

Description

The present invention relates to a method of inhibiting the formation of nitrosamines and nitrites, especially during the preparation and/or storage of amine oxides, an amine oxide composition containing a stabiliser and an proved process for the preparation of tertiary amine oxides.

Amine oxides are conventionally prepared by reacting a tertiary amine with hydrogen peroxide. In order to complete the reaction within a commercially acceptable time it is necessary to heat the reaction mixture and/or to employ a catalyst. Since excessive heating tends to cause (or accelerate) the decomposition of peroxide, the use of a catalyst is preferred.

It has been suggested, e.g. in US 3 333 000 that a mixture comprising sodium bicarbonate in concentrations of from 0.02 to 2% by weight of the amine together with sodium pyrophosphate will catalyse the reaction. In practice, concentrations of bicarbonate in the lower part of the range, i.e. below 1% by weight of the amine were found sufficient to catalyse the reaction and higher concentrations were avoided, so as not to leave any substantial residue of bicarbonate in the product.

Subsequently it has been found that carbon dioxide is a very effective catalyst and its use has now replaced that of sodium bicarbonate (see, for instances GB 2 032 422, FR 2 632 638 or US 4 247 480).

EP 0 409 043 described the use of certain aminophosphonates as catalysts in the preparation of amine oxides.

It has been recognised for some years that nitrosamines, which are widely regarded as being potentially harmful, and nitrites, which may be precursors of nitrosamines are commonly present as minor, but undesirable, trace contaminants of amine oxides. These contaminants are conventionally present in commercial amine oxides at very low levels of between 200 and 1000 parts per billion.

Until recently, such levels have been at or below the limits of detection. However, improved analytical methods, for instance based on chemiluminescence, have now made it possible to detect total nitrosamine and nitrite (referred to herein as "total NO") down to 10 parts per billion, or lower. This is considerably less than normal ambient atmospheric levels.

There is now a pressing demand for products containing less than 50ppb total NO. It is likely that lower levels still would be demanded if they were thought to be achievable. It is an object of our invention to provide amine oxide products containing less than 50ppb total NO preferably less than 20ppb and most preferably less than 10ppb.

A particular problem arises because nitrosamine levels, even in products prepared containing low initial concentrations of total NO, have been found to increase during aging especially at elevated temperatures. A particular object of the invention is therefore to stabilise amine oxides so as to maintain the aforesaid low levels of total NO during storage.

It has been found possible, in theory, to obtain very low levels of total NO by controlling the ratio of peroxide to amine and using highly pure reagents and process water which exclude dissolved polyvalent metal ions. However, the conditions are so sensitive that it is not possible in industrial practice to obtain consistently low total NO levels by this approach. The products moreover are not stabilised against the accumulation of NO on storage.

GB 2 252 320, a document relevant under Articles 54(3) and 54(4) EPC, describes the use of relatively high concentrations of carbonates and/or bicarbonates (greater than 2.5% by weight of the amine) to inhibit the formation of nitrosamines, both initially during the oxidation of amines and, subsequently, to stabilise the product. However, to achieve consistently low levels of total NO using bicarbonates, the amount of bicarbonate required may result in levels of inorganic impurity in the product which are unacceptable to some customers.

EP 409 043 discloses the use of alkyleneaminopoly (methylene phosphonic acid) or water soluble salts thereof in reducing or suppressing nitrosamine formation during the reaction of secondary or tertiary amines with hydrogen peroxide.

A method for increasing the rate of reaction of a tertiary amine with hydrogen peroxide by incorporating a catalytic amount of ammonium bicarbonate or ammonium carbonate or mixtures thereof in the system is described in EP 424 965.

DE 1 518 104 relates to a method for preparing a tertiary amine oxide by reacting a tertiary amine with hydrogen peroxide in the presence of a catalytic amount of an alkali metal bicarbonate and/or an alkali metal phosphate.

We have now discovered that bicarbonates and/or carbonates are synergistic with phosphonates such as organoamino ethylene phosphonates, and their oxides, in inhibiting the formation of nitrosamines and nitrites during the preparation and/or storage of amine oxides. They may in some circumstances assist in lowering the nitrosamine content of a previously contaminated sample.

The present invention provides the use of a synergistic mixture of a carbonate and/or bicarbonate with a phosphonate to inhibit or to reduce nitrosamine contamination in products which are susceptible to contamination with nitrosamine.

The present invention further provides a method stabilising an amine oxide in order to inhibit the formation of nitrosamines and nitrites during preparation, storage and/or heating by adding thereto a synergistic stabiliser comprising:

- (i) from 0.05% to 20% by weight (based on the weight of amine used to prepare the amine oxide) of a bicarbonate and/or a carbonate; and
- (ii) from 0.005% to 5% by weight (based on the weight of amine used to prepare the amine oxide) of a phosphonic acid or its salts, in which (i) and (ii) are added either separately or together to the amine oxide before, during or after the preparation thereof.

The present invention also provides a composition comprising an amine oxide and a synergistic stabiliser comprising from 0.05% to 20% by weight (based on the weight of amine used to prepare the amine oxide) of a bicarbonate and/or a carbonate and from 0.005% to 5% by weight (based on the weight of amine used to prepare the amine oxide) of a phosphonic acid or a salt thereof.

The present invention further provides a method for the preparation of an amine oxide which comprises reacting a tertiary amine with hydrogen peroxide in the presence of a synergistic stabiliser comprising an amount greater than 0.05% by weight (based on the weight of the amine) of a bicarbonate and/or a carbonate and an amount greater than 0.005% by weight of an alkylamino phosphonate such as a polyalkylene amine methylene phosphonate, said amount being sufficient substantially to inhibit nitrosamine and nitrite formation.

The bicarbonate and/or carbonate component(i) may suitably comprise a bicarbonate such as sodium bicarbonate. Alternatively, other water soluble bicarbonates, eg, alkali metal bicarbonates such as potassium bicarbonate or lithium bicarbonate, or alkaline earth metal bicarbonates such as magnesium or calcium bicarbonate may be present.

Preferably, component (i) may comprises a carbonate such as an alkali metal, alkaline earth metal or ammonium carbonate, eg, sodium, magnesium or calcium carbonate, or a mixture of bicarbonate and carbonate, eg, in a molar ratio of from 0.01:1 to 1:0.01 especially 1:1, provided that, if the carbonate is added to the reaction mixture, the pH is not high enough to cause significant decomposition of the hydrogen peroxide during the preparation of amine oxides. E.g. we prefer that the pH of the reaction mixture during the preparation of the amine oxide should be less than 10, preferably less than 9.8, typically less than 9.5. However, when the stabiliser is added to the product after preparation, such a constraint does not arise and therefore higher pH values may be tolerated depending on the desired end use. In a preferred embodiment, if carbonate and/or bicarbonate species are present in the reaction mixture but the pH of the mixture is carefully controlled, eg less than 10, more preferably less than 9.8, typically less than 9.5 for example by the use of dilute acids, excessive decomposition of the peroxide is avoided. Furthermore, at completion of the reaction when maintaining a weakly alkaline pH is not critical, the pH of the reaction mixture can be raised to promote the stability of the sample. We prefer the pH of the product to be raised by, for example an alkali or alkaline metal hydroxide solution, eg sodium hydroxide solution to a pH of 9.5-12.0, preferably 10-11.5, more preferably 10.3-11.2.

The phosphonate (ii) is preferably an organoamino methylene phosphonate of the formula $RR'NCH_2PO_3M_2$, wherein: R and R' may each be separately selected from a $CH_2PO_3M_2$ group, a C_{1-12} , (preferably C_{1-4}) alkyl group, an amino, hydroxy, phosphono or carboxy substituted C_{1-6} (preferably C_{1-4}) alkyl group, or a group of the formula $H[O(CH_2)_m]_n$ or $M_2O_3PCH_2[NCH_2PO_3M_2(CH_2)_m]_n$; each M is hydrogen or a cation such that the composition is water soluble; and n is from 1 to 6 and each m is 2 to 6; or an N-oxide thereof.

Preferably R is a methylenephosphonate group and R' is a polyethylenemino poly (methylenephosphonate) group, e.g. wherein n is from 1 to 5 preferably 2 to 4, or an ethylene or hydroxy ethylene group. Where the amino phosphonate is added to the reaction mixture during the preparation of the amine oxide, the amino phosphonate stabiliser will normally be converted to the corresponding oxide in situ. Examples of suitable amino methylenephosphonate include sodium amino tris (methylenephosphonate), amino tris (methylenephosphonate) N-oxide or preferably sodium diethylenetriamine penta (methylenephosphonate) or sodium tetraethylenepentamine hepta (methylenephosphonate), available respectively as BRIQUEST 301-32S, BRIQUEST 3010-25s, BRIQUEST 543-25S and BRIQUEST 785-25S.

(The word BRIQUEST is a Registered Trade Mark). Our copending application of even date describes the use of ethanolamine bis (methylenephosphonic acid) and its salts as a particularly effective means of inhibiting the formation of nitrosamine during preparation. Accordingly we prefer to use this product, which

is available under the Registered Trade Mark BRIQUEST 221, as a nitrosamine inhibitor for the reaction mixture. We particularly prefer to use a combination of ethanolamine bis (methylenephosphonate) and diethylenetriamine penta (methylenephosphonate) the latter being added either with the former or after preparation.

5 Although we prefer that at least part of the synergistic stabilisers be present initially during the preparation of the amine oxide, it is possible to add some or all of the mixture, or of either component, during or after the preparation. In particular the poly(ethyleneamino) poly (methylenephosphonates) are especially effective for stabilising the product if added after the preparation.

10 The component (i) is preferably present in a total proportion of from 0.1 to 20% by weight based on the weight of amine used to prepare the product, preferably at least 0.5 e.g. at least 1% especially more than 2% in order to achieve effective catalysis and inhibition. We prefer that the proportion of carbonate be as low as possible consistent with adequate catalysis and inhibition in order to minimise inorganic impurities, i.e. less than 12%, preferably less than 8%, all % being based on the weight of amine used. An amount
15 these concentrations will equate to a concentration of from 0.05 to 10% based on the total composition e.g. 0.1 to 5, especially 0.75 to 4%.

The component (ii) is typically present in an amount of from 0.005 to 10% by weight based on the weight of amine used, more preferably 0.05 to 5% e.g. 0.1 to 3% especially 0.2 to 2%.

20 The proportion by weight of (i) to (ii) is usually between 1:0.001 and 1:10, preferably 1:0.01 to 1:2 especially 1:0.02 to 1:1 e.g. 1:0.05 to 1:0.5.

The preparation of the amine oxide is preferably carried out in a conventional manner by reacting a tertiary amine with aqueous hydrogen peroxide. The peroxide may be present in a substantially equimolar amount based on the amine or in a (preferably very small) stoichiometric excess, e.g. in ratio of 1:0.9, amine to peroxide, to 1:1.1. The excess of peroxide is preferably less than 0.05% based on the
25 stoichiometric weight.

The amines that may be used in the process of our invention are typically amines of the general formula $R^1 R^2 R^3 N$, wherein R^1 , R^2 and R^3 represent straight or branched chain alkyl groups, alkenyl groups or aralkyl groups which may be the same or different. They may be lower alkyl groups, i.e. of from 1 to 7, preferably 1 to 4, carbon atoms, but in a preferred embodiment of this invention, the tertiary amines may
30 instead be represented by the general formula $(R)_m (R^1)_n N$, wherein $m = 1$ or 2 and $n = (3-m)$.

The R groups, which may be the same or different, represent in this case C_6-C_{24} alkyl or alkyl groups, C_6-C_{24} alkyl or alkenyl polyalkyleneoxy groups, C_7-C_{23} esteralkyl or ester alkenyl groups, amidoalkyl or amidoalkenyl groups, and the R^1 groups, which may also be the same or different, represent C_1-C_4 alkyl, alkoxy or hydroxyalkyl, or polyalkyleneoxy groups.

35 The alkyleneoxy groups are preferably polyethyleneoxy groups or polypropyleneoxy or mixed ethyleneoxy propyleneoxy groups containing between 1 and 20 ethyleneoxy and/or propyleneoxy groups. The amidoalkyl groups are preferably C_7-C_{23} alkyl or alkenyl-amidopropyl groups.

The amines may alternatively comprise cyclic amines such as imidazolines or pyridines, N-substituted piperazines, or N-substituted morpholines, e.g. N-methyl morpholine.

40 The process of this invention is typically carried out in aqueous solution. Optionally, a non phosphonate sequestrant such as EDTA may be used in the preparation which prevents decomposition of the hydrogen peroxide by chelating the metal ions which catalyse its decomposition. Alternative sequestrants include other chelating agents such as pyrophosphate. We prefer that such transition metal chelants or sequestrants should be present if the phosphonate is added after the commencement of the preparation. They
45 accelerate the reaction but do not have any significant effect on the nitrosamine levels.

The required concentration of product depends on the particular tertiary amine starting material employed, since those that are preferred for this invention give rise to oxide products with surfactant properties which form a mobile L_1 phase at concentrations up to about 30% by weight based on total weight of reaction mixture, subject to exact chemical nature. At higher concentrations the amine oxide
50 products tend to form an immobile M phase. Preferably, water is added to the reaction vessel in the form of aqueous hydrogen peroxide such that the final concentration of product attained is mobile. It is possible at high concentrations, e.g. 60 to 80% amine oxide (by weight based on total weight of reaction mixture to form a mobile G phase. This option is, however, often impractical in a commercial scale manufacture due to the relatively narrow range of concentration over which the G-phase is usually obtained and consequently
55 the most preferred embodiment is usually the most concentrated L_1 phase attainable, usually about 30% by weight based on total weight of reaction mixture. Higher concentrations may be achieved in the presence of phase modifiers such as solvents, cosurfactants, hydrotropes or electrolyte salts. These may raise the L_1/M boundary or broaden the G-phase range. The product may be prepared as anhydrous solid or as a solid

hydrate. On a large scale, temperature rise may be a problem during the reaction, as conditions become closer to adiabatic, hence the use of a heel of amine oxide product is preferable since this limits the extent of the exotherm, by avoiding the induction period as the system passes from 2 phase to 1 phase.

The inventors have found that, in the presence of bicarbonate and/or carbonate in the proportions specified above, with or without phosphonate, careful control of temperature need not be such a crucial factor in limiting the formation of nitrosamines as by-products as is implied by the prior art, wherein it is stated (e.g. European Patent Application 88306270.3) that in order to inhibit the formation of nitrosamines the preparation of amine oxide must be conducted at 45°C or lower; most preferably below 30°C. This then necessitates the usage of a promoter to raise the slow reaction rate.

According to the present invention the inhibitory action of the stabiliser towards nitrosamine formation, reduces the importance of keeping the temperature low, during the preparation and/or the storage of amine oxides.

Accordingly, the temperature of the reaction vessel when carrying out the process of this invention with the carbonate present initially may range from 2°C to 85°C but could be higher e.g. by carrying out the reaction in an autoclave to obtain very rapid reaction rates, the most preferred temperature range being 30°C to 50°C and a typical operating temperature being 40°C. The time to completion of the reaction is generally up to four hours.

Similarly, incorporation of the synergistic stabiliser, according to the invention, into an existing product renders it heat resistant with respect to the formation of nitrosamine impurities. The inventors have found that this effect is apparent even when the above mentioned product was not originally made in the presence of a nitrosamine inhibitor.

The amine oxide may be prepared, according to the present invention, by reacting a tertiary amine with hydrogen peroxide in the presence of the synergistic stabiliser hereinabove described.

The post addition of the poly(alkyleneamino) poly (methylenephosphonates) has been found to be advantageous in stabilising amine oxides generally, including those prepared by prior art methods, even in the absence of carbonate or bicarbonate. Compared with prior art methods in which the amino phosphonates were used to catalyse the preparation of the amine oxide and were necessarily converted to N-oxides in situ, the post addition does not result in the oxidation of the amine groups of the phosphonate. The resulting mixture of amine oxide and unoxidised poly(alkyleneamino) poly(methylenephosphonate) is thus a novel and surprisingly advantageous composition which constitutes a particular aspect of the present invention. The mixture preferably comprises water, 10 to 99% preferably 15 to 85%, e.g. 20 to 35%, amine oxide and 0.005 to 5% especially 0.01 to 1% of the phosphonate all based on the weight of the composition. The phosphonate preferably comprises 1 to 6 preferably 2 to 5 ethylene and/or propylene groups. Optionally the composition may contain a quantity of amine oxide between 50 and 80% corresponding to that at which a G-phase is formed.

Alternatively the concentration may be between 20% and the concentration corresponding to the L₁/M phase boundary, which is typically between 30% and 35%. Phase modifiers such as solvents, cosurfactants, hydrotropes or electrolyte salts, may raise the concentration of surfactant required to form an M-phase, so that the L₁/M phase boundary is found at concentrations of surfactant greater than 35% w/w. Addition of such phase modifiers may also broaden the concentration range over which the G-phase is typically found. It is also possible to prepare the amine oxide as a substantially anhydrous solid, or as a solid hydrate.

The invention may also be applicable to inhibition of nitrosamine and nitrite formation in the context of other reactions and products which involve a nitrosamine and nitrite hazard, for example alkanolamides.

The invention will be further illustrated by the following Examples in which all percentages are by weight based on the total weight of the product or reaction mixture as appropriate except where the context requires otherwise:-

The examples 2 and 3 and 5 were based on the following typical preparative method:

Lauryl myristyl amine, as EMPIGEN AB (EMPIGEN is a Registered Trade Mark) was weighed into a flask with any required stabiliser and any required catalyst and the necessary quantity of water. The resulting mixture was warmed in a water bath to 65°C with stirring for examples 2 and 3, and to 40°C with stirring for example 5. 20% w/w of the total mass of hydrogen peroxide (35%) required was added to the abovementioned reaction mixture and the mixture allowed to stir for 30 minutes in order to overcome the reaction exotherm. After this time, the remaining quantity of hydrogen peroxide (35%) was added to the flask over 30-45 minutes and the reaction allowed to continue for approximately a further two hours, or until such time that it was determined the reaction had gone to completion.

In this instance, the reaction was deemed to have gone to completion when the free amine content of the reaction mixture was ≤0.3% w/w and the hydrogen peroxide content of the reaction mixture was ≤0.1%

w/w, based on the total weight of the reaction mixture. If analysis of a reaction mixture aliquot showed a high free amine content but a low hydrogen peroxide content, more hydrogen peroxide was added and the reaction allowed to proceed until such time that acceptable levels of hydrogen peroxide and free amine content were achieved. Thus, in some instances, the ratio for moles (amine: H_2O_2) may be in excess of (1:1).

Example 1

An unstabilised batch of lauryl myristyl amine oxide containing 30% by weight of the amine oxide 0.1% EDTA and 1176 ppb nitrosamine was mixed with the reagents shown below in Table 1. Samples were stored for two weeks at 70 °C and analysed by a chemiluminescence method for total "NO" content, after destruction of nitrite with sulphamic acid.

TABLE 1 TWO WEEK, 70°C STORAGE TEST WITH POST ADDED STABILISER

Phosphonate	0%	0.01%	0.1%	0.5%
"NO" ppb	10,105	3,987	2,533	2,792
"NO" as % control	-	39%	25%	28%

Phosphonate	0%	0%	0%	0.01%	0.1%	0.5%
NaHCO ₃	0%	2%	3%	2%	2%	2%
"NO" ppb	10,105	6,366	7,207	2,170	1,815	688
"NO" as % control	-	63%	70%	21%	18%	7%

The phosphonate used in this and the following Tables was 25% w/w (expressed as acid) diethylenetriamine penta (methylenephosphonic acid) sodium salt- sold by Albright & Wilson Ltd. under the Registered Trade Mark BRIQUEST 543-25S. The figures in the Tables for % phosphonate are all expressed as 100% acid.

Conclusions

The results show that the minimum level of nitrosamine that can be achieved by bicarbonate alone under the conditions of this experiment is 63% of the control even at high concentrations of stabiliser. Phosphonate alone cannot reduce the nitrosamine to less than 25% of the control.

A combination of 0.5% phosphonate + 2% NaHCO₃ reduces nitrosamine to 7% of the concentration in the control and is thus responsible for a synergistic reduction in the "NO" content on ageing, when compared with unaged starting material, being more effective than the maximum achievable with either material on its own.

Example 2

An amine oxide was prepared using de-ionised water with the additions shown below in Table 2. Both nitrite and nitrosamines were determined by chemiluminescence and are both quoted as "NO".

TABLE 2

TWO WEEK, 70 ° C STORAGE TEST WITH PRE ADDED STABILISER			
Reaction	<u>A</u>	<u>B</u>	<u>C</u>
Reaction time	3 hours	56.5 hours	38 hours
Phosphonate (as acid)	0.1%	-	0.1%
NaHCO ₃	1.0%	1.0%	-
Nitrosamine ppb "NO" start	51	171	240
Nitrosamine ppb "NO" 2 weeks at 70 ° C	170	804	422
NO ₂ (as ppb "NO") start	4,376	15,648	17,386
Moles of (amine: H ₂ O ₂)	(1:1)	(1:1.4)	(1:1.02)
Free amine levels (% w/w) at reaction completion	0.1%	0.3%	0.3%
Peroxide residue (% w/w) at reaction completion	0.024%	0.01%	0.08%

The combination of phosphonate and NaHCO₃ gives reduced initial nitrosamine and nitrite levels, and reduces the formation of these during ageing at 70 ° C. Additionally the reaction time is appreciably reduced.

Example 3

Further reactions were run at 65 ° C using water containing up to 5ppm of Fe (II), distilled water, the results being shown below in Table 3. Iron is a notorious promoter of nitrosamine formation in amine oxides. Moreover in the absence of chelant 5ppm iron prevents the reaction from preceding to completion due to decomposition of peroxide.

TABLE 3

TWO WEEK, 70 ° C STORAGE TEST FOR SAMPLES CONTAINING IRON CONTAMINATED WATER		
Reaction	<u>A</u>	<u>B</u>
Reaction time	40 hours	2 hours
Phosphonate (as acid)	0.1%	0.1%
NaHCO ₃	-	1.0%
"NO" ppb start	162	34
"NO" ppb 2 weeks at 70 ° C	3,940	269
NO ₂ (as ppb "NO") start	15,465	2,670
Moles of (amine: H ₂ O ₂)	(1:1.03)	(1:1)
Free amine levels (% w/w) at reaction completion	0.3%	0.3%
Peroxide residue (% w/w) at reaction completion	0.06%	0.025%

The above results demonstrate the superiority of a combination of NaHCO₃ and phosphonate, as a catalyst for the reaction and as an inhibitor for NO/NO₂ formation both during the reaction and on ageing, even in the presence of iron.

Example 4

The products of reactions A and B, shown above in Table 3, were each dosed, after preparation, with extra phosphonate as shown below in Table 4, (both had 0.1% phosphonate in the reaction charge).

**TABLE 4 TWO WEEK, 70°C STORAGE TEST TO SHOW THE EFFECT OF POST ADDITION
OF FURTHER QUANTITIES OF STABILISER**

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	A	B	C	D	E
Reaction A + phosphonate	-	0.1%	0.3%	0.4%	(CONTROL)*
"NO" ppb Start	162				182
"NO" ppb 2 weeks at 70°C	3940	855	560	520	3753

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*Prepared in a similar way to Reaction A but with 0.5% phosphonate (as acid) included in the reaction.

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Reaction B + phosphonate	-	0.1%	0.3%	0.4%	(CONTROL)*
"NO" ppb Start	34				39
"NO" ppb 2 weeks at 70°C	269	92	109	102	125

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*Prepared in a similar way to Reaction B but with 0.5% phosphonate (as acid) included in the reaction.

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30 Conclusions

Post addition of further phosphonate, as in reaction B,C and D, is more effective in lowering the total nitrosamine and nitrite content of the samples, than is achieved by initially adding the total amount of stabiliser to the reaction mixture. Thus, the stabilizing effect is maximised by post addition of further phosphonate. It should be appreciated that all of the 70°C two week storage tests hereinabove described are conducted in considerably harsher conditions than are typically encountered in practice, in order to demonstrate significant differences within a short period. Usually storage temperatures are in the range of 20 to 45°C, which promotes the formation of nitrosamines and nitrites to a lesser extent than a storage temperature of 70°C, and thus represents a more industrially relevant study.

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EXAMPLE 5

Two further samples (A and B), of amine oxides were prepared using ultra high purity water, with the additions shown below in Table 5 made at the start of the reaction. Another batch of amine oxide (C) received a post addition of phosphonate.

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Both nitrite and nitrosamines were determined by chemiluminescence and both are quoted as "NO".

TABLE 5 TWO WEEK, 45°C STORAGE TESTS

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Reaction	A	B	C
Phosphonate		0.25%	
E.D.T.A.	0.1%		0.1%
Sodium Bicarbonate	1.0%	1.0%	1%
Phosphonate (post addition)			0.25%

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sample		start	14 days	28 days	42 days	56 days
A	ppb nitrosamines	22		68	71	155
	ppb nitrite	428		770	843	1210
B	ppb nitrosamines	<10		20	23	36
	ppb nitrite	183		483	665	759
C	ppb nitrosamines	12	<10		18	
	ppb nitrite	443	338		429	

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Conclusion

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The post addition of phosphonate to sample (C) provides improved inhibition of nitrosamine and nitrite levels on storage at 45°C, illustrating the synergistic effect of phosphonate (post addition) and bicarbonate. The beneficial effect of using phosphonate in preference to E.D.T.A. is seen by comparison of samples A and B.

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Claims

1. The use of a mixture of (i) a carbonate and/or bicarbonate with (ii) a phosphonate to inhibit the formation, or lower the concentration, of nitrosamine in a product susceptible to nitrosamine contamination.
2. A method for inhibiting the formation and/or lowering the concentration of nitrosamine in a product comprising an active ingredient which is susceptible to contamination by nitrosamines which method comprises adding to said product, before during or after the preparation thereof, a synergistic mixture comprising:
 - (i) from 0.05 to 20% by weight of a carbonate or bicarbonate; and
 - (ii) from 0.005 to 5% by weight of a phosphonate; said percentages being based on the weight of said active ingredient.
3. A method according to Claim 2 characterised in that said product is an amine oxide.
4. A method according to Claim 2, in which (i) comprises an alkali metal, or alkaline-earth metal bicarbonate.

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Both nitrite and nitrosamines were determined by chemiluminescence and both are quoted as "NO".

TABLE 5 TWO WEEK, 45°C STORAGE TESTS

Reaction	A	B	C
Phosphonate		0.25%	
E.D.T.A.	0.1%		0.1%
Sodium Bicarbonate	1.0%	1.0%	1%
Phosphonate (post addition)			0.25%

sample		start	14 days	28 days	42 days	56 days
A	ppb nitrosamines	22		68	71	155
	ppb nitrite	428		770	843	1210
B	ppb nitrosamines	<10		20	23	36
	ppb nitrite	183		483	665	759
C	ppb nitrosamines	12	<10		18	
	ppb nitrite	443	338		429	

Conclusion

The post addition of phosphonate to sample (C) provides improved inhibition of nitrosamine and nitrite levels on storage at 45°C, illustrating the synergistic effect of phosphonate (post addition) and bicarbonate. The beneficial effect of using phosphonate in preference to E.D.T.A. is seen by comparison of samples A and B.

Claims

1. The use of a mixture of (i) a carbonate and/or bicarbonate with (ii) a phosphonate to inhibit the formation, or lower the concentration, of nitrosamine in a product susceptible to nitrosamine contamination.
2. A method for inhibiting the formation and/or lowering the concentration of nitrosamine in a product comprising an active ingredient which is susceptible to contamination by nitrosamines which method comprises adding to said product, before during or after the preparation thereof, a synergistic mixture comprising:
 - (i) from 0.05 to 20% by weight of a carbonate or bicarbonate; and
 - (ii) from 0.005 to 5% by weight of a phosphonate; said percentages being based on the weight of said active ingredient.
3. A method according to Claim 2 characterised in that said product is an amine oxide.
4. A method according to Claim 2, in which (i) comprises an alkali metal, or alkaline-earth metal bicarbonate.



5. A method according to Claim 2, in which (i) comprises an alkali metal, alkaline-earth metal or ammonium carbonate.
6. A method according to Claim 2, in which (i) is a mixture of sodium bicarbonate and sodium carbonate.
7. A method according to Claim 6 wherein the weight ratio of carbonate to bicarbonate is from 0.01:1 to 1:0.01.
8. A method according to any foregoing Claim, in which (ii) comprises an amino tris (methylenephosphonate), ethylenediamine tetrakis (methylenephosphonate), diethylenetriamine penta (methylenephosphonate), triethylenetetramine hexa (methylenephosphonate) or tetraethylenepentamine hepta (methylenephosphonate) or an oxide of any of the aforesaid phosphonates.
9. A method according to any one of Claims 2 to 8, in which the amine oxide is produced by reacting a tertiary amine with hydrogen peroxide in the presence of a synergistic stabiliser comprising from 0.05% to 20% by weight (based on the weight of amine) of (i) and from 0.005% to 5% by weight (based on the weight of amine) of (ii).
10. A method according to any one of Claims 2 to 9, in which at least part of the synergistic stabiliser or a component thereof is added to the amine oxide after the preparation thereof.
11. A method according to any one of Claims 2 to 8 or 10, in which (A) the amine oxide is produced by reaction of a tertiary amine with hydrogen peroxide in the presence of from 0.05% to 20% (by weight based on the amine) of (i), together with a catalytic amount of sequestrant for transition metal ions and (B) from 0.005% to 5% (by weight based on the initial amine content of the mixture of (ii) is added to said amine oxide during and/or after the preparation thereof.
12. A method according to any of Claims 2 to 11, in which the tertiary amine has the general formula $R^1R^2R^3N$, wherein R^1 , R^2 and R^3 represent straight or branched chain alkyl groups, alkenyl groups or aralkyl groups, which may be the same or different.
13. A method according to Claim 12, in which the tertiary amine has the general formula $(R)_m(R^1)_nN$, wherein $m = 1$ or 2 and $n = (3-m)$, the R groups, which may be the same or different, represent C_8 to C_{24} alkyl or alkenyl, C_8 to C_{24} alkyl - or alkenyl-polyalkyleneoxy, C_7 to C_{23} esteralkyl or esleralkenyl, C_7 to C_{23} amidoalkyl or amidoalkenyl or C_6 to C_{23} alkyl- or alkenyl-amidopropyl groups, and the R^1 groups, which may be the same or different, represent alkyl, alkoxy, hydroxyalkyl or polyalkyleneoxy groups having from 1 to 4 carbon atoms.
14. A method according to any one of Claims 1 to 9, in which the tertiary amine is a cyclic amine.
15. A method according to Claim 14, in which the tertiary amine is an imidazoline, a pyridine, an N-substituted morpholine or an N-substituted piperazine.
16. A method according to any one of Claims 2 to 11, in which the molar ratio of amine to hydrogen peroxide is from 1:0.9 to 1:1.1.
17. A method according to Claim 16, in which the molar ratio of amine to hydrogen peroxide is from 1:1 to 1:1.09.
18. A method according to any one of Claims 2 to 17, carried out at a temperature of from 2°C to 85°C .
19. A method according to Claim 18, in which the temperature is from 30°C to 50°C .
20. A method according to Claim 18 or 19, in which the temperature is 40°C .
21. A composition comprising an amine oxide and a synergistic stabiliser wherein said stabiliser comprises:
 - (i) from 0.05% to 20% by weight (based on the weight of the amine oxide) of a bicarbonate and/or a carbonate; and



(ii) from 0.005% to 5% by weight (based on the weight of the amine oxide) of a phosphonate.

22. A composition according to Claim 21 wherein said phosphonate is an aminophosphonate or aminophosphonate N-oxide.
23. A composition according to Claim 22 wherein said phosphonate is a poly(alkyleneamino) poly-(methylenephosphonate) or an N-oxide thereof.
24. A composition according to Claim 23 wherein said alkyleneamino groups are selected from ethyleneamino and propylene amino groups.
25. A composition according to Claim 24 wherein said phosphonate comprises from 2 to 6 ethyleneamino and/or propylene amino groups.
26. A composition according to Claim 21 wherein (ii) comprises diethylenetriamine pentakis (methylenephosphonate), triethylenetetramine hexakis(methylenephosphonate) or tetraethylenepentamine heptakis (methylenephosphonate).
27. A composition according to Claim 21 wherein said amino oxide is a solid amino oxide or amino oxide hydrate.
28. A composition according to Claim 21 comprising water and from 10 to 99% by weight of said composition of said amino oxide.
29. A composition according to Claim 28 wherein said amino oxide is present as a G-phase.
30. A composition according to Claim 28 wherein said amino oxide is present as an L₁ phase.
31. A composition according to Claim 30 containing at least 20% by weight of said amino oxide.

Patentansprüche

1. Die Verwendung eines Gemisches aus
 - (I) einem Carbonat und/oder Bicarbonat mit
 - (II) einem Phosphonat
 zur Verhinderung der Bildung oder Verminderung der Konzentration von Nitrosamin in einem Produkt, in dem eine Nitrosamin-Verunreinigung entstehen kann.
2. Ein Verfahren zur Verhinderung der Bildung und/oder Verminderung der Konzentration von Nitrosamin in einem Produkt, das einen aktiven Bestandteil enthält, von dem eine Nitrosamin-Verunreinigung ausgehen kann, dadurch gekennzeichnet, daß diesem Produkt vor, während oder nach seiner Herstellung ein synergistisch wirkendes Gemisch zugesetzt wird, das enthält:
 - (I) 0,05 bis 20 Gew.-% Carbonat oder Bicarbonat; und
 - (II) 0,005 bis 5 Gew.-% Phosphonat;
 wobei die Prozentangaben jeweils auf das Gewicht des aktiven Bestandteiles bezogen sind.
3. Ein Verfahren nach Anspruch 2, dadurch gekennzeichnet, daß das Produkt ein Aminoxid ist.
4. Ein Verfahren nach Anspruch 2, dadurch gekennzeichnet, daß die Komponente (I) ein Alkalimetallbicarbonat oder ein Erdalkalimetallbicarbonat enthält.
5. Ein Verfahren nach Anspruch 2, dadurch gekennzeichnet, daß



die Komponente (I) ein Alkalimetallcarbonat, ein Erdalkalimetallcarbonat oder ein Ammoniumcarbonat enthält.

6. Ein Verfahren nach Anspruch 2,
dadurch gekennzeichnet, daß
die Komponente (I) eine Mischung aus Natriumbicarbonat und Natriumcarbonat ist.
7. Ein Verfahren nach Anspruch 6,
dadurch gekennzeichnet, daß
diese Mischung das Carbonat und Bicarbonat in einem Gewichtsverhältnis von 0,01:1 bis 1:0,01 enthält.
8. Ein Verfahren nach einem der Ansprüche 2 bis 7,
dadurch gekennzeichnet, daß
die Komponente (II) aufweist; ein Amino-tris-(methylenphosphonat), ein Ethylendiamin-tetrakis-(methylenphosphonat), ein Diethylentriamin-penta-(methylenphosphonat), ein Triethylentetramin-hexa-(methylenphosphonat) oder ein Tetraethylenpentamin-hepta-(methylenphosphonat) oder ein Oxid der vorstehend genannten Phosponate.
9. Ein Verfahren nach einem der Ansprüche 2 bis 8,
dadurch gekennzeichnet, daß
das Aminoxid erhältlich ist durch Umsetzung eines tertiären Amines mit Wasserstoffperoxid in Anwesenheit eines synergistisch wirkenden Stabilisators, der aufweist:
0,05 bis 20 Gew.-% der Komponente (I) und
0,005 bis 5 Gew.-% der Komponente (II),
jeweils bezogen auf das Gewicht des Amines.
10. Ein Verfahren nach einem der Ansprüche 2 bis 9,
dadurch gekennzeichnet, daß
wenigstens ein Teil des synergistisch wirkenden Stabilisators oder eine Komponente dieses Stabilisators dem Aminoxid nach dessen Herstellung zugesetzt wird.
11. Ein Verfahren nach einem der Ansprüche 2 bis 8 oder 10,
dadurch gekennzeichnet, daß
(A) das Aminoxid erhältlich ist durch Umsetzung eines tertiären Amines mit Wasserstoffperoxid in Anwesenheit von 0,05 bis 20 Gew.-% der Komponente (I) - bezogen auf das Gewicht des Amines -, zusammen mit einer katalytisch wirksamen Menge eines Komplexbildners für Übergangsmetallionen, und
(B) 0,005 bis 5 Gew.-% der Komponente (II) - bezogen auf das Gewicht des anfänglichen Amingehaltes der Mischung - dem Aminoxid zugesetzt wird während und/oder nach dessen Herstellung.
12. Ein Verfahren nach einem der Ansprüche 2 bis 11,
dadurch gekennzeichnet, daß
das tertiäre Amin eine Verbindung mit der Strukturformel $R^1R^2R^3N$ ist, wobei
 R^1 , R^2 und R^3 jeweils stehen für gleiche oder unterschiedliche, geradkettige oder verzweigt-kettige Alkylgruppen, Alkylengruppen oder Arylalkylgruppen.
13. Ein Verfahren nach Anspruch 12,
dadurch gekennzeichnet, daß
das tertiäre Amin eine Verbindung mit der Strukturformel $(R)_m(R^1)_nN$ ist, wobei
 m eine ganze Zahl mit dem Werten 1 oder 2 ist,
 n eine ganze Zahl mit dem Wert $(3-m)$ ist,
 R steht für gleiche oder verschiedene C_8-24 -Alkylgruppen oder -Alkenylgruppen, für C_8-24 -Alkyl- oder Alkenyl-polyalkylenoxygruppen, für C_7-23 -Esteralkylgruppen oder -Esteralkenylgruppen, für C_7-23 -Amidoalkylgruppen oder -Amidoalkenylgruppen, oder für C_6-23 -Alkyl- oder Alkenyl-amidopropylgruppen; und
 R^1 steht für gleiche oder unterschiedliche Alkyl-, Alkoxy-, Hydroxyalkyl- oder polyalkylenoxy-Gruppen, jeweils mit 1 bis 4 Kohlenstoffatomen.



14. Ein Verfahren nach einem der Ansprüche 2 bis 9,
dadurch gekennzeichnet, daß
das tertiäre Amin ein cyclisches Amin ist.
- 5 15. Ein Verfahren nach Anspruch 14,
dadurch gekennzeichnet, daß
das tertiäre Amin ein Imidazolin, ein Pyridin, ein N-substituiertes Morphinol oder ein N-substituiertes
Piperazin ist.
- 10 16. Ein Verfahren nach einem der Ansprüche 2 bis 11,
dadurch gekennzeichnet, daß
ein molares Verhältnis von Amin zu Wasserstoffperoxid von 1:0,9 bis 1:1,1 vorgesehen ist.
- 15 17. Ein Verfahren nach Anspruch 16,
dadurch gekennzeichnet, daß
das molare Verhältnis von Amin zu Wasserstoffperoxid 1:1 bis 1:1,09 beträgt.
- 20 18. Ein Verfahren nach einem der Ansprüche 2 bis 17,
dadurch gekennzeichnet, daß
die Umsetzung bei einer Temperatur von 2 bis 85 ° C durchgeführt wird.
- 25 19. Ein Verfahren nach Anspruch 18,
dadurch gekennzeichnet, daß
die Umsetzung bei einer Temperatur von 30 bis 50 ° C durchgeführt wird.
- 30 20. Ein Verfahren nach Anspruch 18 oder 19,
dadurch gekennzeichnet, daß
die Umsetzung bei einer Temperatur von 40 ° C durchgeführt wird.
- 35 21. Eine Zusammensetzung, enthaltend ein Aminoxid und einen synergistisch wirkenden Stabilisator,
dadurch gekennzeichnet, daß
der Stabilisator aufweist:
(I) 0,05 bis 20 Gew.-% Bicarbonat und/oder Carbonat - bezogen auf das Gewicht des Aminoxides;
und
(II) 0,005 bis 5 Gew.-% Phosponat - bezogen auf das Gewicht des Aminoxides.
- 40 22. Eine Zusammensetzung nach Anspruch 21,
dadurch gekennzeichnet, daß
das Phosponat ein Aminophosponat oder ein Aminophosponat-N-oxid ist.
- 45 23. Eine Zusammensetzung nach Anspruch 22,
dadurch gekennzeichnet, daß
das Phosponat ein poly(alkylenamino)-poly(methylenphosponat) oder ein N-Oxid dieser Phosponate
ist.
- 50 24. Eine Zusammensetzung nach Anspruch 23,
dadurch gekennzeichnet, daß
die Alkylenaminogruppen Ethylenaminogruppen und Propylenaminogruppen sein können.
- 55 25. Eine Zusammensetzung nach Anspruch 24,
dadurch gekennzeichnet, daß
das Phosponat 2 bis 6 Ethylenaminogruppen und/oder Propylenaminogruppen enthält.
26. Eine Zusammensetzung nach Anspruch 21,
dadurch gekennzeichnet, daß
die Komponente (II) aufweist:
Diethylentriamin-pentakis(methylenphosponat) oder
Triethylentetramin-hexakis(methylenphosponat) oder



Tetraethylenpentamin-heptakis(methylenphosphonat).

27. Eine Zusammensetzung nach Anspruch 21,
dadurch gekennzeichnet, daß
das Aminoxid ein festes Aminoxid oder ein Aminoxid-Hydrat ist.
28. Eine Zusammensetzung nach Anspruch 21,
dadurch gekennzeichnet, daß
die Zusammensetzung 10 bis 90 Gew.-% Aminoxid und Wasser enthält.
29. Eine Zusammensetzung nach Anspruch 28,
dadurch gekennzeichnet, daß
das Aminoxid als G-Phase vorliegt.
30. Eine Zusammensetzung nach Anspruch 28,
dadurch gekennzeichnet, daß
das Aminoxid als L₁-Phase vorliegt.
31. Eine Zusammensetzung nach Anspruch 30,
dadurch gekennzeichnet, daß
die Zusammensetzung wenigstens 20 Gew.-% Aminoxid enthält.

Revendications

1. Utilisation d'un mélange (i) d'un carbonate et/ou bicarbonate avec (ii) un phosphonate pour inhiber la formation, ou diminuer la concentration, de nitrosamines dans un produit susceptible de contamination par les nitrosamines.
2. Procédé d'inhibition de la formation et/ou de diminution de la concentration de nitrosamines dans un produit comprenant un ingrédient actif qui est susceptible de contamination par les nitrosamines, qui comprend l'addition audit produit, avant, durant ou après la préparation de celui-ci, d'un mélange synergique comprenant :
- (i) de 0,05 à 20% en poids de carbonate ou de bicarbonate; et
 - (ii) de 0,005 à 5% en poids d'un phosphonate; lesdits pourcentages étant basés sur le poids dudit ingrédient actif.
3. Procédé conformément à la revendication 2, caractérisé en ce que ledit produit est un oxyde d'amine.
4. Procédé conformément à la revendication 2, dans lequel (i) comprend un bicarbonate de métal alcalin, ou de métal alcalino-terreux.
5. Procédé conformément à la revendication 2, dans lequel (i) comprend un carbonate de métal alcalin, de métal alcalino-terreux ou d'ammonium.
6. Procédé conformément à la revendication 2, dans lequel (i) est un mélange de bicarbonate de sodium et de carbonate de sodium.
7. Procédé conformément à la revendication 6, dans lequel la proportion en poids du carbonate au bicarbonate est de 0,01:1 à 1:0,01.
8. Procédé conformément à l'une quelconque des revendications précédentes, dans lequel (ii) comprend un aminotris (méthylène phosphonate), un éthylènediaminetétrakis(méthylène phosphonate), un diéthylènetriaminépenta(méthylène phosphonate), un triéthylènetétraminehexa(méthylène phosphonate) ou un tétraéthylène pentaminehepta(méthylène phosphonate) ou un oxyde de l'un quelconque des phosphonates précités.
9. Procédé conformément à l'une quelconque des revendications 2 à 8, dans lequel l'oxyde d'amine est produit par réaction d'une amine tertiaire avec du peroxyde d'hydrogène en présence d'un stabilisateur



synergique composé de 0,05% à 20% en poids (sur base du poids de l'amine) de (i) et de 0,005% à 5% en poids (sur base du poids de l'amine) de (ii).

- 5 10. Procédé conformément à l'une quelconque des revendications 2 à 9, dans lequel au moins une partie du stabilisateur synergique ou un composant de celui-ci est ajoutée à l'oxyde d'amine après la préparation de celui-ci.
- 10 11. Procédé conformément à l'une quelconque des revendications 2 à 8 ou 10, dans lequel (A) l'oxyde d'amine est produit par réaction d'une amine tertiaire avec du peroxyde d'hydrogène en présence de 0,05% à 20% (en poids sur base de l'amine) de (i), conjointement avec une quantité catalytique de séquestrant pour les ions des métaux de transition et (B) de 0,005% à 5% (en poids sur base de la teneur initiale en amine du mélange) de (ii) sont ajoutés audit oxyde d'amine durant et/ou après la préparation de celui-ci.
- 15 12. Procédé conformément à l'une quelconque des revendications 2 à 11, dans lequel l'amine tertiaire a la formule générale $R^1R^2R^3N$, dans laquelle R^1 , R^2 et R^3 représentent des radicaux alcoyles en chaîne droite ou ramifiée, des radicaux alcényles ou des radicaux aralcoyles, qui peuvent être identiques ou différents.
- 20 13. Procédé conformément à la revendication 12, dans lequel l'amine tertiaire a la formule générale $(R)_m-(R^1)_nN$, dans laquelle $m = 1$ ou 2 et $n = (3-m)$; les radicaux R , qui peuvent être identiques ou différents, représentent des radicaux alcoyles ou alcényles en C_8 à C_{24} , des radicaux alcoyl- ou alcénylpolyalcoylèneoxy en C_8 à C_{24} , des radicaux esteralcoyles ou esteralcényles en C_7 à C_{23} , des radiaux amidoalcoyles ou amidoalcényles en C_7 à C_{23} , ou des radicaux alcoyle- ou alcényleamidopropyles en C_6 à C_{23} et les radicaux R^1 , qui peuvent être identiques ou différents, représentent des radicaux alcoyles, alcoxy, hydroxyalcoyle ou polyalcoylèneoxy ayant de 1 à 4 atomes de carbone.
- 25 14. Procédé conformément à l'une quelconque des revendications 1 à 9, dans lequel l'amine tertiaire est une amine cyclique.
- 30 15. Procédé conformément à la revendication 14, dans lequel l'amine tertiaire est une imidazoline, une pyridine, une morpholine N-substituée ou une pipérazine N-substituée.
- 35 16. Procédé conformément à l'une quelconque des revendications 2 à 11, dans lequel la proportion molaire de l'amine au peroxyde d'hydrogène est de 1:0,9 à 1:1,1.
17. Procédé conformément à la revendication 16, dans lequel la proportion molaire de l'amine au peroxyde d'hydrogène est de 1:1 à 1:1,09.
- 40 18. Procédé conformément à l'une quelconque des revendications 2 à 17, effectué à une température de $2^\circ C$ à $85^\circ C$.
19. Procédé conformément à la revendication 18, dans lequel la température est de $30^\circ C$ à $50^\circ C$.
- 45 20. Procédé conformément à la revendication 18 ou 19, dans lequel la température est de $40^\circ C$.
21. Composition comprenant un oxyde d'amine et un stabilisateur synergique dans laquelle ledit stabilisateur comprend :
 - 50 (i) de 0,05% à 20% en poids (sur base du poids de l'oxyde d'amine)) d'un bicarbonate et/ou d'un carbonate; et
 - (ii) de 0,005% à 5% en poids (sur base du poids de l'oxyde d'amine) d'un phosphonate.
22. Composition conformément à la revendication 21, dans laquelle ledit phosphonate est un aminophosphonate ou un N-oxyde d'aminophosphonate.
- 55 23. Composition conformément à la revendication 22, dans laquelle ledit phosphonate est un poly-(alcoylèneamino)poly(méthylèneposphonate) ou un N-oxyde de celui-ci.



24. Composition conformément à la revendication 23, dans laquelle lesdits radiaux alcoylèneamino sont choisis parmi les radicaux éthylèneamino et propylèneamino.
- 5 25. Composition conformément à la revendication 24, dans laquelle ledit phosphonate comprend de 2 à 6 radiaux éthylèneamino et/ou propylèneamino.
- 10 26. Composition conformément à la revendication 21, dans laquelle (ii) comprend le diéthylènetriaminepentakis(méthylènegphosphonate), le triéthylènetétraminehexakis(méthylènegphosphonate) ou le tétraéthylènegpentamineheptakis(méthylènegphosphonate).
- 15 27. Composition conformément à la revendication 21, dans laquelle ledit oxyde d'amine est un oxyde d'amine solide ou un oxyde d'amine hydraté.
28. Composition conformément à la revendication 21, comprenant de l'eau et de 10 à 99% en poids de ladite composition dudit oxyde d'amine.
- 20 29. Composition conformément à la revendication 28 dans laquelle ledit oxyde d'amine est présent comme une phase G.
- 30 30. Composition conformément à la revendication 28, dans laquelle ledit oxyde d'amine est présent comme une phase L₁.
- 35 31. Composition conformément à la revendication 30, contenant au moins 20% en poids dudit oxyde d'amine.
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