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PATENTS ACT 1990

PATENT REQUEST : STANDARD PATENT

I/We being the person(s) identified below as the Applicant(s), request the grant of a patent to the person(s) identified below as the Nominated Person(s), for an invention described in the accompanying standard complete specification.

Full application details follow:

[71/70] Applicant(s)/Nominated Person(s):

Rohm and Haas Company

of

100 Independence Mall West, Philadelphia, Pennsylvania, 19106-2399, United States of America

[54] Invention Title:

Stabilization of 3-isothiazolone solutions

[72] Name(s) of actual inventor(s):

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Basic Convention Application(s) Details:

[31] Application Number	[33] Country	Code	[32] Date of Application
08/355759	United States of America	US	14 December 1994

DATED this TWENTY FIRST day of SEPTEMBER 1995

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a member of the firm of DAVIES COLLISON CAVE for and on behalf of the applicant(s)

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NOTICE OF ENTITLEMENT

We, **Rohm and Haas Company**, the applicant/Nominated Person named in the accompanying Patent Request state the following:-

The Nominated Person is entitled to the grant of the patent because the Nominated Person derives title to the invention from the inventors by assignment.

The Nominated Person is entitled to claim priority from the basic application listed on the patent request because the Nominated Person is the assignee of the applicants in respect of the basic application.

DATED this TWENTY FIRST day of SEPTEMBER 1995

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a member of the firm of
DAVIES COLLISON CAVE
for and on behalf of the
applicant(s)

(DCC ref: 1772849)

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(54) Title
STABILIZATION OF 3-ISOTHIAZOLONE SOLUTIONS

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(56) Prior Art Documents
US 5160527
US 5364649
US 5242223

(57) Claim

1. A composition comprising a solution of 5-chloro-2-methyl-3-isothiazolone and/or 2-methyl-3-isothiazolone in water, which further comprises non-chelated copper ion in the form of a copper salt other than an organic carboxylic acid of at least six carbon atoms, nitrate, nitrite or citrate, the weight ratio of non-chelated copper ion to total 3-isothiazolone being from 0.0008:1.5 to 0.02:1.5, said solution being substantially free of nitrate, nitrite and magnesium.

6. A method of stabilizing a solution of 5-chloro-2-methyl-3-isothiazolone and/or 2-methyl-3-isothiazolone in water against chemical decomposition, comprising incorporating therewith 0.02 to 0.0008 parts by weight of non-chelated copper ion in the form of a copper salt other than an organic carboxylic acid of at least 6 carbon atoms, nitrate, nitrite or citrate, per 1.5 parts by weight of total 3-isothiazolone, wherein said solution is substantially free of nitrite, nitrate and magnesium.

7. A method according to claim 1, wherein the concentration of total 3-isothiazolone in solution is from 0.5 to 5 parts by weight per 100 parts by weight solution.

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COMPLETE SPECIFICATION

NAME OF APPLICANT(S):

Rohm and Haas Company

ADDRESS FOR SERVICE:

DAVIES COLLISON CAVE
Patent Attorneys
1 Little Collins Street, Melbourne, 3000.

INVENTION TITLE:

Stabilization of 3–isothiazolone solutions

The following statement is a full description of this invention, including the best method of performing it known to me/us:–

This invention relates to stabilization of dilute solutions of 3-isothiazolones and their use in cosmetics.

Both 5-chloro-2-methyl-3-isothiazolone ("CMI") and 2-methyl-3-isothiazolone ("MI") are well known microbicides which have achieved commercial success in a range of applications. Particularly successful is a mixture of CMI and MI in an approximate ratio of 3:1. These isothiazolones are naturally unstable and much research has been devoted to stabilizing them in various solutions: (1) "Concentrates", which are about 14 to 25% by weight aqueous solutions of CMI and MI; (2) "Dilute Solutions", which are about 0.5 to 5% by weight aqueous solutions of CMI and MI which are designed to be further diluted when added to a locus; and (3) "Use Dilutions", which are the end use dilution in the locus to be protected and comprise substantially less than 1% by weight CMI and MI. Each of these solutions presents special challenges to stabilization of CMI and MI. Concentrates and Dilute Solutions are sold commercially and are diluted and incorporated in loci as Use Dilutions.

1.5% Dilute Solutions are usually stabilized either with high levels magnesium nitrate (23%); with a combination of low levels of magnesium nitrate (1.5-5%) and very low levels of copper nitrate (0.037-0.14% as copper ion); or with a combination of low levels of magnesium nitrate (1.5-5%) and 0.6% hydrogen peroxide. 4% Dilute Solutions of mixtures of CMI and MI are stabilized with both 4.6% magnesium nitrate and 4% copper sulfate.

U.S. Reissue No. 34,185 teaches that non-aqueous solutions of 3-isothiazolones can be stabilized against chemical decomposition by using organic hydroxylic solvents, such as ethylene glycol. JP 02-304005 discloses non-aqueous compositions of mixtures of CMI and MI in ethylene glycol and an anionic surfactant that comprise low levels of copper ion to protect the isothiazolone against attack by the surfactant. CMI and MI are stable in ethylene glycol alone (see Example 7 below): this reference does not teach the applicability of copper ion to stabilize isothiazolones against chemical decomposition in systems that have 100% water as the solvent.

When 3-isothiazolone dilute solutions stabilized with high levels of magnesium nitrate (23%) are added to latices, for example, the high salt level can cause coagulation of the latices. Nitrates also cause problems. There is a concern about nitrates in certain applications where amines may be present because of the possibility of nitrosamine formation. Even as little as 0.14% copper nitrate is a concern in some countries due to limits on the amount of copper permitted in water discharge streams.

We have discovered that aqueous solutions of CMI and/or MI can be stabilised by very low levels of copper ion without the need for nitrite, nitrate, or magnesium. These "salt free" extremely low level copper-stabilized compositions are especially useful to protect cosmetic compositions.

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Accordingly a first aspect of the invention provides a composition comprising a solution of 5-chloro-2-methyl-3-isothiazolone and/or 2-methyl-3-isothiazolone in water, which further comprises non-chelated copper ion in the form of a copper salt other than an organic carboxylic acid of at least six carbon atoms, nitrate, nitrite or citrate, the weight ratio of non-chelated copper ion to total 3-isothiazolone being from 0.0008:1.5 to 0.02:1.5, said solution being substantially free of nitrate, nitrite and magnesium.

A further aspect of the invention provides a method of stabilizing a solution of 5-chloro-2-methyl-3-isothiazolone and/or 2-methyl-3-isothiazolone in water against chemical decomposition, comprising incorporating therewith 0.02 to 0.0008 parts by weight of non-chelated copper ion in the form of a copper salt other than an organic carboxylic acid of at least 6-carbon atoms, nitrate, nitrite or citrate, per 1.5 parts by weight of total 3-isothiazolone, wherein said solution is substantially free of nitrite, nitrate and magnesium.

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The preferred concentration of the 3-isothiazolone compound(s) in solution is 0.5 to 5 parts by weight per 100 parts by weight solution. The most preferred concentration of the 3-isothiazolone compound(s) in solution is 1 to 2 parts by weight per 100 parts by weight solution.

The CMI and MI may be used either alone or in admixture. When in admixture, the preferred ratio of CMI to MI is from about 90:10 to 2:98. Especially preferred is a ratio of 75:25 to 80:20.

A wide variety of copper salts are known in the art. Any copper salt which is sufficiently water soluble to provide the desired level of copper ion in solution may be used. Suitable examples are copper sulfate, copper acetate, copper chloride, copper bromide, copper chlorate, copper perchlorate, and the like. Copper sulfate is preferred.

Typically, the ratio of copper ion to 3-isothiazolone compound(s) is from about 1:1000 to about 1:60. Less copper ion is needed at lower 3-isothiazolone concentrations than at higher concentrations. As the concentration of the isothiazolone is increased, proportionally more copper ion is required to achieve the same stability. For example, a ratio of copper ion to 3-isothiazolone compound(s) of 1:1000 is sufficient to stabilize a 1.5% 3-isothiazolone dilute solution, while a ratio of 1:60 is needed for 5% 3-isothiazolone dilute solutions to achieve equivalent stability (although less would achieve stability too, albeit a lower degree).

The compositions of the invention are prepared by mixing the isothiazolone, water, and copper salt in any order.

The term microbicide includes bactericides, fungicides, and algaecides. Microbicidal or biocidal activity is intended to include both the elimination of and inhibition of growth of microbial organisms, such as bacteria, fungi, and algae.

Uses of these stabilized microbicides are typically at any locus subject to contamination by bacteria, fungi, yeast or algae. Typically, loci are in aqueous systems such as cooling water systems, laundry rinse water, oil systems such as cutting oils, lubricants, oil fields and the like, where microorganisms need to be killed or where their growth needs to be controlled. However, these stabilized microbicides may also be used in all applications for which known microbicidal compositions are useful; preferred utilities of the compositions of the invention are to protect wood, latex, adhesive, glue, paper, textile, leather, plastics, cardboard, caulking, feed, cosmetics; e.g. shampoos, conditioners, lotions, and creams; household products; e.g. dish detergents, floor waxes, cleaning products, etc.

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Because isothiazolones are so active as microbicides and only low levels of copper ion are required to achieve stabilization, the amount of copper ion in systems being treated will be very low, and therefore it is not likely to interfere with other components in systems requiring protection or with systems to which protected systems will be applied.

It is known in the art that the performance of microbicides may be enhanced by combination with one or more other microbicides. Thus, other known microbicides may be combined advantageously with the composition of this invention.

In the following examples, the 3-isothiazolones used were an approximate 3:1 mixture of CMI and MI (96.5% pure) containing no stabilizer, and the level of copper reported in parts per million ("ppm") is the level of copper(II) ion. Samples were considered stable when 80% of CMI remained after 4 weeks storage at 55°C. All samples were analyzed by HPLC with UV detection.

Example 1

To each of three 30 ml screw cap, glass vials, samples 1-1, 1-2 and 1-3, were added 0.16 g of 3-isothiazolones. To sample 1-1 were further added 0.008 g of copper sulfate (equivalent to 200 ppm copper ion) and 9.83 g of deionized ("DI") water and to sample 1-2 were added 0.003 g of copper sulfate (equivalent to 77 ppm copper ion) and 9.83 g of DI water. Sample 1-3 was comparative and contained only the 3-isothiazolones and 9.84 g of DI water. These samples contained 1.5% 3-isothiazolones by weight. The samples were capped, manually shaken to dissolve the salts and stored in an oven at 55°C. The samples were analyzed for remaining CMI after 1, 2, 4, and 6 weeks of storage. The results are reported below.

Table 1

		% CMI Remaining			
Sample	Copper (ppm)	1 Week	2 Weeks	4 Weeks	6 Weeks
1-1	200	99	98	95	95
1-2	77	100	98	94	94
1-3*	0	0	-	-	-

* = comparative

These data show that low levels of copper stabilize dilute solutions of 3-isothiazolones without the need for additional stabilizers.

Example 2

This example demonstrates the stabilizing effect of low levels of copper ion. A 1% Cu^{2+} stock solution was prepared by adding 0.196 g of copper sulfate to 5.0 g DI water in a 30 ml screw cap, glass vial. The samples were prepared by adding 0.16 g of 3-isothiazolones to each of four 30 ml screw cap, glass vials, samples 2-1 to 2-4. To sample 2-1 was further added 9.74 g DI water and 0.10 g of the 1% Cu^{2+} stock solution (equivalent to 100 ppm of copper ion), to sample 2-2 was further added 9.79 g DI water and 0.05 g of the 1% Cu^{2+} stock solution (equivalent to 50 ppm of copper ion), and to sample 2-3 was further added 9.82 g DI water and 0.02 g of the

1% Cu^{2+} stock solution (equivalent to 20 ppm of copper ion). Sample 2-4 was comparative (no copper stabilizer) and only 9.84 g of DI water were added to the sample. All the samples contained 1.5% 3-isothiazolone by weight. The samples were capped, stored in an oven at 55° C and analyzed for remaining CMI after 1, 2, 3, and 4 weeks of storage. The results are reported below.

Table 2

		% CMI Remaining			
Sample	Copper (ppm)	1 Week	2 Weeks	3 Weeks	4 Weeks
2-1	100	100	100	98	97
2-2	50	99	98	96	95
2-3	20	99	96	93	92
2-4*	0	0	-	-	-

* = comparative

From these data it can be seen that very low levels of copper ion are sufficient to stabilize dilute solutions of 3-isothiazolones.

Example 3

A 0.1% Cu^{2+} stock solution was prepared in a 30 ml screw cap, glass vial by adding 0.038 g of copper sulfate and 9.962 g DI water The samples were prepared by adding 0.16 g of 3-isothiazolones to each of two 30 ml screw cap, glass vials. To sample 3-1 was further added 0.15 g of the 0.1% Cu^{2+} stock solution (equivalent to 15 ppm of copper ion) and 9.69 g DI water. To sample 3-2 was further added 0.10 g of the 0.1% Cu^{2+} stock solution (equivalent to 10 ppm copper ion) and 9.74 g DI water. Both samples contained 1.5% 3-isothiazolone by weight. The samples were capped, stored in an oven at 55°C and analyzed for remaining CMI after 2, 3, and 4 weeks of storage. The results are reported below.

Table 3

		% CMI Remaining		
Sample	Copper (ppm)	2 Weeks	3 Weeks	4 Weeks
3-1	15	93	88	82
3-2	10	92	68	NA

NA = not analyzed

These data show that a ratio of copper ion to 3-isothiazolone of 1:1000 provides sufficient stability for 1.5% 3-isothiazolone dilute solutions.

Example 4

A sample was prepared by adding 2.50 g of the 0.1% Cu^{2+} stock solution prepared in Example 3, 6.98 g DI water and 0.52 g of 3-isothiazolones. This sample contained 5% 3-

isothiazolone by weight and 250 ppm of copper ion. The sample was capped, stored in an oven at 55° C and analyzed after 2, 3, and 4 weeks storage. The results are reported below.

Table 4

		% CMI Remaining		
Sample	Copper (ppm)	2 Weeks	3 Weeks	4 Weeks
4-1	250	90	84	65

These data show that higher ratios of copper ion to 3-isothiazolone are needed to sufficiently stabilize 5% 3-isothiazolone dilute soltions than are needed for 1.5% 3-isothiazolone dilute solutions.

Example 5

This example demonstrates the superior stabilizing effects of low levels of copper ion over the prior art. A dilute copper sulfate solution was prepared by dissolving 0.0196 g of copper sulfate in 4.984 g DI water in a 30 ml glass vial to yield a 0.10% copper ion solution. Sample 5-1 was prepared by adding 0.77 g of the dilute copper sulfate solution to a 30 ml screw cap, glass vial along with 9.07 g DI water and 0.16 g of 3-isothiazolones. This gave a sample with 77 ppm copper ion and 1.5% 3-isothiazolones. Sample 5-2 was prepared by adding 2.77 g of magnesium nitrate (64% anhydrous), 5.99 g DI water and 1.24 g 3-isothiazolones to a 30 ml screw cap, glass vial. This sample represented a commercial concentrate and had 12% 3-isothiazolones and 16% magnesium nitrate as stabilizer. Sample 5-3 was prepared by adding 0.26 g magnesium nitrate (64% anhydrous), 9.58 g DI water and 0.16 g 3-isothiazolones to a 30 ml screw cap, glass vial. This sample represented a dilute solution made by simply diluting a commercial concentrate sample and had 1.5% 3-isothiazolones and 1.5% magnesium nitrate as stabilizer. Sample 5-4 was prepared by adding 3.98 g of magnesium nitrate (64% anhydrous), 5.86 g of DI water and 0.16 g 3-isothiazolones to a 30 ml screw cap, glass vial. This sample represented a commercial sample of a stable dilute solution and had 1.5 % 3-isothiazolones and 23% magnesium nitrate as stabilizer.

All samples were capped, shaken, and stored in an oven at 40°C. The samples were analyzed for remaining CMI after 1, 2, 3, and 4 weeks storage. The results are reported below.

Table 5

			% CMI Remaining			
Sample	% ITA	% $Mg(NO_3)_2$	1 Week	2 Weeks	3 Weeks	4 Weeks
5-1	1.5	-	100	100	96	99
5-2*	12	16	101	100	96	95
5-3*	1.5	1.5	80	68	57	52
5-4*	1.5	23	101	100	96	102

* = comparative

Throughout this specification and the claims which follow, unless the context requires otherwise, the word "comprise", and variations such as "comprises" and "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

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These data show that when a 3-isothiazolone concentrate sample is diluted to form a dilute solution, additional stabilizer is required to achieve the desired stability. It was unexpected that such a low level of copper ion would be able to stabilize an isothiazolone dilute solution absent other stabilizers, such as magnesium nitrate.

Example 6

This example demonstrates the effect of higher levels of copper ion as a stabilizer for 3-isothiazolones. Sample 6-1 was prepared by adding 0.59 g copper sulfate (64% anhydrous), 8.17 g DI water and 1.24 g 3-isothiazolone to a 30 ml glass, screw cap vial. Sample 6-2 was prepared by adding 8.76 g DI water and 1.24 g 3-isothiazolone to a 30 ml glass, screw cap vial. The vials were capped, shaken and stored in an oven at 40° C. Sample 6-1 contained 12% 3-isothiazolone and 1.5% (15000 ppm) Cu^{2+} ion. Sample 6-2 contained 12% 3-isothiazolone and no copper. The samples were analyzed at various time points and the results reported below.

Table 6

		% CMI Remaining			
Sample	ppm Cu^{+2}	1 Week	2 Weeks	3 Weeks	4 Weeks
6-1	15000	16	1	NA	NA
6-2	-	96	87	80	73

NA = not analyzed

These results show that higher levels of copper ion are antagonistic to the stability of the 3-isothiazolones.

Example 7 (Comparative)

This example demonstrates that non-aqueous, ethylene glycol solutions of 3-isothiazolones are stable. Sample 7-1 was prepared by adding 8.76 g ethylene glycol and 1.24 g 3-isothiazolone to a 30 ml glass, screw cap vial. Sample 7-2 was prepared by adding 9.84 g ethylene glycol and 0.16 g 3-isothiazolone to a 30 ml glass, screw cap vial. The vials were capped, shaken and stored in an oven at 40° C. Sample 7-1 contained 12% 3-isothiazolone in ethylene glycol with no water or copper ion. Sample 7-2 contained 1.5% 3-isothiazolone and no water or copper ion. The samples were analyzed at various time points and the results reported below.

Table 7

	% CMI Remaining			
Sample	1 Week	2 Weeks	3 Weeks	4 Weeks
7-1	102	104	106	104
7-2	101	100	92	89

These data show that non-aqueous, ethylene glycol solutions of 3-isothiazolones are stable, and therefore that the copper ions present in JP 02 304005A mentioned above are not necessary for stabilisation against decomposition by this non-aqueous solvent.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A composition comprising a solution of 5-chloro-2-methyl-3-isothiazolone and/or 2-methyl-3-isothiazolone in water, which further comprises non-chelated copper ion in the form of a copper salt other than an organic carboxylic acid of at least six carbon atoms, nitrate, nitrite or citrate, the weight ratio of non-chelated copper ion to total 3-isothiazolone being from 0.0008:1.5 to 0.02:1.5, said solution being substantially free of nitrate, nitrite and magnesium.

2. A composition according to claim 1, wherein the concentration of total 3-isothiazolone in solution is from 0.5 to 5 parts by weight per 100 parts by weight solution.

3. A composition according to claim 2, wherein the concentration of total 3-isothiazolone in solution is from 1 to 2 parts by weight per 100 parts by weight solution.

4. A composition according to any preceding claim wherein the copper salt comprises copper sulfate, copper acetate, copper chloride, copper bromide, copper chlorate or copper perchlorate.

5. A composition according to claim 4 wherein the copper salt comprises copper sulfate.

6. A method of stabilizing a solution of 5-chloro-2-methyl-3-isothiazolone and/or 2-methyl-3-isothiazolone in water against chemical decomposition, comprising incorporating therewith 0.02 to 0.0008 parts by weight of non-chelated copper ion in the form of a copper salt other than an organic carboxylic acid of at least 6 carbon atoms, nitrate, nitrite or citrate, per 1 5 parts by weight of total 3-isothiazolone, wherein said solution is substantially free of nitrite, nitrate and magnesium.

7. A method according to claim 1, wherein the concentration of total 3-isothiazolone in solution is from 0.5 to 5 parts by weight per 100 parts by weight solution.

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8. A method according to claim 2, wherein the concentration of total 3-isothiazolone in solution is from 1 to 2 parts by weight per 100 parts by weight solution.

9. A method according to any preceding claim wherein the copper salt comprises copper sulfate, copper acetate, copper chloride, copper bromide, copper chlorate or copper perchlorate.

10. A method according to claim 4 wherein the copper salt comprises copper sulfate.

11. An isothiazolone solution composition substantially as hereinbefore described with reference to the Examples, excluding the comparative examples.

12. A method of stabilizing an isothiazolone solution substantially as hereinbefore described with reference to the Examples, excluding the comparative examples.

DATED this 30th day of April 1998

ROHM AND HAAS COMPANY

By its patent attorneys
DAVIES COLLISON CAVE

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ABSTRACT

The present invention provides a method of stabilizing solutions of 3-isothiazolone compound(s) selected from the group consisting of 5-chloro-2-methyl-3-isothiazolone, 2-methyl-3-isothiazolone, and mixtures thereof in water free of nitrate or nitrite by the use of extremely low levels of copper ion, and compositions comprising water solutions of 3-isothiazolone compound(s) selected from the group consisting of 5-chloro-2-methyl-3-isothiazolone, 2-methyl-3-isothiazolone, and mixtures thereof, and extremely low levels copper ion.