

Microbial Control

Technical Data Sheet

KATHON® CG/ICP Preservative KATHON® CG/ICP II Preservative KATHON® ICP III Preservative

Highly Effective Preservatives for Use in Household and Industrial Products

General

Why Choose KATHON® CG/ICP, KATHON® CG/ICP II or KATHON® ICP III Preservatives?

DuPont discovered the active ingredients of KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III preservatives in the late 1960s. For more than 30 years we have driven the progress of isothiazolinone chemistry to meet your evolving needs. Our goal is to provide our customers with much more than a preservative.

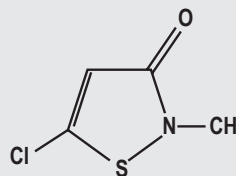
DuPont is committed to both the isothiazolinone chemistry and the household and industrial products industry. We have extensive toxicological and environmental databases and internal expertise that have allowed KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III preservatives to be registered with the U.S. EPA.

Many consumer and industrial products are susceptible to microbial contamination which can affect the appearance, odor, and performance of the products.

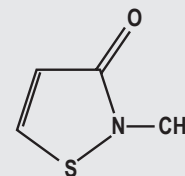
The preservatives' broad-spectrum activity, excellent physical and chemical compatibility and low toxicity at recommended use levels provide formulators with an economical, effective, and environmentally acceptable alternative to other commercial preservatives.

The information presented in this bulletin will help you evaluate KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III preservatives. For further information on our products, please contact your local DuPont technical representative.

Structures



Component 1 (MCI)
5-chloro-2-methyl-
4-isothiazolin-3-one
Empirical Formula:
C₄H₄ClNOS



Component 2 (MI)
2-methyl-
4-isothiazolin-3-one
Empirical Formula:
C₄H₅NOS

Chemical Composition

	CAS #	Empirical Formula
Active Ingredients		
Methyl chloro isothiazolinone (MCI)	26172-55-4	C ₄ H ₄ ClNOS
Methyl isothiazolinone (MI)	2682-20-4	C ₄ H ₅ NOS
Inert Ingredients		
Magnesium chloride	7786-30-3	MgCl ₂
Magnesium nitrate	10377-60-3	Mg(NO ₃) ₂
Cupric nitrate	10031-43-3	Cu(NO ₃) ₂ ·3H ₂ O

Physical Properties

The following are typical properties of KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III preservatives. **They are not to be considered product specifications.**

	KATHON® CG/ICP	KATHON® CG/ICP II	KATHON® ICP III
Active Ingredients			
5-chloro-2-methyl-4-isothiazolin-3-one	1.15%	1.15%	1.15%
2-methyl-4-isothiazolin-3-one	0.35%	0.35%	0.35%
Total	1.50%	1.50%	1.50%
Inert Ingredients			
Magnesium salts	23.00%	2.80%	—
Cupric nitrate	—	0.15%	—
Water	75.50%	95.55%	90.1%
Total	98.50%	98.50%	98.50%

	KATHON® CG/ICP	KATHON® CG/ICP II	KATHON® ICP III
Appearance	clear liquid	clear liquid	clear liquid
Color	colorless to pale yellow	pale blue to pale green	pale blue to pale green
Odor	mild	mild	mild
Specific gravity	1.19 @ 20°C	1.02 @ 20°C	1.00 @ 25°C
Density, lb/gal	9.9	8.4	8.3
pH, as supplied	1.5–3.0	2.5–4.5	1.7–3.7
Stability	Stable at least one year at ambient temperatures and at least six months at 50°C.		

Choose the Best Preservative

What Makes KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III the Best Preservatives?

- Lowest dose
- Broader spectrum of activity
- Supplied as aqueous solutions readily incorporated into household/industrial formulations
- Good compatibility with surfactants and emulsifiers, irrespective of their ionic nature
- Effective over a broad pH range
- No color or odor imparted to household/industrial consumer products
- Safe at recommended use levels
- Environmentally acceptable
- Rapidly biodegradable
- Nonpersistent in the environment
- Not bioaccumulating

Choose the Best Service Package

In the current regulatory environment, where more and more data is required by regulatory authorities, it is important to choose not only the right preservative, but also the right supplier—one who can supply you with a high-purity product of consistent quality and the support that you need

DuPont Has More Than 30 Years of Experience With Isothiazolinone Chemistry:

- Regulatory data
- Extensive toxicological database
- Environmental fate database that is continually updated
- Safe handling expertise that can help you in your manufacturing facilities
- Technical expertise with isothiazolinone chemistry and product preservation in general
- More than 100 patents obtained since the 1960s

Chemical Identification

KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III preservatives contain the same type and level of active ingredients (A.I.)—a mixture of two isothiazolinones identified by the IUPAC system of nomenclature as 5-chloro-2-methyl-4-isothiazolin-3-one and 2-methyl-4-isothiazolin-3-one.

The compositions of KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III preservatives differ only in the level and type of salts they contain. Their preservative performance is identical. Typical compositions, as supplied, are presented in the table below.

Typical Properties

Each KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III preservative is a precise formulation of active ingredients and inert salts in aqueous solution. Every batch of KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III preservative is manufactured to exact specifications and a certificate of analysis can be provided with each order.

Miscibility

KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III preservatives are totally miscible in water, lower alcohols and glycols and have low solubility in hydrocarbons.

Current Regulatory Status

KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III are highly effective preservatives approved for use by the U.S. Environmental Protection Agency (EPA) in a wide variety of household and industrial products. The EPA registration numbers are: KATHON® CG/ICP 707-166, KATHON® CG/ICP II 707-196 and KATHON® ICP III. The products are also registered with:

- California Reg. No. 707-166AA
- Canada PCP No. 17726
- Japan MITI approved

Applications/Directions for Use

Directions

The maximum recommended use level for KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III preservatives is 0.15% by weight of product as supplied (22.5 parts per million active ingredients). Since the components of formulations vary considerably and may impact on the effect of preservatives, we urge each manufacturer to confirm the efficacy and stability of KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III preservatives in use.

Applications

Typical applications for use include:

Cleaners and polishes, such as:

- all purpose cleaners
- floor and furniture polishes/waxes
- automotive washes, polishes and waxes

Laundry products, such as:

- liquid laundry detergents
- fabric softeners
- pre-spotters

Liquid detergents, such as:

- hand dishwashing detergents
- hand cleaners
- hand soaps

Miscellaneous:

- moist towelettes
- air fresheners
- moist sponges
- gel air fresheners

Raw materials and surfactants

Microbiological Properties

KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III preservatives exhibit outstanding antimicrobial activity against gram-positive and gram-negative bacteria, yeasts and molds. The following table gives the minimum level in ppm of KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III preservatives, as supplied and as active ingredients that inhibited the growth of various microorganisms in test tube cultures. The data demonstrate the broad activity of KATHON® CG/ICP preservatives, but must not be taken as recommended use concentrations.

Minimum Inhibitory Concentrations (MICs) of KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III Preservatives

Organism	ATCC No.	ppm (as supplied)	ppm (A.I.)
Bacteria*			
Gram-Positive			
<i>Bacillus cereus</i> var. <i>mycoides</i>	(R&H No. L5)	150	2
<i>Bacillus subtilis</i>	(R&H No. B2)	150	2
<i>Brevibacterium ammoniagenes</i>	6871	150	2
<i>Sarcina lutea</i>	9341	300	5
<i>Staphylococcus aureus</i>	6538	150	2
<i>Staphylococcus epidermidis</i>	155	150	2
<i>Streptococcus pyogenes</i>	624	600	9
Gram-Negative			
<i>Achromobacter parvulus</i>	4335	150	2
<i>Alcaligenes faecalis</i>	8750	150	2
<i>Enterobacter aerogenes</i>	3906	300	5
<i>Escherichia coli</i>	11229	300	5
<i>Flavobacterium suaveolens</i>	958	600	9
<i>Proteus vulgaris</i>	8427	300	5
<i>Pseudomonas aeruginosa</i>	15442	300	5
<i>Pseudomonas cepacia</i>	(Gibraltar 165)	50	0.75
<i>Pseudomonas fluorescens</i>	13525	150	2
<i>Pseudomonas oleoverans</i>	8062	300	5
<i>Salmonella typhosa</i>	6539	300	5
<i>Shigella sonnei</i>	9292	150	2
Fungi*			
<i>Aspergillus niger</i>	9642	600	9
<i>Aspergillus oryzae</i>	10196	300	5
<i>Chaetomium globosum</i>	6205	600	9
<i>Cladosporium resinae</i>	11274	300	5
<i>Gliocladium fimbriatum</i>	(QM 7638)	600	9
<i>Mucor rouxii</i>	(R&H L5-83)	300	5
<i>Penicillium funiculosum</i>	9644	300	5
<i>Penicillium variable</i> (glaucum)	(U.S.D.A.)	150	2
<i>Phoma herbarum</i> (pigmentivora)	12569	150	2
<i>Pullularia</i> (<i>Aureobasidium</i>) <i>pullulans</i>	9348	300	5
<i>Rhizopus stolonifer</i>	10404	300	5
<i>Trichophyton mentagrophytes</i> (<i>interdigitale</i>)	9533	300	5
<i>Candida albicans</i> (yeast)	11651	300	5
<i>Rhotorula rubra</i> (yeast)	9449	150	2
<i>Saccharomyces cerevisiae</i> (yeast)	2601	150	2

* Bacteriostatic and fungistatic tests performed by serially diluting test compounds in trypticase soy broth and 1:100 inoculation with 24-hour broth cultures of the test bacterium or a fungal spore suspension prepared from 7-14 day culture slants washed with 7 mL of deionized water. Minimum inhibitory concentration levels determined visually after 2 days incubation at 37°C for bacteria and 28-30°C for fungi.

Formulation Recommendations

Maximizing Stability

As with many chemicals, the stability of KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III preservatives may be affected by various chemical or environmental conditions. Whether stability problems develop or not depends upon a product's formulation and the degree of destabilizing influence present. The following tips will help you optimize preservative stability in your product. It is recommended that the stability of KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III preservatives be tested in specific product formulations before commercialization. Your evaluation should also consider the length of time preservation is needed.

High Temperature (above 60°C)

Avoid high temperatures for extended periods of time. KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III preservatives are best added when the temperature is below 45°C. Figure 1 shows an example of how elevated storage temperatures can affect KATHON® CG/ ICP preservative stability.

High pH (above pH 8)

Some degradation of active ingredients may occur above pH 8. The degree of degradation experienced is highly dependent on the formulation components. Preservative degradation can be minimized by:

1. Lowering the pH below 8. Optimum pH values for long-term stability are 7 or lower. Figure 2 shows the effect of pH on KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III preservative stability in deionized water.
2. Adding a divalent copper salt to the formulation at a level of copper equal to the level of KATHON® preservative active ingredients. An example of the effect of copper on KATHON® CG/ICP preservative stability in a liquid cleaner at pH 8 is shown in Figure 3.
3. When adjusting pH upward during manufacturing, it is best to use an alkali metal base (NaOH) rather than an amine base (NH₄OH, TEA, DEA, MEA). Figure 4 shows the effect of different bases on the stability of KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III preservatives in a polymeric raw material.

Figure 1. Stability of KATHON® CG/ICP Preservatives in a Fabric Softener at Two Temperatures

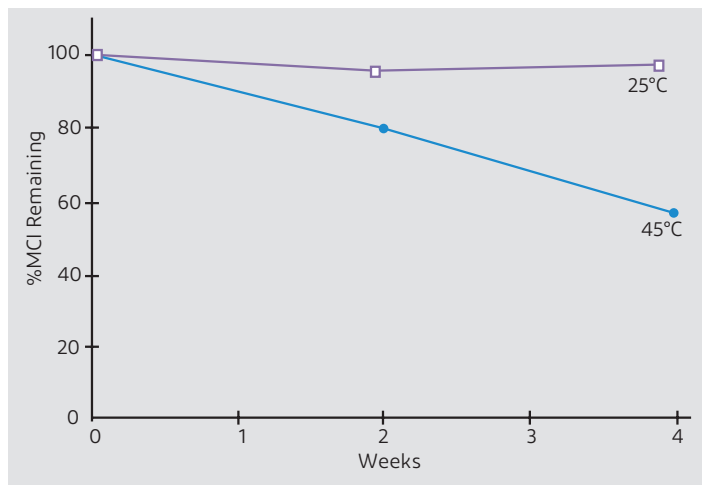


Figure 2. Stability of KATHON® CG/ICP Preservatives at Various pHs and Temperatures

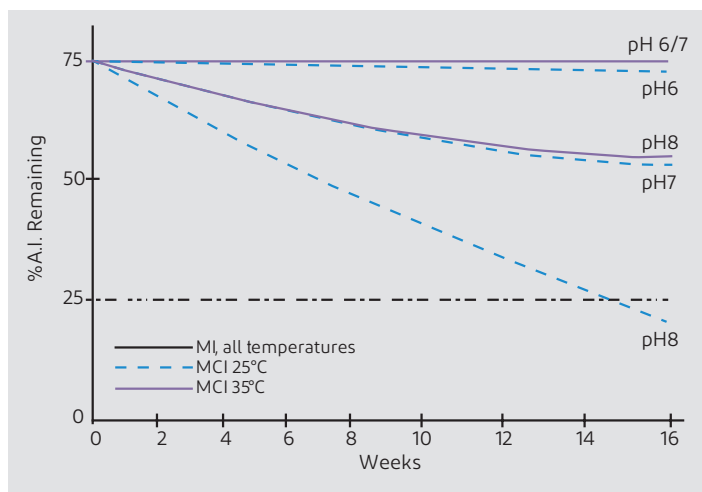
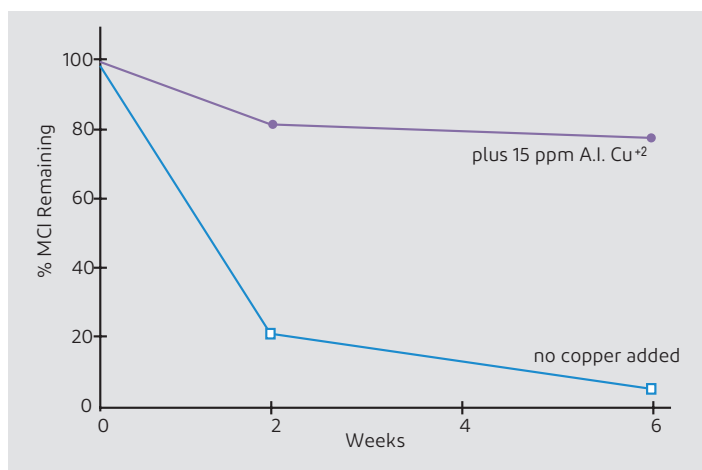


Figure 3. Stability of KATHON® CG/ICP Preservative With and Without Copper in a Liquid Cleaner at 37°C



Reducing Agents/Oxidizing Agents/Nucleophiles

Under certain conditions, reducing agents (such as sulfite, bisulfite, sulfide, mercaptan), oxidizing agents (such as sodium hypochlorite, hydrogen peroxide), and nucleophiles (such as primary and secondary amines) can deactivate some or all of the active ingredients in KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III preservatives.

The following suggestions will help prevent or reduce the severity of this reaction:

1. Remove the reducing agents or oxidizing agents by adding an appropriate level of oxidizing or reducing agent. Residual levels of such agents should be <25 ppm prior to the addition of the preservative. An example of removing a reducing agent (sulfite, in this case) and improving KATHON® CG/ICP preservative stability in a surfactant is shown in Figure 5.
2. Avoid storage of product at elevated temperatures (see Figure 1).
3. Reduce the pH of the product to less than 8, if possible. Reducing the pH protonates amine nucleophiles and greatly reduces their reactivity with KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III preservatives. Figure 6 shows the effects of pH and temperature on KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III preservative stability.
4. Reduce or remove the nucleophiles present. While the stability of KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III preservatives in the presence of nucleophiles may be improved by avoiding elevated temperatures and by reducing pH, it is also possible to improve stability by reducing nucleophile levels by using higher grade raw materials which contain lower levels of free amine, especially secondary amines. The effects of pH, temperature and raw material quality on stability in a laundry detergent are shown in Figure 7. Lower levels of DEA are present in 99% TEA versus 85% TEA. KATHON® CG/ICP stability is significantly better in the laundry detergent formulated with the purer TEA grade.
5. Add copper salts to the formulation at a level equal to the level of KATHON® preservative active ingredient (see Figure 3).
6. Increase the level of KATHON® preservative to compensate for the low level of degradation.

For additional information concerning stability and for guidelines to test the compatibility of KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III preservatives in your formulations, consult DuPont Technical Bulletins No. CS-596, "Stability in Surfactants," No. CS-607, "Determination of ppm Levels of KATHON® CG/ICP by HPLC," or contact your DuPont technical representative.

Figure 4. Effect of pH Adjusters on KATHON® CG/ICP II Preservative Stability in a Polymeric Raw Material

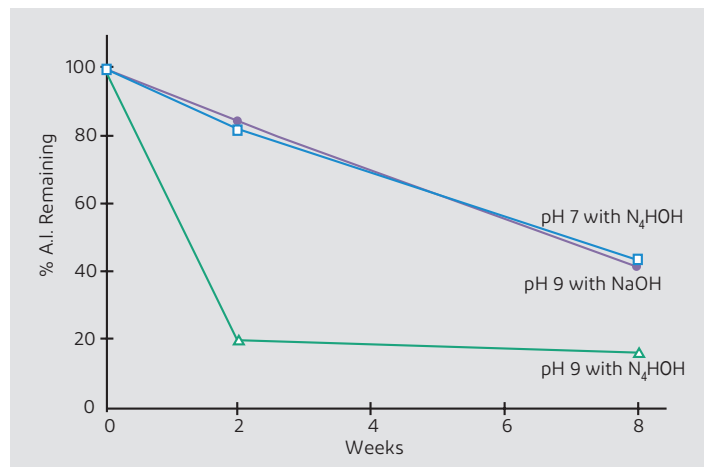


Figure 5. Stability of KATHON® CG/ICP Preservative in a Surfactant Raw Material

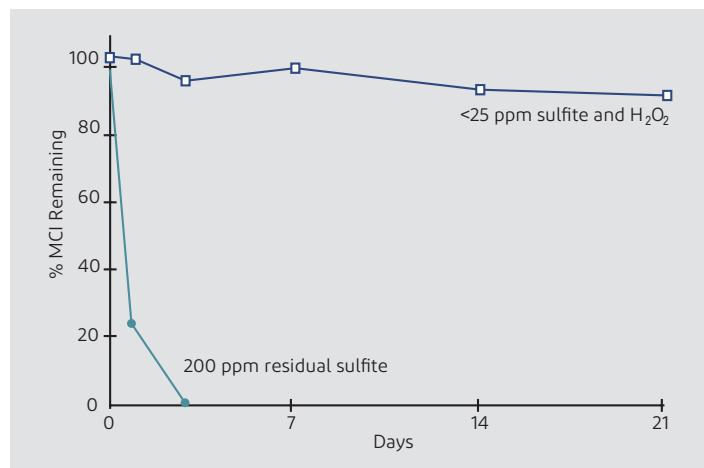


Figure 6. Stability of KATHON® CG/ICP Preservative in a Surfactant-Based Product at pH 6 and 8

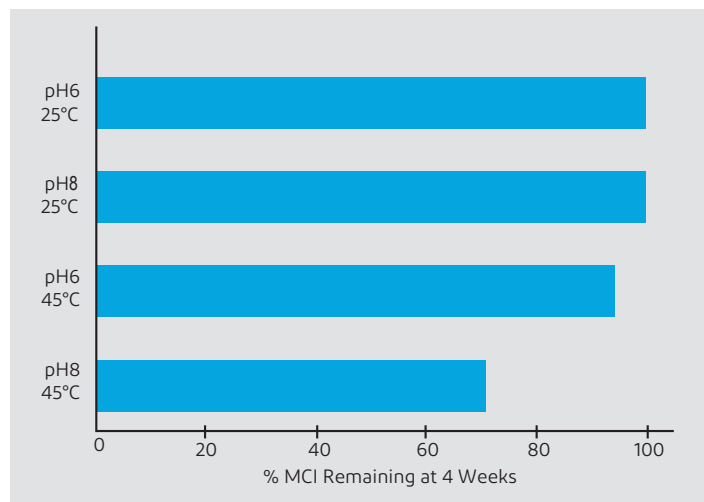
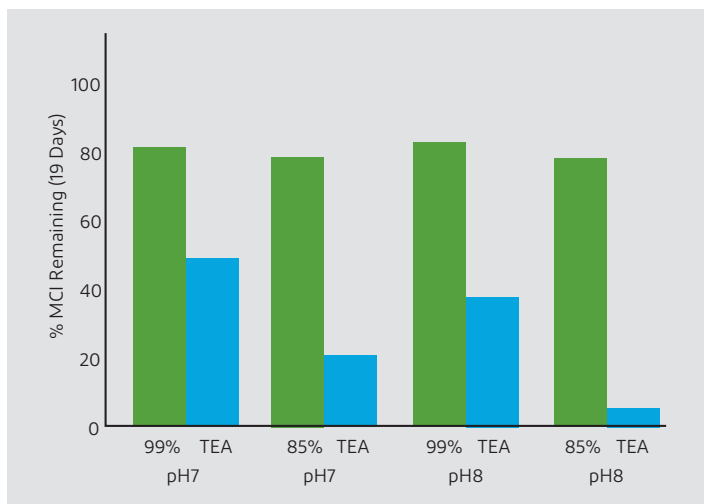


Figure 7. Effect of Nucleophiles on the Stability of KATHON® CG/ICP Preservative in a Liquid Laundry Detergent



Compatibility with Other Preservatives

The compatibility of KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III preservatives is excellent with other preservatives frequently used in household and industrial products. In addition, some preservatives, such as formaldehyde donors, can help stabilize KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III in aggressive environments. More-detailed information can be obtained from your local technical representatives.

Efficacy in Household and Industrial Products

The microbiological performance of KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III preservatives in most products is excellent. Long-term microbiological protection is obtained employing use levels up to 22.5 ppm active ingredients (0.15% product, as supplied, by weight). Typical use levels for most household and industrial products are in the range of 5 ppm to 10 ppm active ingredient. For each formulation, it is important to ensure stability of the active ingredients and assess the efficacy through a microbiological challenge test.

DuPont typically uses a 4-week challenge test with 2 inoculations of a mixed inoculum, coupled with an analysis of the active ingredients by High-Performance Liquid Chromatography (HPLC). More details of this procedure can be obtained from your nearest DuPont sales office.

Growth Rating Description for Tables 1-3

Growth Rating	Colony Forming Units/mL
0	< 10
T	10 to 100
1+	100 to 1,000
2+	1,000 to 10,000
3+	10,000 to 100,000
4+	>100,000
ND	Not Determined

Note: All data presented in the tables above for KATHON® CG/ICP preservative also apply to KATHON® CG/ICP II preservative.

Table 1. KATHON® CG/ICP Preservative Evaluation in a Dishwashing Detergent

As Supplied ppm	Active Ingredient ppm	Growth Remaining After			
		2 wks	4 wks	6 wks	8 wks
0	0	3+	4+	4+	4+
400	6	0	0	0	0
600	9	0	0	0	0
1,000	15	0	0	0	0
1,500	22.5	0	0	0	0

Table 2. Preservation of a Heavy-Duty Liquid Detergent

As Supplied ppm	Active Ingredient ppm	Growth Remaining After		
		2 wks	4 wks	6 wks
KATHON® CG/ICP Preservatives				
0	0	3+	4+	4+
300	4.5	0	0	0
600	9	0	0	0
Formalin (37%)				
0	0	3+	4+	4+
2,700	1,000	3+	4+	4+

Table 3. KATHON® CG/ICP Preservative Evaluation in a Fabric Softener

As Supplied ppm	Active Ingredient ppm	Growth Remaining After				
		2 wks	4 wks	6 wks	8 wks	10 wks
0	0	4+	4+	4+	4+	4+
200	3	0	0	0	0	0
400	6	0	0	0	0	0

Analytical Procedures

High-Performance Liquid Chromatography (HPLC) analysis is the preferred method for determining low levels (0.01-0.15%) of KATHON® CG/ICP preservatives.

This method can be used to determine KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III preservatives levels in your formulations. If you require detailed information on HPLC methods, please contact your local DuPont sales office to request our bulletin "Determination of ppm Levels of KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III by HPLC" CS-607.

Toxicology, Environmental Hazard, Deactivation and First Aid For product safety information, refer to Safety Data Sheet (SDS).

Good Manufacturing Practices

A preservative is formulated into household and industrial products principally to protect the products from chance or occasional microbial challenge during production, storage and final customer use. It should not be expected to cope with severe contamination problems brought about by poor manufacturing practices. In the manufacturing plant, it is important that all potential sources of microbial contamination are identified and controlled.

Some of the important sources of microbial contamination include:

- raw materials
- water supplies
- poor housekeeping and plant design
- poor hygiene
- inadequate cleaning and sanitization protocols
- product reworking or recycling

Good manufacturing practices, backed up by regular and effective monitoring programs, are key factors in controlling microbial contamination. For further information, please see DuPont publication, "Preventing Microbial Contamination in Manufacturing" CS-626.

Reference

The following can be obtained by contacting your local DuPont Technical Representative:

- CS-607 High-Performance Liquid Chromatographic Determination of ppm Levels of KATHON® CG/ICP, KATHON® CG/ICP II and KATHON® ICP III Preservatives
- CS-596 Stability in Surfactants
- CS-606 The Environmental Fate of KATHON® CG/ICP preservatives
- CS-632 KATHON® Preservatives—Mechanism of Action
- CS-626 Preventing Microbial Contamination in Manufacturing
- CS-649 Spill Clean-Up and Deactivation Procedure.

Handling Precautions

Please refer to the Safety Data Sheet (SDS) of this product for precise handling instructions.

The processing and use of industrial chemicals require adequate technical and professional knowledge. In general, avoid eye and skin contact, wear safety goggles, gloves and protective clothing.

In case of eye or skin contact despite precautionary measures, wash immediately and thoroughly with plenty of warm water and obtain medical attention.

The legal requirements prevailing in your country, especially on working hygiene and in the avoidance of accidents, must be observed.

Storage

Store products in tightly closed original containers at temperatures recommended on the product label.

Disposal Considerations

Dispose in accordance with all local, state (provincial) and federal regulations. Empty containers may contain hazardous residues. This material and its container must be disposed in a safe and legal manner.

It is the user's responsibility to verify that treatment and disposal procedures comply with local, state (provincial) and federal regulations. Contact your DuPont Technical Representative for more information.

Product Stewardship

When considering the use of any DuPont product in a particular application, review the latest Safety Data Sheet (SDS) and country-specific product label to ensure the intended use is within the scope of approved uses. DuPont 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 DuPont products – from the initial concept and research, to manufacture, use, sale, disposal, and recycle of each product.

Customer Notice

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



Nutrition & Biosciences

Microbial Control

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DuPont strongly encourages its customers to review both their manufacturing processes and their applications of DuPont products from the standpoint of human health and environmental quality to ensure that DuPont products are not used in ways for which they are not intended or tested. DuPont product literature, including safety data sheets, should be consulted prior to use of DuPont products. Current safety data sheets are available from DuPont. DuPont assumes no obligation and hereby DISCLAIMS ALL LIABILITY for the information in this document. References to "DowDuPont" "DuPont" or the "Company" means the DuPont legal entity selling the products to Customer unless otherwise expressly noted. Other than as set forth in a contract of sale, DUPONT MAKES NO WARRANTY, EXPRESS OR IMPLIED, AS TO THE INFORMATION AND/PRODUCTS DESCRIBED HEREIN, INCLUDING THE WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE. Use biocides safely. Always read the label and product information before use.