protocol allowed for the growth of both high populations of SRB's as well as the accumulation of bacterial metabolites such as sulfide.² As these results show, glutaraldehyde was effective against these field isolates.

Field Test Methods for Glutaraldehyde

Increasing regulation of the discharge of chemicals into the environment requires that there be careful monitoring and control over the use of biocides. The active concentration of glutaraldehyde in AQUICAR™ GA 25 Water Treatment Microbiocide blends can easily

be determined by a glutaraldehyde field test kit. There are several different kits that are commercially available and all allow for the rapid on-site determination of glutaraldehyde concentrations, discharge levels, half-life, and biocide/system compatibility. By regularly monitoring the active concentration of biocide in the system, the cost effectiveness of the treatment program can be maximized by accurately regulating biocide additions.

Compatibility

While glutaraldehyde is compatible with most commonly used system additives (scale and corrosion inhibitors), there are some incompatibilities that should be noted. Glutaraldehyde is incompatible with primary amines and ammonia. Secondary amines are not as problematic as primary amines, but if a secondary amine is present at high concentrations (>1000 ppm), then care should be taken to add the glutaraldehyde at a distance from the addition point of the secondary amine. Information is available which predicts the loss of glutaraldehyde from systems that contain ammonia. This information is helpful in anticipating the expected decrease in active glutaraldehyde concentration in systems that contain ammonia. Please contact your Dow representative for copies of this data.

Glutaraldehyde is also incompatible with bisulfite-based oxygen scavengers. This interaction can most easily be managed by temporarily shutting off the bisulfite feed during the addition of glutaraldehyde. If shutting off the bisulfite feed is not an option, then it is important to realize that the ratio of reaction of glutaraldehyde with the oxygen scavenger is approximately 1:2. That is, 1 ppm of glutaraldehyde will react with and consume 2 ppm of oxygen scavenger.

Application Summary

The following are recommended uses for the AQUICAR™ GA 25 Water Treatment Microbiocide. For specific directions for use, please refer to the EPA approved label for this product.

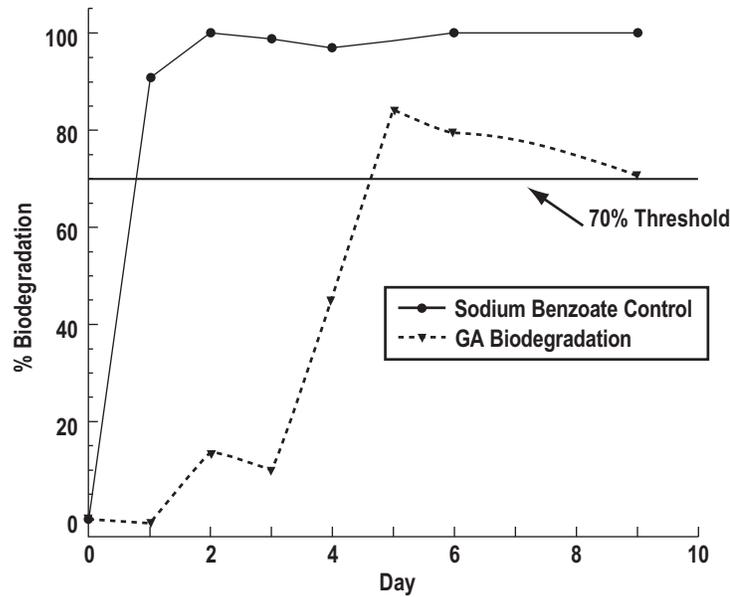
Application	Purpose of Biocide	Typical Dosage Rate (active ingredient)
Waterfloods	To prevent the introduction of harmful bacteria into the formation and to control MIC in the injection system	50 to 2500 ppm
Drilling, Completion and Workover Fluids	To control microbial contamination of these fluids and prevent the introduction of bacteria into the formation	25 to 500 ppm
Packer Fluids	To control microbial contamination of the fluids and prevent the introduction of bacteria into the formation	25 to 300 ppm
Gas Storage Wells and Systems	To control microbiological contamination of the injection water and prevent the souring of the gas	250 to 2500 ppm
Hydrotesting	To prevent the introduction of potentially harmful bacteria into the pipeline	50 to 2000 ppm
Pipeline Pigging and Scraping Operations	To treat the inner surfaces of the pipeline in order to kill biofilm associated bacteria on freshly exposed (pigged) areas	500 to 5000 ppm
Paper Mills and Paper Mill Process Water Systems	To control the growth of bacteria and fungi present in papermaking systems and prevent slime formation	500 to 3000 ppm per ton of pulp or paper (dry basis) initially as a slug dose and 300 to 2000 ppm per ton of pulp or paper (dry basis) subsequently as a slug dose to maintain control

Glutaraldehyde and the Environment

Many studies have been performed on glutaraldehyde to determine its potential to biodegrade in the environment. The details of two of the many biodegradation studies that have been performed on glutaraldehyde are given in the following tests.

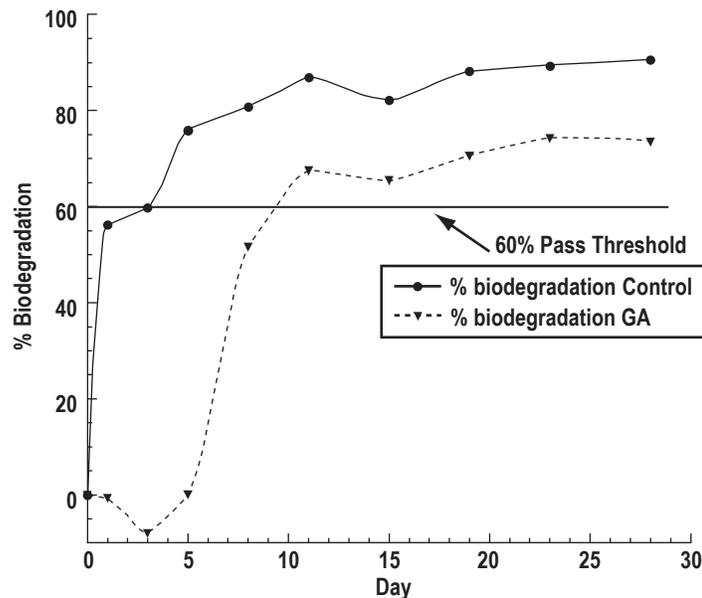
The OECD 301 series of biodegradation protocols are designed to determine the biodegradation potential of substances under stringent conditions. In one such biodegradation test, glutaraldehyde met and exceeded the OECD ready biodegradability classification criteria and thus was found to be readily biodegradable.

% Biodegradation of Glutaraldehyde in OECD 301A Test



The OECD 306 test determines the potential for a substance to biodegrade in seawater. This test is unique in that seawater is both test medium and the sole source of microorganisms. Although this test is not a test for ready biodegradability, substances that pass this test are considered to have the potential for biodegradation in the marine environment. When glutaraldehyde was evaluated in the OECD 306 test, a high rate of biodegradation was achieved, and thus it met the pass criteria of the OECD 306 test. It should be noted that glutaraldehyde is one of the few commonly used oilfield biocides that passes this test.

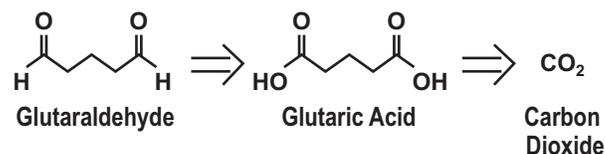
% Biodegradation of Glutaraldehyde in OECD 306 Test



A study of the aquatic metabolism of glutaraldehyde in river water sediment under aerobic and anaerobic conditions was performed. The results indicate that the metabolism of glutaraldehyde is rapid. Under aerobic conditions, the metabolism proceeds to complete mineralization with carbon dioxide as the principal metabolite. Under anaerobic conditions, only primary degradation is observed with the production of 1,5-pentanediol as the major metabolite. Both pathways of degradation are shown in the adjacent column.

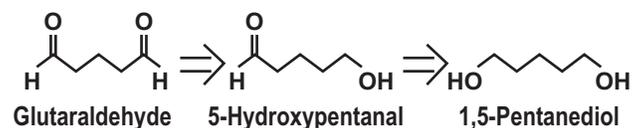
Aerobic Aquatic Metabolism

$T_{1/2}$ in river water – 10.6 hr. Carbon dioxide was major metabolite, with glutaric acid as intermediate.



Anaerobic Aquatic Metabolism

$T_{1/2}$ in river water – 7.7 hr. 1,5-Pentanediol was major metabolite.



The compiled ecotoxicology data indicate that glutaraldehyde is a readily biodegradable compound which has little environmental impact when handled properly. Due to its rapid metabolism and biodegradation under both aerobic and anaerobic conditions, it has a favorable ecotoxicology profile. Complete details on the biodegradation tests mentioned above, as well as many other environmental fate and ecotoxicology tests that have been performed on glutaraldehyde, are summarized in a Dow publication entitled “*Ecotoxicology of Glutaraldehyde*” (253-01418).

Toxicology

For product safety information, refer to product Safety Data Sheet (SDS).

Storage, Handling and Disposal

Product Handling

Handle AQUICAR™ GA 25 Water Treatment Microbiocide in well ventilated areas and wear appropriate protective equipment for the task. At a minimum, this includes proper gloves, splash-proof monogoggles (chemical goggles) or both safety glasses with side shields and a wrap-around full-face shield, coveralls and boots. Atmospheric levels should be maintained below the exposure guideline. When respiratory protection is required for certain operations, use an approved air-purifying respirator.

Disposal of AQUICAR™ GA 25 Water Treatment Microbiocide

If excess product cannot be used according to use directions, it must be sent to an approved waste disposal facility. Because disposal regulations can vary by location, contact the regulatory authority for waste disposal guidance in your location. This product should never be disposed of by dumping into lakes, streams, ponds, estuaries, oceans, sewers, ditches, or into soil at any time.

Disposal of Product Containers

Empty containers of AQUICAR™ GA 25 Water Treatment Microbiocide should be triple rinsed with water to remove excess product promptly after emptying. The rinse water should be collected and sent to an approved waste handling facility. If allowed by local regulations

offer empty product containers for recycling or reconditioning or puncture and dispose of according to local regulations.

In the United States, refer to the product label for specific precautions and use directions. Further information and precautions regarding the handling, storage, and disposal of AQUICAR™ GA 25 Water Treatment Microbiocide can be obtained by consulting the latest Safety Data Sheet (SDS) for this product and the “*Glutaraldehyde Safe Handling and Storage Guide*” (Form No. 253-01338), available from your Dow representative.

Summary

The AQUICAR™ Microbiocide line of products are effective biocides that can meet all of the requirements for an oilfield biocide. Dow offers the combination of proven efficacy of our glutaraldehyde-based products, along with both technical and customer service that ensures success in the use of our products.

References

1. D. H. Pope et al, “Mitigation Strategies for Microbiologically Influenced Corrosion in Gas Industry Facilities,” CORROSION/89, paper no. 192, (Houston, TX: NACE International, 1989).
2. L.A. Grab and A. B. Theis, “Comparative Biocidal Efficacy vs. Sulfate-Reducing Bacteria,” Corrosion/92, paper no. 184, (Houston, TX: NACE International, 1992).

Product Stewardship

Dow has a fundamental concern for all who make, distribute, and use its products, and for the environment in which we live. This concern is the basis for our product stewardship philosophy by which we assess the safety, health, and environmental information on our products and then take appropriate steps to protect employee and public health and our environment. The success of our product stewardship program rests with each and every individual involved with Dow products – from the initial concept and research, to manufacture, use, sale, disposal, and recycle of each product.

Customer Notice

Dow strongly encourages its customers to review both their manufacturing processes and their applications of Dow products from the standpoint of human health and environmental quality to ensure that Dow products are not used in ways for which they are not intended or tested. Dow personnel are available to answer your questions and to provide reasonable technical support. Dow product literature, including Safety Data Sheets (SDS), should be consulted prior to use of Dow products. Current Safety Data Sheets are available from Dow.

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