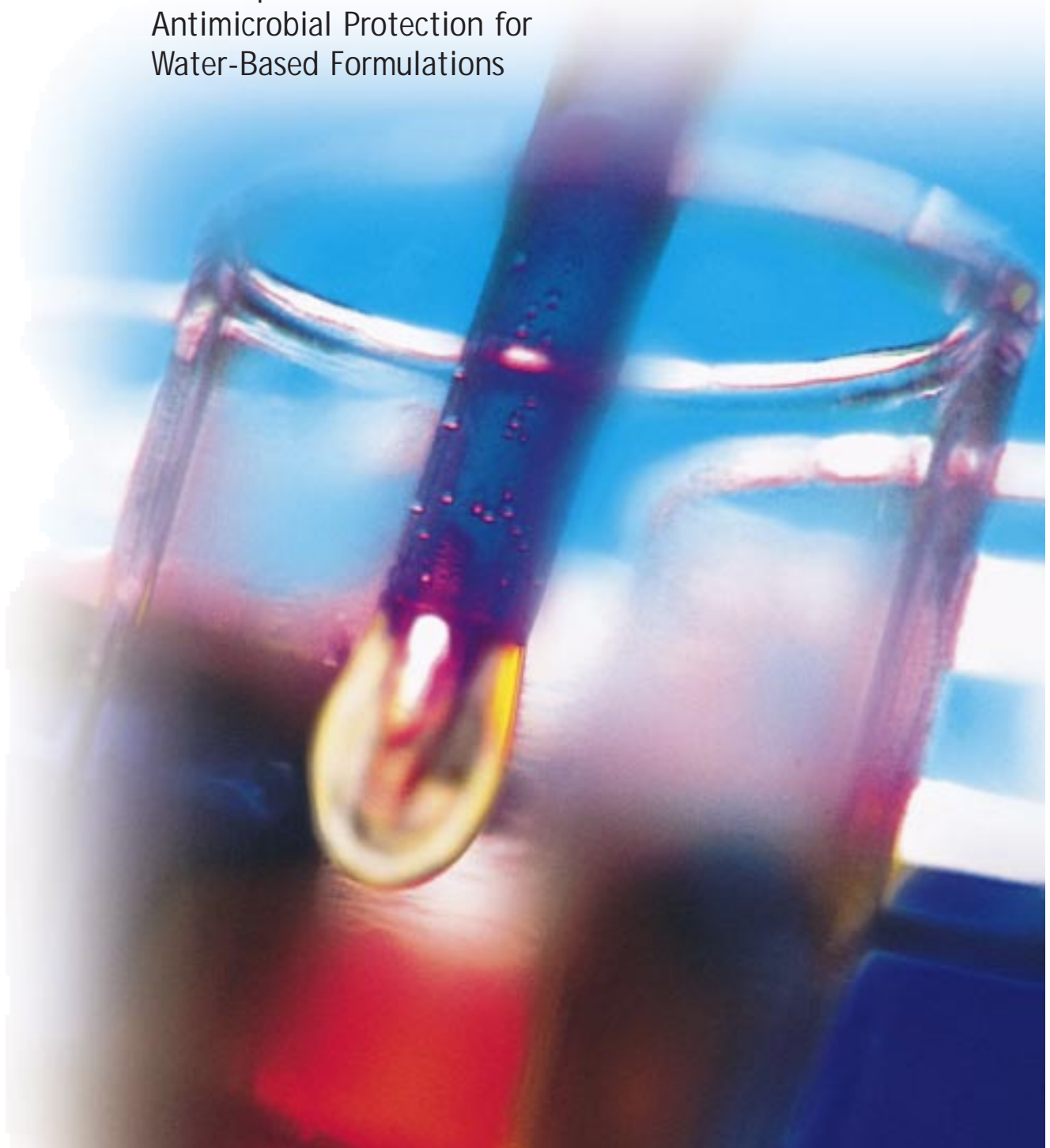




DOWICIL 75 PRESERVATIVE

Broad-Spectrum, Cost-Effective
Antimicrobial Protection for
Water-Based Formulations





Introduction

Asked to describe an ideal preservative for aqueous formulations, any two industrial chemists would probably give different answers. But a general blueprint would probably develop.

First, the preservative should provide reliable, highly effective control of microorganisms in the intended formulation. Second, it should not interfere with the formulation's properties or appearance. And third, a preservative satisfying the first two criteria should also be economical.

Those three criteria are in fact the key reasons why so many industrial chemists have chosen DOWICIL* 75 Preservative for so many types of aqueous formulations.

DOWICIL 75 Preservative is the Dow product designation for 1-(3-chloroallyl)-3,5,7-triaza-1-azoniaadamantane chloride combined with a stabilizer (sodium bicarbonate). It is designed to provide highly effective antimicrobial activity in aqueous formulations, including adhesives, paints, construction materials, latexes, and detergents, to name just a few.

A somewhat closer, introductory look at the many desirable properties of DOWICIL 75 Preservative explains why it can prove beneficial in your formulation.



DOWICIL 75 Preservative offers an excellent combination of properties for preserving aqueous solutions

Effective at low concentrations

DOWICIL 75 Preservative provides highly effective antimicrobial activity at low concentrations – typically 0.01 to 0.27% by weight in formulations. You get maximum antimicrobial effectiveness with minimum potential for undesirable effects on your formulation.

Broad-spectrum activity

A formulation preserved with DOWICIL 75 is protected against a wide variety of bacteria and fungi. DOWICIL 75 Preservative is particularly effective against *Pseudomonas aeruginosa*, the most common spoilage organism. The preservative is also effective against other frequently encountered organisms, such as *Bacillus subtilis*, *Aspergillus niger*, and numerous others.

Excellent formulation compatibility

DOWICIL 75 Preservative has been shown to be compatible with many formulation systems. Anionic, cationic, and nonionic surfactants will not inactivate DOWICIL 75. Further, DOWICIL 75 Preservative has very little effect on the surface tension of aqueous systems, and it has no solubilizing-coupling action.

Cost-effective

Because it provides highly effective antimicrobial activity at low concentrations, DOWICIL 75 is one of the most cost-effective aqueous system preservatives available. In many applications, such as acrylic latex paints, it's difficult to find equivalent antimicrobial protection at a cost lower than that of DOWICIL 75 Preservative.

High water solubility

Because spoilage microorganisms must have water for metabolic processes, they will thrive only in the aqueous phase of a formulation. DOWICIL 75 Preservative is highly soluble in water, and has very low solubility in oils and organic solvents. So DOWICIL 75 Preservative will stay in the water phase of a formulation, where it's needed.

Wide pH latitude

Most microorganisms require an environment with a pH between 5 and 9. Occasionally, certain species will survive at a pH as low as 2 or as high as 12. The antimicrobial activity of DOWICIL 75 Preservative has been demonstrated in formulations with a pH ranging from 2 to 12.5. That means you get good pH compatibility with almost any formulation, plus a margin of assurance in the event of moderate pH drift by the formulation over time.

Easy to use

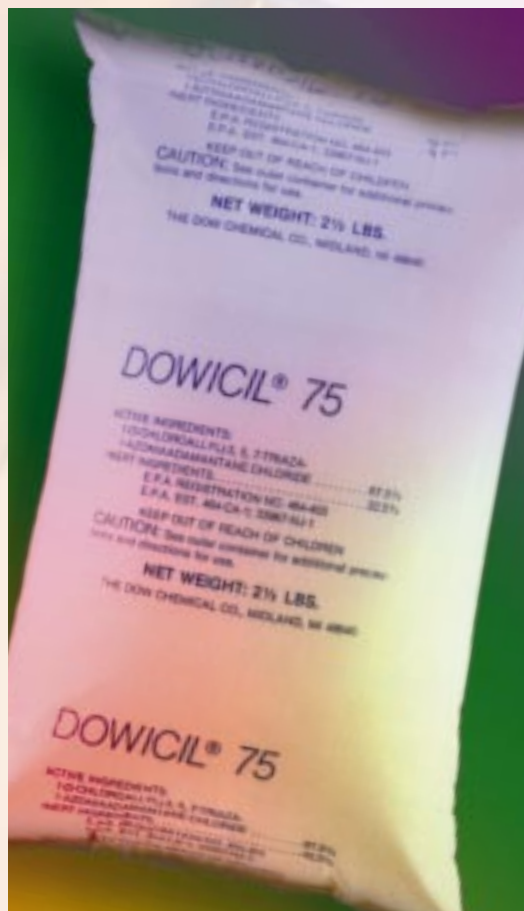
DOWICIL 75 Preservative may be handled either by preparing a liquid concentrate or as a free-flowing powder that dissolves readily in water. The dry powder may be purchased in bulk form (100-lb fibre paks) or prepackaged in 2½-lb water-soluble bags (40 bags/fibre pak). So it's versatile in the formulating step, yet easy to transport and store.

The bags are easy to handle, and eliminate the need to work in direct contact with the dry powder. So you get an extra margin of safety against employee exposure. For more information, contact Dow and ask for the "DOWICIL 75 Preservative in 2½-lb Water-Soluble Bags" brochure.

Favorable toxicologic profile

Extensive laboratory testing with DOWICIL 75 Preservative shows a favorable toxicologic profile – one that should present no significant hazards through proper handling during manufacturing, formulation, or ultimate use.

Those are some very good reasons to give DOWICIL 75 first consideration as you begin to evaluate preservative systems for use in your new or existing formulation. The following pages will give you a closer look at this unique antimicrobial material. There's specific information on the many types of aqueous products in which DOWICIL 75 Preservative may be used. You'll also learn about Dow services that can be of considerable assistance as you work with your formulation. More detailed technical information about DOWICIL 75 Preservative is also provided, including toxicologic properties, formulating recommendations, and proper handling methods.





Excellent preservative performance in a broad array of applications

Aqueous products contain a variety of water-soluble surfactants, dispersants, stabilizers, thickening agents, and other organic materials. Microorganisms and the enzymes they produce can attack and degrade many of these materials, with adverse effects on the properties and performance of the end product.

DOWICIL 75 Preservative is currently providing excellent, cost-effective antimicrobial performance in a wide variety of applications. Here's an overview of some of the formulation types in which DOWICIL 75 may be used.

Adhesives

Adhesives based on starches, latexes, proteins, and natural or synthetic gums are subject to attack by bacteria and fungi during manufacturing, storage, and use. Microbial attack may cause loss of adhesive properties, changes in viscosity, pH drop, and/or odor formation.

DOWICIL 75 can be used to preserve adhesives with no adverse effects on formulation properties. Table 1 provides the recommended concentrations of DOWICIL 75 required for various adhesive types. These recommendations are based on tests conducted on typical formulations.

Starch-based adhesives used to make corrugated board are a special case because of their alkaline pH. Only a

small group of organisms has adapted to this harsh environment, but they can cause significant problems. DOWICIL 75 has been shown to provide effective protection of these adhesives for up to two weeks when used at concentrations between 0.03 and 0.05% by weight (300 - 500 ppm).

Construction materials

Materials such as caulking, grouting, spackling compounds, and joint cements are subject to microbial attack, resulting in loss of viscosity, separation, discoloration, odor formation, and decreased shelf life.

DOWICIL 75 Preservative, added by dry blending or as an aqueous concentrate, will provide antimicrobial protection at concentrations from 0.07 - 0.3% by weight. Many commercial formulations tested in our lab were shown to be protected at levels near the low end of the range – at concentrations of 0.1% or less.

Latexes

Latexes are highly susceptible to microbial contamination for reasons relating to both basic composition and production methods. Formulations based on styrene-butadiene, polyvinyl acetate, acrylics, and vinyl chloride all involve particles of organic matter suspended in water – a nearly ideal environment for microbial growth. Moreover, bulk storage and handling systems often leave latex formulations exposed to air- and waterborne microbial contaminants.

Table 1 – Suggested Concentrations of DOWICIL 75 to Preserve Selected Adhesives¹

| Types of Adhesive | % by Weight of DOWICIL 75 |
|--|---------------------------|
| Natural Gum | 0.07 - 0.27 |
| Natural Rubber Latex | 0.07 - 0.20 |
| Polyvinyl Acetate Emulsions | 0.07 - 0.20 |
| Synthetic Gums | 0.07 - 0.20 |
| Starch-based (non-covered starches such as corn, tapioca, sago, potato, etc.) | 0.13 - 0.27 |
| Protein-derived animal glues such as hide, bone, fish, and blood glues and gelatin | 0.13 - 0.66 |

¹NOTE: DOWICIL 75 Preservative is incompatible with casein in both liquid and dry systems and with some types of amine-modified clays.

Microbial contamination can cause gassing, odor formation, discoloration, formation of slime, pH shifts, and deterioration of physical properties.

Preservative performance is very dependent on the specific latex formulation. However, most latexes can be adequately preserved with DOWICIL 75 at concentrations between 0.05% and 0.3% by weight.

Paints

Defoamers, coalescing agents, dispersants, stabilizers and thickening agents used in paints may be attacked and degraded by microorganisms and their by-product enzymes. Gas formation is a primary resulting problem; adverse effects on viscosity, stability, and foul odor may also occur.

The active ingredient in DOWICIL 75 Preservative has been providing cost-effective antimicrobial protection in paints for over thirty years. In fact, it was the original alternative to mercury-based paint preservative systems, and is safer, and exhibits less mammalian toxicity than mercurials.

DOWICIL 75 Preservative may be added to paints at any point in the formulation process as either a liquid

concentrate or a dry powder. It may also be used to preserve aqueous formulation components during storage. DOWICIL 75 Preservative will not affect the pH, viscosity, or color of paint formulations.

Comprehensive testing has shown that DOWICIL 75 Preservative will protect paints after repeated contamination with a mixture of spoilage organisms. Highly favorable results have also been obtained in tests involving freeze-thaw cycling, heat aging, and long-term storage. Figure 1 shows results typical of such testing.

Many paint formulations are also protected after drying with a film preservative. Latex paint formulations containing DOWICIL 75 Preservative are compatible with the following paint film fungicides:

Troysan® Polyphase; Skane® M-8; Amical® 50; Busan® 11-M1; and Metasol® TK-100.

If you use Nopocide® N-96 film preservative, we recommend that you test for compatibility with DOWICIL 75. Laboratory studies have shown that this combination of preservatives may cause discoloration in some formulations.

¹Paint was removed from this sample for other tests. Not enough sample remained to obtain an accurate viscosity.

Figure 1 – Performance of DOWICIL 75 Preservative in Evaluation Tests in Three Types of Latex Paint

| Latex Base | % DOWICIL 75 (By Weight) | Initial Properties | | Properties After 5 Freeze-thaw Cycles | | | Properties After One Week @ 140°F | | | Properties After 2 Years @ Ambient Temp. | | |
|-------------------|--------------------------|--------------------|--------------|---------------------------------------|--------------|----------------------------------|-----------------------------------|--------------|----------------------------------|--|-----------------|----------------------------------|
| | | pH | Viscosity Ku | pH | Viscosity Ku | No. of Challenges to Contaminate | pH | Viscosity Ku | No. of Challenges to Contaminate | pH | Viscosity Ku | No. of Challenges to Contaminate |
| Acrylic | 0.1 | 8.3 | 102 | 8.2 | 104 | >10 | 8.0 | 100 | >5 | 7.8 | 100 | 4 |
| | 0.2 | 8.3 | 102 | 8.2 | 104 | >10 | 7.7 | 102 | >5 | 7.5 | 82 ¹ | >4 |
| Styrene-Butadiene | 0.1 | 8.4 | 93 | 8.4 | 101 | >10 | 8.1 | 96 | >5 | 7.95 | 93 | >4 |
| | 0.2 | 8.4 | 93 | 8.4 | 97 | >10 | 7.9 | 95 | >5 | 7.75 | 95 | >4 |
| Polyvinyl Acetate | 0.1 | 6.8 | 80 | 6.6 | 85 | >10 | 6.3 | 82 | 4 | 6.7 | 89 | >4 |
| | 0.2 | 6.85 | 80 | 6.6 | 84 | >10 | 6.3 | 83 | >5 | 6.5 | 88 | >4 |

NOTE: "No. of Challenges to Contaminate" refers to the number of repeated inoculation-incubation cycles required to cause sustained microbial growth in the formulation. See page 13 of this brochure for a description of the Dow 10-Cycle Challenge Test method.

Petroleum production and recovery

DOWICIL 75 provides effective protection for polymer-based drilling muds and completion fluids at concentrations of 0.03 - 0.05% (0.075 - 0.125 pounds per barrel). For underground floods, DOWICIL 75 may be used at concentrations between 0.0025% and 0.005% (25 and 50 ppm) by weight. When tested according to the American Petroleum Institute Test Method RP-38¹, DOWICIL 75 showed highly effective activity against *Desulfovibrio desulfuricans* (Mid-continent, Strain A), *Pseudomonas fluorescens* (NRRL B-4290) at 750-1250 ppm, and *Bacillus cereus* (NRRL B-4278).

Detergents

Solutions of biodegradable surfactants such as dishwashing liquids, household cleaning products, and industrial cleaners are subject to microbial contamination. Microbial attack will cause odor formation, breakdown of surfactants, and decreased shelf life.

DOWICIL 75 Preservative effectively protects these materials and formulations at concentrations as low as 0.04% by weight. Depending on the type of surface active material present and the period of shelf life required, effective concentrations of DOWICIL 75 range from 0.04 - 0.13% by weight.

Figure 2 shows results of testing conducted on a typical dishwashing liquid preserved with various levels of DOWICIL 75. The test method used was the Dow 10-Cycle Challenge Test, in which the formulation undergoes repeated inoculation-incubation cycles. A later section of this brochure (see page 13) describes the Dow test in detail.

Inks

DOWICIL 75 Preservative has been evaluated in several applications ranging from fountain pen ink to ink used for the printing of fabrics and fiber containers. Ink formulations typically require 0.2 - 0.27% by weight of DOWICIL 75 Preservative for adequate preservation. The required concentration is dependent on the formulation and the shelf life desired.

Starch

Commercial and household starch formulations can be protected against deterioration by the incorporation of DOWICIL 75 Preservative at concentrations of 0.07 - 0.2% by weight.

Polyurethane resins

When used in accordance with good manufacturing practices, DOWICIL 75 meets the requirements of 21 CFR 177.1680 for the preservation of polyurethane resins in contact with bulk quantities of dry food.

¹American Petroleum Institute, 1975. "API Recommended Practice for Biological Analysis of Subsurface Injection Waters," API RP-38, Third Edition. API Production Dept., Dallas, TX. Dec.

Figure 2 – Performance of DOWICIL 75 Preservative in a Typical Dishwashing Liquid Using the Ten-Cycle Challenge Test¹

| DOWICIL 75 (ppm) | Challenge Number | | | | | | | | | | |
|-------------------|------------------|---|----|----|---|----|----|---|----|----|----|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Control | 1 ² | 1 | 10 | 10 | — | — | — | — | — | — | — |
| 75 | 1 | 1 | 1 | 1 | 4 | 10 | 10 | — | — | — | — |
| 150 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 | 10 | — |
| 250 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 500 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

¹Each challenge consisted of 0.1 mL of a mixed inoculum (10⁹ organisms/mL).

²Numerical ratings indicate the number of bacterial colonies observed after incubation; 1=none, 2=1-4; 3=5-10; 4=11-25; 5=26-50; 6=51-100; 7=101-200; 8=201-300; 9=too many to count; and 10=solid mass.

Liquid floor polishes and floor waxes

Water-based floor polishes and waxes can be adequately preserved with DOWICIL 75 at concentrations of 0.07 - 0.2% by weight. In general, the natural waxes and the natural wax and latex combinations not containing any monomer require slightly higher levels of DOWICIL 75 than do the latex-based formulations containing some monomer.

Aqueous agricultural products

DOWICIL 75 may be used as a preservative (inert ingredient) at concentrations up to 0.2% in water-based agricultural products that do not come in contact with food, food crops, foodstuffs, and water supplies, and which are not applied to humans or food-producing animals. These include products such as insecticides, lawn weed killers, and flea or tick sprays and pet shampoos.

Textile production materials

DOWICIL 75 Preservative is effective in preventing spoilage of spinning emulsions for nylon and rayon, and of finishing solutions. It will also prevent viscosity and pH changes caused by bacteria in printing pastes. Each such textile production material can be preserved by adding 0.13 - 0.27% DOWICIL 75 by weight of the formulation.

Pulp and paper components

Coatings, finishes, and printing colors based on natural or synthetic starch and/or latex can be protected from bacterial and fungal attack by adding 0.13 - 0.27% DOWICIL 75 by weight of the formulation. These concentrations will protect against bacterial and fungal growth for three to six days. Longer periods of preservation may require higher concentrations. The active ingredient in DOWICIL 75 Preservative meets the requirements of 21 CFR 176.170 and 21 CFR 176.180 when used at concentrations up to 0.3% to preserve latexes used as pigment binders that contact non-acidic and non-alcoholic food at room temperature or below. It is also cleared under 176.170 and 176.180 for use as a preservative at a level not to exceed 0.07% by weight in latexes and 0.05% by weight in pigment slurries used as components of coatings.



Metalworking fluids

Synthetic, semi-synthetic, and soluble oil-based metalworking fluids are generally water emulsions that contain ingredients such as mineral oil, emulsifying agents, rust inhibitors, and antifoam agents. Microbial attack on these ingredients can cause fluids to turn rancid and develop foul odors, shift pH from alkaline to acidic, and lose lubricating ability. Pathogenic bacteria may multiply in open recirculating fluid systems, which can cause health problems among workers.

DOWICIL 75 Preservative provides effective control of microorganisms in metalworking fluid systems. Its stabilized pH of about 8.5 matches the alkaline pH of 8-10 typical of most metalworking fluids. Because DOWICIL 75 is available in pre-measured 2½-lb water-soluble bags, it's easy and convenient to add.

DOWICIL 75 is effective in metalworking fluids at concentrations of 0.015 - 0.25% by required, effective concentrations of weight. In systems subject to unusual potential for contamination, "slugging" the system with makeup fluid containing DOWICIL 75 at twice the normal concentration can prove highly effective. Alternate doses of makeup fluid are added unpreserved; the same amount of preservative is used over time, but microbial growth is controlled better.



E.P.A. and F.D.A. status of DOWICIL 75 Preservative

The E.P.A. registration number of DOWICIL 75 Preservative is 464-403. DOWICIL 75 is registered by the E.P.A. for all of the applications discussed on the previous pages (4 to 7) at the concentrations listed. Table 2, below, summarizes those applications and use concentrations.

Table 2 – Applications and Use Concentrations for DOWICIL 75 Preservative

¹NOTE: DOWICIL 75 Preservative is incompatible with casein in both liquid and dry systems and with some types of amine-modified clays.

| Application | Recommended Use Concentrations of DOWICIL 75, % by Weight of Formulation |
|-------------------------------------|--|
| Adhesives ¹ | |
| Natural Gum | 0.07 - 0.27 |
| Natural Rubber Latex | 0.07 - 0.20 |
| Polyvinyl Acetate Emulsions | 0.07 - 0.20 |
| Synthetic Gums | 0.07 - 0.20 |
| Starch Based | 0.13 - 0.27 |
| Protein Derived | 0.13 - 0.66 |
| Construction Materials ¹ | 0.07 - 0.30 |
| Latexes | 0.05 - 0.30 |
| Latex and Emulsion Paints | 0.01 - 0.20 |
| Metalworking Fluids | 0.015 - 0.25 |
| Petroleum Production and Recovery | 0.0025 - 0.05 |
| Detergents | 0.04 - 0.13 |
| Inks | 0.20 - 0.27 |
| Starch | 0.07 - 0.20 |
| Liquid Floor Polishes and Waxes | 0.07 - 0.20 |
| Textile Production Materials | 0.13 - 0.27 |
| Pulp and Paper | 0.13 - 0.27 |
| Aqueous Agricultural Products | Up to 0.2 |

Table 3 provides information on indirect food contact applications for which DOWICIL 75 Preservative meets F.D.A. requirements. In all cases DOWICIL 75 is listed under its active ingredient, 1-(3-chloroallyl)-3,5,7-triaza-1-azoniaadamantane chloride. Percentages given are for the active ingredient.

European inventory and food contact status of DOWICIL 75 Preservative

DOWICIL 75 Preservative is listed in European Inventory of Existing Chemical Substances (EINECS) under the registration number 223-805-0. DOWICIL 75 Preservative is registered for use as a chemical and/or a biocide in the European Union with the exception of certain EU member states (such as The Netherlands, Belgium or Sweden) where additional requirements exist for products marketed and used as “biocides.” Biocidal products used as preservatives in products such as paints or inks are not regarded as biocides in the sense of the Dutch, Belgium and Nordic regulations.

Food Status/EU Plastics Directive – German BgVV

The active ingredient of DOWICIL 75 Preservative – 1-(3-chloroallyl)-3,5,7-triaza-1-azoniaadamantane chloride – is listed in EU Synoptic Document #7 of May 15, 1994, under PM REF#43600, SCF list 2. It has been given a Tolerable Daily Intake (TDI) value of 0.005 mg/kg body weight and a Specific Migration Limit of 0.3 mg/kg.

The same active ingredient is listed under the German BgVV recommendation XIV “Plastic Dispersions,” with a limit of 0.05 mg/dm² in the dispersion film.

Table 3 – Food and Drug Administration Food Additive Regulations Covering Indirect Food Contact Applications for Which DOWICIL 75 Preservative Is Approved.

| Food Additive Regulation | Parameters of Regulation |
|--------------------------|--|
| 21 CFR 175.105 | Preservation in Adhesives |
| 21 CFR 176.170 | Preservative in latexes used as pigment binders in paper and paperboard intended to contact non-acidic and non-alcoholic aqueous and fatty foods at room temperature or below (maximum use level is 0.3%). Preservatives in latexes (0.07% by weight maximum) and in pigment slurries (0.05% by weight maximum) used as components of coatings for paper and paperboard. |
| 21 CFR 176.180 | Preservative in latexes used as pigment binders in paper and paperboard intended to contact non-acidic and non-alcoholic dry foods at room temperature or below (maximum use level is 0.3%). Preservatives in latexes (0.07% by weight maximum) and in pigment slurries (0.05% by weight maximum) used as components of coatings for paper and paperboard. |
| 21 CFR 177.1680 | Preservative in polyurethane resins in contact with bulk quantities of dry foods. |



How unique Dow support services can help make the best of your formulation

If every preservative had its own unvarying set of working characteristics, regardless of the formulation environment, the task of specifying one would be relatively simple.

Unfortunately, that's often not the case. The behavior of any preservative differs in each unique formulation environment. So selecting the right level of the right preservative can be difficult.

That's where Dow can help. We offer comprehensive, free 10-Cycle Challenge Test services to aid in this selection. And a highly qualified staff of Dow microbiologists is always ready and willing to answer questions and provide expert technical advice.

Three tests help you determine your antimicrobial requirements

If you need help evaluating your preservative system, we're ready to help you with three types of informative tests. These tests can help you to answer three key questions: 1) How much preservative do you need to provide sufficient antimicrobial activity in the formulation? 2) Does the preservative have any undesirable effects on the formulation? and 3) Are there cost-performance advantages?

The first test is the rigorous Dow 10-Cycle Challenge Test. We'll run this test on your formulation with various concentrations of DOWICIL 75 Preservative to determine which concentration can provide cost-effective protection for your formulation. (A later section of this brochure describes the 10-Cycle Challenge Test and its specific advantages.)

Second, we'll be glad to run side-by-side tests with DOWICIL 75 Preservative and other preservatives that you may be considering. So you'll be able to compare performance and compatibility with your formulation in real, quantitative terms.

Third is compatibility testing. We'll incorporate DOWICIL 75 Preservative into your formulation. You will then be able to assess for yourself the actual performance and effects of DOWICIL 75 Preservative.

These Dow testing services provide an excellent benchmark by which to evaluate preservative performance, whether you use the information by itself or in conjunction with other tests. And getting started can be as easy as contacting your local Dow representative or distributor.

Put Dow experience to work in your formulation

Dow support services are more than just formulation testing. For example, another basic service is assistance with the ways to incorporate DOWICIL 75 Preservative into your specific formulation.

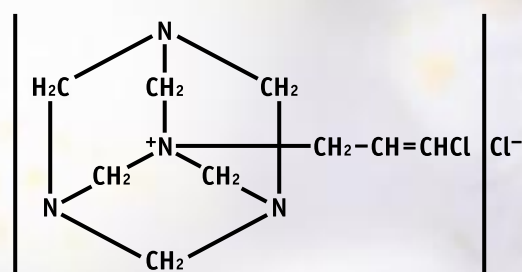
Moreover, Dow has more than 60 years of experience as a manufacturer and supplier of antimicrobials.

The result is a unique body of knowledge about the behavior of preservatives in aqueous systems. And we'll be glad to share what we've learned to help you solve problems and maximize the performance of the antimicrobial in your formulation. That assistance is as close as your phone.

Physical Properties

The information provided here is based on laboratory results typical of the properties of DOWICIL 75 Preservative; this information should not be considered as specifications.

Structure



| | |
|--|--|
| Formula | C ₆ H ₁₂ N ₄ (CH ₂ CHCHCl)Cl |
| Molecular Wt. | 251.2 |
| Bulk Density | 43 lb/ft ³ |
| Bulking Value | 0.0779 gal/lb |
| Mineral Oil/Water Partition Coefficient | -1.09 (log P) @ 25°C |
| Description | Off-white powder |
| Active Ingredient | |
| 1-(3-chloroallyl)-3,5,7-triaza-1-azoniaadamantane chloride | maximum 67.5% |
| Inert Ingredients | maximum 32.5% |
| Sodium Bicarbonate | 25±2% |
| Others, max. | 9.5 |
| Color, Gardner, max. | 4 |
| Sieve Analysis, through #5 U.S. Standard Sieve | 100% |

Solubility

The solubility characteristics of DOWICIL 75 Preservative give it a decided advantage in preserving water-based systems. As Table 4 shows, the active ingredient (1-(3-chloroallyl)-3,5,7-triaza-1-azoniaadamantane chloride) is highly soluble in water, and has very low solubility in non-aqueous solvents. In an oil-in-water emulsion, little DOWICIL 75 Preservative migrates to the oil phase. Instead, it stays in the water phase, where it can be most effective against microorganisms that thrive only in the presence of water.

The inert ingredient, sodium bicarbonate, is insoluble in all of the solvents listed in Table 4, with the exception of water. Therefore, the difference in the relative solubilities of the active ingredient and the sodium bicarbonate may be used to separate the two components. For example, you can add only the active ingredient to a formulation by putting DOWICIL 75 into propylene glycol; the bicarbonate will be easily removed by simple filtration or decantation.

Table 4 – Solubility of the Active Ingredient in DOWICIL 75 in Common Solvents

| Solvent | Solubility (g/100 g solvent @ 25°C) |
|---------------------------|-------------------------------------|
| Water | 222.0 |
| Hexane | <0.01 |
| Glycerine (99.5%) | 2.17 |
| Ethanol, Absolute | 4.49 |
| DOWANOL* PM Glycol Ether | 1.36 |
| DOWANOL* DPM Glycol Ether | 0.17 |
| Acetone | 0.05 |

DOWICIL 75 Preservative is soluble in water to the extent that solutions of 20% by weight can be prepared easily. Above 20%, the solubility of sodium bicarbonate becomes limiting. Note that concentrated aqueous solutions (10 - 20% by weight) should not be stored for longer than two weeks at ambient temperature. Longer storage will result in a gradual loss of antimicrobial activity.

Solution pH

Concentrated and diluted aqueous solutions of DOWICIL 75 Preservative display good pH stability. Fresh solutions of DOWICIL 75 Preservative have an initial pH of approximately 7.5. (This may vary depending on the pH of the water.) During the first 24 hours, solutions in the range of 1 - 20% by weight will drift slightly alkaline and stabilize at a pH of about 8.5.

*Trademark of The Dow Chemical Company



Broad spectrum antimicrobial effectiveness that can be confirmed with the industry's toughest test method

The primary function of any preservative is to prevent the growth of microorganisms. DOWICIL 75 Preservative is highly effective against bacteria and fungi, as the data in Table 5 show.

Note that Table 5 presents agar inhibition data. The agar inhibition test is quite simple. Various levels of the preservative are incorporated into samples of sterile nutrient agar, a gel-like substance that provides an environment favorable to the growth of microorganisms. Then several species of microorganisms are added to all samples. After incubation, the samples are checked for microbial growth. The results indicate the concentration of preservative required to inhibit the growth of each type of microorganism under a standard set of conditions.

The agar inhibition test is a good starting point, because it can be an early indicator of a preservative's merit or potential shortcomings.

But the information shown in Table 5 is just the beginning. We've also run extensive laboratory evaluations on a wide variety of aqueous formulations. These tests consistently demonstrate that concentrations of DOWICIL 75 from 0.01 - 0.27% by weight maintain effective control after repeated exposure to typical spoilage microorganisms such as *Pseudomonas aeruginosa*, *Enterobacter aerogenes*, *Bacillus subtilis*, and others.

Obviously, the most effective level of DOWICIL 75 Preservative should be determined for each specific formulation using appropriate testing procedures. That's the only way to make a precise determination of the antimicrobial effectiveness of any preservative in a given formulation.

Table 5 – Antibacterial and Antifungal Efficacy of DOWICIL 75 Preservative Using the Agar Inhibition Technique

| Test Organism | Concentration of DOWICIL 75 Required to Inhibit Growth |
|--------------------------------------|--|
| Bacteria | (ppm) |
| <i>Escherichia coli</i> | 250 |
| <i>Staphylococcus aureus</i> | 100 |
| <i>Salmonella choleraesuis</i> | 100 |
| <i>Pseudomonas aeruginosa PRD-10</i> | 500 |
| <i>Klebsiella pneumoniae</i> | 100 |
| <i>Proteus vulgaris</i> | 50 |
| Fungi | |
| <i>Aspergillus niger</i> | 1600 |
| <i>Rhizopus nigricans</i> | 1000 |

How the Dow 10-Cycle Challenge Test is performed

The Dow 10-Cycle inoculation-incubation procedure has been used with considerable success for over 25 years. This test method is the procedure that Dow employs to help formulators evaluate the performance of DOWICIL 75 Preservative.

A separate Dow bulletin describes the 10-Cycle procedure in complete detail. The following summary, though, will familiarize you with the test method.

- 1) We start by testing samples of your formulation for sterility. We use a separate sample for each level of preservative tested and include suitable controls.
- 2) Each sample is inoculated with a 24-hour culture of mixed bacteria followed by an incubation period lasting 24 hours. The samples are then streaked on agar plates. Both the samples and the agar plates are incubated for 48 hours, after which the plates are examined for growth.
- 3) Step 2 is repeated for a total of ten inoculation-incubation cycles. The preservative is considered to be effective only if the sample remains essentially sterile throughout the 10-Cycle Challenge Test.

The basic test procedure can also be performed using various fungi for inoculations. The optimum conditions for fungal growth differ from those for bacteria, so appropriate changes in culture media, number of inoculations, temperatures, and incubation times must be made to obtain the most meaningful results.



Advantages of the 10-Cycle Challenge Test

The 10-Cycle Test method provides you with two fundamental benefits that you won't get with other types of testing.

First, it's a repeated inoculation study, which contaminates the same sample again and again. So it's a good simulation of the type of repeated exposure your formulation may be subjected to during manufacturing, shipping, and use. Other tests, such as time-kill tests, don't involve repeated contamination. Some tests aren't even designed to be run in a specific formulation. So they may not reliably predict the antimicrobial's performance under end-use conditions.

The Dow 10-Cycle Challenge Test can offer a second benefit: it is designed to reveal the minimum level of preservative required to protect a specific formulation. That eliminates much of the guesswork from cost analysis and compatibility studies.



Extensive testing shows a favorable toxicologic profile

Extensive animal studies have provided a comprehensive base of safety substantiation data on DOWICIL 75 Preservative. The results of these studies indicate that DOWICIL 75 has a favorable toxicologic profile. The material should present no handling, utilization, or waste disposal problems, when used in accordance with instructions on the label.

Table 6 below provides summary toxicologic information obtained from several studies on laboratory animals. If you have further questions, consult your local Dow representative.

Table 6 – Summary of Mammalian Toxicologic Data for DOWICIL 75 Preservative

| Test | Animal | Results |
|------------------------|--------|---|
| Acute Oral | Rat | LD ₅₀ : 1000 mg/kg body wt |
| Subchronic Oral | Rat | Dietary levels up to 15 mg active ingredient/kg body wt per day for 90 days produced no evidence of significant toxicological effect. |
| | Dog | The no observable effect dose level of the active ingredient administered orally in capsule to beagle dogs daily for 90 days was 7.5 mg/kg per day. |
| Eye Irritation | Rabbit | When applied to the eyes of six rabbits, undiluted DOWICIL 75 produced slight conjunctival redness, slight to moderate edema, and slight discharge. The eyes were normal within 7 days. |
| Skin Irritation | Rabbit | A 4-hour occluded application of moistened DOWICIL 75 to intact skin of rabbits produced very slight erythema in 5 of 6 rabbits when examined in 24 hours. Three of the 6 rabbits also had very slight to slight edema at the application site at 24 hours. The erythema and edema were resolved within 7 days. Prolonged (24-hour) application to occluded skin, or application to abraded skin, may be more irritating. |
| Skin Absorption | Rabbit | The skin absorption LD ₅₀ was greater than 5000 mg/kg, the limit dose for male and female New Zealand white rabbits. |
| Repeated Dermal 25 Day | Rabbit | The material, when applied to rabbit skin as 0.5, 1.0 and 2.0% aqueous solutions (25, 50, 100 mg/kg/day) for 6 hours per day, 5 days/week for 3-1/2 weeks (18 exposure days) produced no significant toxicological effects. The parameters studied were mortality, hematology, clinical chemistries, gross and histopathology, and organ-to-body weight ratios. |
| Skin Sensitization | Human | The active ingredient in DOWICIL 75 was tested for skin irritation, skin fatiguing, sensitization, and photosensitization properties. It was concluded that DOWICIL 75 is not a primary irritant, fatiguing agent, skin sensitizer, or photosensitizer at concentrations up to 1.0%. Higher concentrations may be weak sensitizers in susceptible individuals. |
| Inhalation | Rat | Exposure to concentrations of 9.33 mg dust/liter of air for 1 hour caused no observable effects during or after the exposure. Gross pathological examination of the animals 14 days after exposure revealed no compound-related changes. Exposure by nose only to 5.2 mg dust/liter of air for 4 hours resulted in slight red nasal discharge and staining of the eyelids for approximately 3 days. All rats survived for 14 days after exposure and gross pathologic examination revealed no compound-related changes. |

Formulating with DOWICIL 75 Preservative

For most applications, DOWICIL 75 Preservative is added in its dry form to the aqueous phase of a formulation. With its high water solubility, DOWICIL 75 rapidly goes into solution.

DOWICIL 75 Preservative may also be added to formulations as an aqueous concentrate. Solution concentrations in the range of 10 to 20% are most common (preparation of more concentrated solutions will exceed the solubility limits of the sodium bicarbonate). Stock solutions of DOWICIL 75 Preservative are easy to prepare.

Preparation of aqueous solutions

Solutions of DOWICIL 75 Preservative are best prepared in vented vessels. Take special precautions and follow good engineering practices if you use an airtight container. Concentrated solutions of DOWICIL 75 Preservative can develop pressure in closed systems, especially in the presence of an acid, which will cause the release of carbon dioxide. For special cases, consult your Dow technical service representative.

Most materials of construction commonly used for handling industrial chemicals are compatible with solutions of DOWICIL 75 Preservative. However, avoid using aluminum, which is corroded by sodium bicarbonate.

To prepare a stock solution, draw the desired quantity of water and begin agitation with a slow-speed propeller-type mixer. Weigh out the desired amount of DOWICIL 75 Preservative and add it slowly to the vortex. Lumping may occur if the powder is added too rapidly, although lumps will dissolve with continued agitation.

Concentrated stock solutions of DOWICIL 75 Preservative should be used within two weeks of preparation. After that time, the preservative properties of the solution will slowly decline and a yellow color may develop. Development of color alone, however, does not indicate a loss of performance.

Water-soluble bags simplify solution makeup

DOWICIL 75 Preservative is available packaged in 2½-lb water-soluble bags that make it exceptionally easy and safer to use.

After you know your batch size and the concentration of DOWICIL 75 Preservative required, it's easy to determine the total required weight of DOWICIL 75 Preservative. You then simply add the appropriate number of 2½-lb bags to either the water phase of the formulation, or to water for preparation of a concentrated solution. There's no need for weighing, and the contents of the bag dissolve completely.

The bags, of course, are easy to handle. They eliminate the need to work in direct contact with the dry powder. So you get an extra margin of safety against employee exposure.

Temperature considerations

The water used for solution makeup should be cool, 15 to 20°C (59 to 68°F). Use of very cold water may result in incomplete solubility of the inert ingredient at high concentrations. And the use of hot water may unnecessarily hasten hydrolysis of the active ingredient.

Solutions of DOWICIL 75 Preservative at normal use concentrations (usually 0.2% or less) can be boiled for 30 minutes or held at 80°C for up to 24 hours without significant loss of activity. In most circumstances, products containing up to 0.2% DOWICIL 75 Preservative will have a shelf life of two years.

NOTE: Always refer to the most current Material Safety Data Sheet for use and handling information.



How to handle, store and dispose of DOWICIL 75 Preservative

The precautions are general in nature and are directed toward exposure to undiluted DOWICIL 75 Preservative or to strong solutions (10% by weight or more). Specific recommendations can be made only when specific handling conditions are known.

Handling

Observe reasonable precautions to avoid ingestion and skin contact, especially with strong (10% by weight or more) aqueous solutions. Avoid contact with the undiluted material when the skin is wet, as with perspiration. Keep concentrated solutions or the dry powder of DOWICIL 75 Preservative away from cuts or wounds.

After working with DOWICIL 75 Preservative, wash hands and face well before eating, drinking, or smoking. Remove contaminated clothing immediately and wash it before reuse. Wash contaminated skin with soap and a large quantity of water. Personnel working in a dusty atmosphere should shower and change to clean clothing at the end of each work period.

The Dow Chemical Company has established an Industrial Hygiene Guide (IHG) of 1 mg/m³ of air for airborne concentrations of the active ingredient. Proper ventilation should be maintained to control dusts to below this level. Use dust respirators if necessary. Protective clothing impervious to this material should be used to avoid skin contact. Selection of specific items (gloves, apron, etc.) will depend upon operation. Use adequate eye protection, such as safety glasses. Locate an eye wash shower reasonably close to personnel working with the product. Review the current Material Safety Data Sheet for the product for further information.

Storage

DOWICIL 75 Preservative must be stored in a cool, dry place at temperatures below 60°C (140°F). Excess heat may cause thermal decomposition, which will release smoke and flammable vapors.

If the entire contents of a drum are not used after opening, reseal the lid to keep moisture from caking the product. Keep aqueous solutions of DOWICIL 75 Preservative at temperatures below 25°C (77°F) for maximum stability.

As noted previously, the preparation and storage of solutions of DOWICIL 75 Preservative is best done in vented vessels. Take special precautions if an airtight container is used. A concentrated solution can develop pressure in a closed system, especially in the presence of an acid, by releasing carbon dioxide.

Disposal

Spills can be swept up. Use a floor sweeping compound, then flush the spill area with water. Avoid contamination of public water supplies. Collected (swept-up) material can be disposed of either on site or at an approved waste disposal facility.

In disposal of any wastes, be certain all applicable federal, state, and local laws and regulations are met.

Customer notice

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. Your Dow sales representative can arrange the proper contacts. Dow product literature, including Material Safety Data Sheets, should be consulted prior to use of Dow products. Producers using this product to formulate pesticides are responsible for obtaining EPA registrations for their formulated products.

For more information about DOWICIL 75 Preservative:

From the U.S. and Canada call 1-800-447-4369

From Mexico call 95-880-447-4369

In Europe call +31/20.691.6268

FAX +31/20.691.6418

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