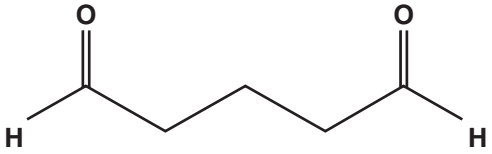
UCARCIDE Antimicrobials

UCARCIDE 25 Antimicrobial and UCARCIDE 50 Antimicrobial
CAS Reg. No. 111-30-8

General

UCARCIDE™ 25 Antimicrobial and UCARCIDE 50 Antimicrobial consist of glutaraldehyde-based products that have found widespread use in a variety of preservative applications. The Dow Chemical Company offers two different UCARCIDE antimicrobial formulations that are ideally suited to meet the diverse demands of many preservative applications.

Structure



Physical Properties

The following are typical properties of UCARCIDE antimicrobials; **they are not to be considered product specifications.**

UCARCIDE 25 Antimicrobial

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:	0.2 mm Hg based on glutaraldehyde (0.27 hPa)

UCARCIDE 50 Antimicrobial

Appearance	Transparent, colorless
Active, % Glutaraldehyde (w/w)	50
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:	-21°C/-6°F
Specific gravity, @ 20/20°C (68°F):	1.129
Vapor pressure @ 20°C/68°F:	0.2 mm Hg based on glutaraldehyde (0.27 hPa)

Introduction

A major concern in the preparation of water-based chemical specialty products is adequate protection against microbiological contamination. Such contamination can be introduced from many sources, including:

- Raw materials, especially water
- Containers and their closures
- Manufacturing equipment and the plant environment
- The user and the environment during normal consumer life of the product

UCARCIDE 25 Antimicrobial and UCARCIDE 50 Antimicrobial can help to eliminate microbial contamination problems. Based on the powerful and unparalleled antimicrobial action of glutaraldehyde, these high-performance antimicrobials provide excellent control

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over a wide variety of microorganisms. UCARCIDE antimicrobials are also extremely effective at very low concentrations.

Special Features

UCARCIDE 25 Antimicrobial and UCARCIDE 50 Antimicrobial have many important features that make these products effective antimicrobials for water-based formulated products. These special features include:

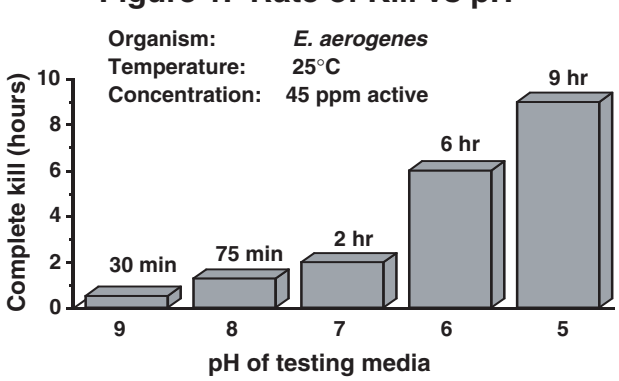
- Antimicrobial efficacy against bacteria, mold, and yeast at low use concentrations (0.01-0.1% active ingredient).
- Excellent compatibility with anionic, nonionic, and cationic surfactants
- Biocidal activity over a broad pH and temperature range
- No odor at end-use concentrations
- Good chemical compatibility with many other antimicrobials
- High salt tolerance
- Complete solubility in water
- End-use concentrations of glutaraldehyde can easily be analyzed on site with field test kits, or in the laboratory by several different methods

Product Performance

UCARCIDE 25 Antimicrobial and UCARCIDE 50 Antimicrobial are broad-spectrum biocides that are easily dissolved in water. Their biocidal activity is due to the ability of glutaraldehyde to react with primary amines, such as those present in the lysine and arginine amino acids that are components of the microbial cell wall. The fixative action can prevent a microorganism from carrying on its normal metabolic functions, resulting in cell death. UCARCIDE antimicrobials are effective in both acidic and basic systems. However, the rate of antimicrobial activity is dependent on several factors, including pH, time, temperature, and concentration. Of these factors, pH is the most important in determining preservative activity under typical use conditions.

The effect of pH on the rate of kill of *Enterobacter aerogenes,* a Gram-negative bacterium, is profiled in Figure 1.

Figure 1. Rate of Kill vs pH



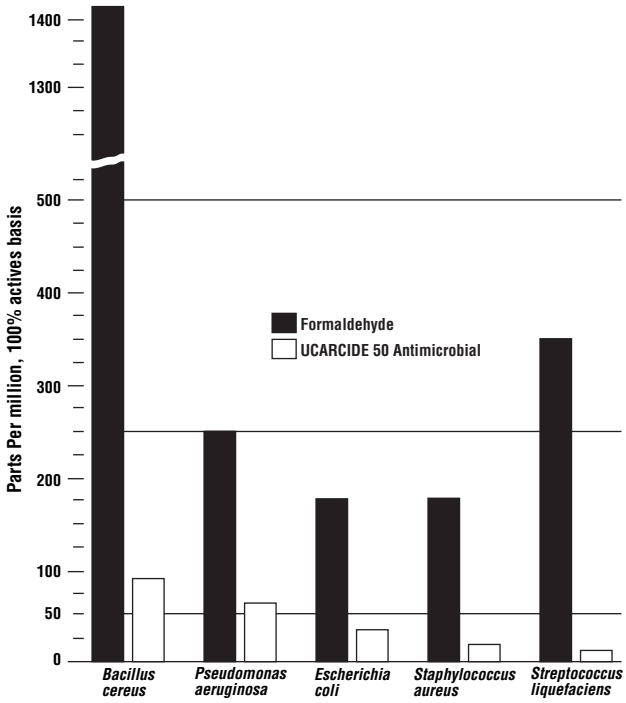
It can be seen that the rate of kill is approximately ten times faster at pH 8.5 than at pH 5. This difference is presumably caused by the slower reaction rate of this biocide with the protonated amine groups of the cell-wall amino acids at acidic pH.

Increases in temperature and UCARCIDE antimicrobial concentration will enhance antimicrobial activity at all pH's. In the acid state, surfactants can enhance the activity of UCARCIDE antimicrobials by wetting the surface of the organism and thereby permitting faster penetration. Since UCARCIDE antimicrobials are compatible with most cationic,

nonionic, and anionic surface-active agents, the matrix will ultimately influence the selection of a surfactant.

Figure 2 compares the effectiveness of UCARCIDE 50 Antimicrobial to the efficacy of formaldehyde against several different bacteria. This study was conducted in isotonic saline at pH of 6.5 and 25°C/77°F without surfactant, and shows UCARCIDE 50 Antimicrobial to be several times more efficacious than formaldehyde on an active basis. The minimal cidal concentration for each bacterium was determined after a 24-hour contact time.

Figure 2. Minimum Cidal Concentrations of UCARCIDE 50 Antimicrobial and Formaldehyde on Various Organisms in Saline Solution



Compatibility Concerns

The presence of ammonia, primary amines, or proteins in a product formulation or contaminated system can decrease the effectiveness of UCARCIDE antimicrobials. However, the loss of efficacy may be minimized by adjusting the pH of the sample to an acidic pH (if the sample to be preserved will maintain its integrity at an acidic pH). This action will form amine salts that are far less reactive with glutaraldehyde than is the free-amine form. UCARCIDE antimicrobials will not react with, and are useful in, systems containing secondary amines (at concentrations of less than 0.05%), tertiary amines, and quaternary ammonium compounds.

Laboratory Evaluation of UCARCIDE Antimicrobials

Since UCARCIDE antimicrobials will react with ammonia and primary amines at neutral to alkaline pH's, laboratory evaluation of antimicrobials that involve growing microorganisms in culture media can yield misleading results when using glutaraldehyde-containing products. The proteins in the growth media will react with and deactivate the glutaraldehyde. Evaluating the effectiveness of UCARCIDE antimicrobials in aliquots of the product to be preserved will present a more accurate picture of their microbiocidal activity. Preservative tests, such as those described by the CTFA[1] or USP[2], are generally satisfactory and compatible with the UCARCIDE formulations.

Application Summary

The exact concentration of UCARCIDE needed to effectively preserve a product will vary, and is best determined through the use of laboratory preservation tests such as those described previously. However, the following are recommended uses for the UCARCIDE 25 and 50 Antimicrobials. For specific directions for use, please refer to the EPA approved labels for these products.

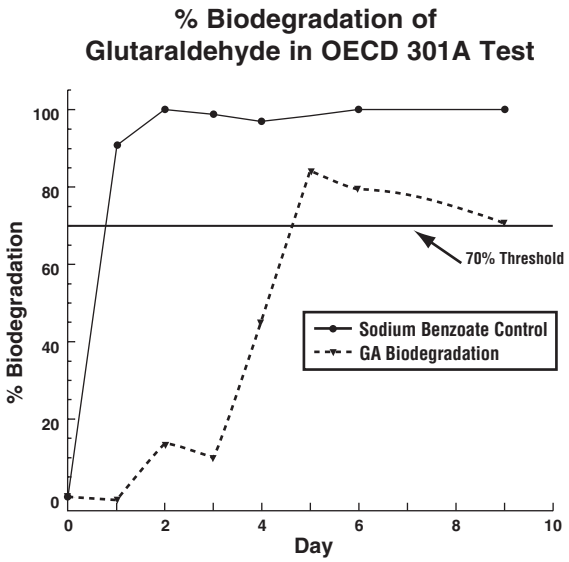
Application	Purpose of Biocide	Recommended Product	Typical Dosage Rate
General preservative use	To control the growth of bacteria and fungi in aqueous or water-containing products and systems, including industrial, institutional and consumer in-can processes and products	UCARCIDE 25 Antimicrobial	400 to 4000 ppm based on water content of product. (0.04% to 0.4%)
		UCARCIDE 50 Antimicrobial	200 to 2000 ppm based on water content of product. (0.02% to 0.2%)
Preservation of concentrates	Use in concentrates where effective preservation is needed after dilution	UCARCIDE 25 Antimicrobial	Added at a rate such that the diluted end-use product will contain 400 to 4000 ppm (0.04% to 0.4%)
		UCARCIDE 50 Antimicrobial	Added at a rate such that the diluted end-use product will contain 200 to 2000 ppm (0.02% to 0.2%)
Reverse osmosis membranes	Preservation of reverse osmosis elements. Preservation of in-line recirculating systems for preservation with installed out-of-service reverse osmosis equipment	UCARCIDE 25 Antimicrobial	Immerse element in tank containing 400 to 4000 ppm. (0.04% to 0.4%)
		UCARCIDE 50 Antimicrobial	Immerse element in tank containing 200 to 2000 ppm. (0.02% to 0.2%)
Concrete admixtures	Control growth of microorganisms in concrete admixtures	UCARCIDE 25 Antimicrobial	4000 to 16,000 ppm (0.4% to 1.6%)
		UCARCIDE 50 Antimicrobial	2000-8000 ppm (0.2% to 0.8%)
Household Products	Highly effective at preserving against bacterial, fungal and yeast contamination in household products	UCARCIDE 25 Antimicrobial	400 to 4000 ppm based on water content of product. (0.04% to 0.4%)
		UCARCIDE 50 Antimicrobial	200 to 2000 ppm based on water content of product. (0.02% to 0.2%)

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 detailed below.

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.

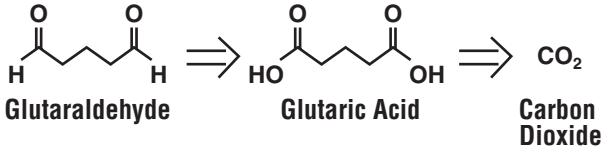
% Biodegradation of Glutaraldehyde in OECD 301A Test



A study of the aquatic metabolism of glutaraldehyde in river water sediment under aerobic and anaerobic conditions was performed. The results, shown below, 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 below.

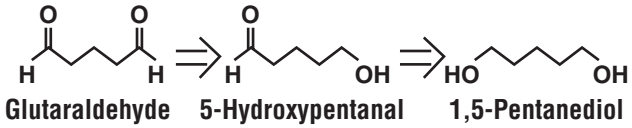
Aerobic Aquatic Metabolism

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



Anaerobic Aquatic Metabolism

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



The compiled ecotoxicology data indicates that glutaraldehyde is a readily biodegradable compound that 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 Chemical publication entitled *"Ecotoxicology of Glutaraldehyde"* (Form No. 253-01418).

Toxicology

The following is a partial listing of toxicological data on glutaraldehyde, the active ingredient in UCARCIDE 25 Antimicrobial and UCARCIDE 50 Antimicrobial. For product safety information, refer to the Safety Data Sheet. For a complete discussion of the toxicology of

glutaraldehyde, please ask your Dow Chemical sales representative for a copy of the booklet entitled *"Toxicology of Glutaraldehyde"* (Form No. 253-01419).

Toxicity of Glutaraldehyde

Test	Animal	Results
Oral Acute Toxicity	Rat – male	LD_{50} – 1.30 mL 50% a.i./kg body wt.
Dermal Acute Toxicity	Rabbit	LD_{50} = 2.54 mL 50% a.i. /kg 24 hour occluded. Necrosis at application site
Inhalation	Rat – male and female	Dynamic generation of vapor, 4 hour = 16.3 ppm, room temperature. Mortality: 0/5
Eye Irritation	Rabbit	The no-effect concentration for eye irritation with glutaraldehyde-based solutions is 0.1%. The threshold for conjunctival irritation is 0.2 to 0.5%, and for corneal injury 0.5 to 1.0%. Eye injury is moderate at 2% and severe at 5% and above. Alkalinization may slightly enhance the degree of eye injury.
Fish Toxicity	Rainbow Trout Bluegill Sunfish Sheepshead Minnow	96Hr LC_{50} 12 mg/L 96Hr LC_{50} 11 mg/L 96Hr LC_{50} 32 mg/L
Avian	Bobwhite Quail	LC_{50} >5000 mg/L

See Safety Data Sheet for full safety information.

Safe Handling, Storage, and Disposal

When applying UCARCIDE 25 Antimicrobial and UCARCIDE 50 Antimicrobial, it is important to wear the appropriate protective equipment. This equipment includes proper gloves, splash-proof monogoggles or both safety glasses with side shields and a wrap-around full-face shield, coveralls, and when necessary, respiratory equipment. **Please refer to the product label for specific precautions and use directions.** Further information and precautions regarding the handling, storage, and disposal of UCARCIDE 25 and 50 Antimicrobials can be obtained by consulting the latest Dow Safety Data Sheet and the *Glutaraldehyde Safe Handling and Storage Guide* (Form No. 253-01431), available from your Dow representative.

Summary

The UCARCIDE antimicrobial line of products are extremely effective biocides that can provide microbial protection of water-based chemical specialty products. The Dow Chemical Company 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. Put us to the test.

References

1. TGA Cosmetic Journal, Vol. 2, "A Guideline for the Determination of Adequacy of Preservation of Cosmetic and Toiletry Formulations," 20, 1970.

2. United States Pharmacopeia, XX, Microbiological Tests (51), "Antimicrobial Antimicrobials – Effectiveness," 873, 1980.

Product Stewardship

Dow encourages its customers to review their applications of Dow products from the standpoint of human health and environmental quality. To help ensure that Dow products are not used in ways for which they are not intended or tested, Dow personnel are willing to assist customers in dealing with ecological and product safety considerations. Contact your representative if you need any assistance or information. When considering the use of any Dow Chemical Company product in a particular application, review the latest Safety Data Sheet and country-specific product label to ensure the intended use is within the scope of approved uses and can be accomplished safely. Before handling any of the products mentioned in the text, obtain available product safety information and take necessary steps to ensure safety of use.

For further information visit our website:
www.dowbiocides.com
or call:

United States and Canada:	1-800-447-4369	(phone)
	1-989-832-1560	(phone)
	1-989-832-1465	(fax)
Europe:	800-3-694-6367	(phone)
	32-3-450-2240	(phone)
	32-3-450-2815	(fax)
Pacific:	800-7776-7776†	(phone)
	603-7958-3392	(phone)
	603-7958-5598	(fax)
Latin America:	55-11-5188-9555	(phone)
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	1-989-832-1465	(fax)

†except Indonesia and Vietnam

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