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(54) Title: COMPOSITION AND USES THEREOF

(57) Abstract: The composition disclosed by the present invention comprises two or more salts independently selected from alkali metal salts and alkali earth metal salts. Use of compositions of the invention in treating water and waste streams which contain ammonia, are also disclosed.



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COMPOSITION AND USES THEREOF

TECHNICAL FIELD

[0001] The present invention relates to a chemical composition for use in the treatment of water and waste streams containing ammonia. In particular, the invention is directed to a chemical composition for treating industrial and other waste water systems to remove dissolved ammonia, although the scope of the invention is not necessarily limited thereto.

BACKGROUND ART

[0002] Many industrial processes use ammonia and consequently, industrial waste streams, such as waste water, often contain ammonia as a contaminant. For example, ammonia is found as a contaminant in cooling waters from the extraction of iron from its ores. Also, ammonia is used in the extraction of nickel from nickel ore and thus is a contaminant in waste water resulting from the extraction process.

[0003] Other waste water systems can also contain ammonia as a contaminant. In particular raw sewage can have a high level of dissolved ammonia.

[0004] Non-industrial bodies of water which contain ammonia as a contaminant include swimming pools and aquariums.

[0005] Ammonia in swimming pools is problematic, as it reacts with chlorine (the most common disinfectant used in swimming pools) to form chloramines. Chloramines are irritating to eyes and the respiratory system. The main sources of ammonia in swimming pools are perspiration and urine. When levels of ammonia and thus chloramines are too high, the pool needs to be closed until chloramine levels are reduced. Current techniques for reducing chloramine levels include addition of large excesses of chlorine, addition of oxidizers (such as hydrogen peroxide or potassium peroxymonosulphate), ultra violet (UV) light, or dilution by the addition of fresh water.

[0006] There are a number of sources of ammonia in aquariums, including fish excretions and bacterial breakdown of organic material present in the aquarium. Continued exposure to ammonia can make fish more susceptible to disease, whilst high levels of ammonia are toxic to fish and other animals in the aquarium. Consequently, control of ammonia levels in aquariums is an important aspect of aquarium maintenance and can be expensive and time consuming.

[0007] The presence of ammonia in industrial waste water leads to problems with disposal of the water as it cannot be simply discharged. As noted above with respect to aquariums, high levels of dissolved ammonia in water can be toxic to aquatic organisms and can lead to fish kills. Other problems associated with discharge of industrial waste water containing dissolved ammonia include algal blooms and weed infestation.

[0008] A number of different processes for the treatment of industrial waste containing ammonia are known. One process involves a biological treatment, whereby an ammonia-contaminated waste stream is introduced into a tank and treated with ammonia oxidizing bacteria followed by nitrite oxidizing bacteria. Further treatment with denitrifying bacteria results in the production of nitrogen gas, which is released into the atmosphere.

[0009] Another process for the removal of ammonia from industrial waste water involves the addition of chlorine resulting in the formation of nitrogen gas and hydrochloric acid. However, this process is not favoured as it requires the use of chlorine and produces hydrochloric acid, both of which are hazardous materials. A similarly hazardous process requires the addition of large quantities of a basic compound, such as sodium hydroxide, to increase the pH of waste water thereby shifting the ammonium-ammonia equilibrium towards ammonia to facilitate removal of the ammonia.

[0010] A more simplistic process for the removal of ammonia from industrial waste streams involves adsorption of the ammonia onto zeolites. However, this process is not only inefficient in terms of removal of ammonia, but it also requires large quantities of zeolites and agitation of the waste stream with the zeolites in order to adsorb the ammonia.

SUMMARY OF INVENTION

[0011] The present invention is directed to a method of treating water and waste streams which contain ammonia, which may at least partially overcome at least one of the abovementioned disadvantages or provide the consumer with a useful or commercial choice.

[0012] With the foregoing in view, the present invention in one form resides broadly in a composition comprising two or more salts independently selected from alkali metal salts and alkali earth metal salts.

[0013] In an alternative form, the present invention resides in a composition comprising two salts independently selected from alkali metal salts and alkali earth metal salts.

[0014] In a further form, the present invention resides in a composition comprising approximately equimolar amounts of two salts independently selected from alkali metal salts and alkali earth metal salts.

[0015] In a further form, the present invention resides in method for treating a waste stream comprising ammonia, the method including the step of contacting said waste stream with a composition comprising two or more salts independently selected from alkali metal salts and alkali earth metal salts.

[0016] The method can include a step of agitating the waste stream following contacting said waste stream with a composition comprising two or more salts independently selected from alkali metal salts and alkali earth metal salts.

[0017] Any alkali metal salt can be used in the compositions of the invention. Particularly preferred alkali metal salts are sodium and potassium salts, as these salts are not only readily available, but are also relatively inexpensive. Examples of alkali metal salts which can be utilized in the compositions of the invention include sodium carbonate, potassium carbonate, sodium bicarbonate, potassium bicarbonate, sodium aluminium sulphate, potassium aluminium sulphate, sodium oxalate and potassium oxalate.

[0018] Any alkali earth metal salt can be used in the compositions of the invention. Particularly preferred alkali earth metal salts are calcium salts, as these salts are not only readily available, but are also relatively inexpensive. Examples of alkali earth metal salts which can be utilized in the compositions of the invention include calcium carbonate, calcium hydroxide and calcium oxide.

[0019] In one embodiment of the invention, the composition comprises a mixture of sodium carbonate and sodium bicarbonate.

[0020] Compositions according to the invention can comprise any suitable ratio of salts, being alkali metal salts or alkali earth metal salts. For example, a composition comprising two salts can comprise an approximately 30:70 molar ratio of the two salts. Alternatively, the composition can comprise an approximately 70:30 molar ratio of the two salts. In further alternative embodiments, the molar ratio of the two salts can fall within the ratio range of approximately 30:70 to approximately 70:30.

[0021] The molar ratio of two salts in a composition of the invention can thus be approximately 30:70, 40:60, 50:50, 60:40 or 70:30.

[0022] A particularly preferred embodiment of the invention is a composition comprising approximately equimolar amounts (50:50 molar ratio) of sodium carbonate and sodium bicarbonate.

[0023] Waste streams which can be treated according to methods of the invention, can be aqueous or non-aqueous waste streams. Many industrial processes produce aqueous waste streams which contain dissolved ammonia. Compositions of the invention can be applied directly to an aqueous waste stream in a suitable amount to reduce the ammonia content of the waste stream to a suitable level, such that the waste stream can be discharged. The required amount of the composition of the invention required will typically be adjusted to obtain required or desired levels of ammonia in the output.

[0024] Following application of a composition of the invention to an ammonia-containing aqueous waste stream, the waste stream can be agitated to assist in the chemical reaction and the release of ammonia gas. The agitation can be achieved by any suitable means known in the art. Such agitation means can include bubbling a gas such as nitrogen or normal air, through the aqueous waste stream.

[0025] The reaction between the salt mixture and dissolved ammonium ions can take place at ambient temperatures. Alternatively, the temperature of the aqueous waste stream can be varied to assist in the release of ammonia gas. For example, prior to addition of a composition of the invention, the waste stream can be heated to a temperature above ambient temperature to achieve a faster reaction. Alternatively, the waste stream can be heated to a temperature above ambient temperature following addition of a composition of the invention.

[0026] The waste stream can remain in contact with a composition of the invention for a period of time sufficient to reduce the ammonia content of the waste stream to a suitable level. The period of contact time will be dependent on a number of factors, including the initial amount of ammonia in the waste stream, the amount of the composition added to the waste stream, the temperature of the waste stream and the degree of agitation of the waste stream following application of a composition of the invention.

[0027] Typically, the waste stream remains in contact with a composition of the invention for 1 to 5 days (depending on the temperature, level of agitation and the content of ammonia in the water). To ensure sufficient reduction in the amount of ammonia in the waste stream, it is preferable for the waste stream to remain in contact with a composition of the invention for 3 to 5 days.

[0028] Following reduction of the ammonia in an aqueous waste stream to acceptable levels, the treated waste stream can be filtered, prior to discharge, to remove any insoluble materials or precipitate. Alternatively, any insoluble materials or precipitate can be allowed to settle, and the treated waste stream simply decanted.

[0029] The extent of formation of insoluble material will typically depend on the level of contamination of the water; for example, if ions such as Mg^{2+} are present, these will be precipitated as carbonates. When no ions other than ammonium are present in the water and a stoichiometric quantity of the preferred salt mixture required to remove ammonium ions is added, no formation of insoluble material is expected.

[0030] The invention also provides for the treatment of non-aqueous waste streams which contain ammonia. Methods of treating non-aqueous waste streams are similar to those detailed above for the treatment of aqueous waste streams. Specifically, the application rate of a composition according to the invention can be varied dependent on the amount of ammonia in the waste stream. Other aspects of the method, including duration of application, temperature of the waste stream and level of agitation once a composition of the invention has been added to the waste stream can all be varied to achieve optimum removal of ammonia from the waste stream.

[0031] In further embodiments, compositions of the invention can be used in methods of treating ammonia-contaminated soil. Soil which has been contaminated by ammonia as a result of industrial waste stream run-off, can be particularly difficult to remediate. In such circumstances, it is particularly important that the treatment is non-toxic to the environment. The compositions of the present invention are thus particularly well suited to such applications.

[0032] Any of the features described herein can be combined in any combination with any one or more of the other features described herein within the scope of the invention.

[0033] Preferred features, embodiments and variations of the invention may be discerned from the following Description of Embodiments which provides sufficient information for those skilled in the art to perform the invention. The Description of Embodiments is not to be regarded as limiting the scope of the preceding Summary of Invention in any way.

DESCRIPTION OF EMBODIMENTS

[0034] According to a first preferred embodiment of the present invention, a composition comprising two or more salts independently selected from alkali metal salts and alkali earth metal salts is provided.

[0035] The alkali metal salts can all be sodium salts, they can all be potassium salts, or they can all be calcium salts. In a further alternative, the composition can comprise a mixture of two or more salts, selected from sodium, potassium and calcium salts.

[0036] According to a second preferred embodiment of the present invention, a composition comprising two salts independently selected from alkali metal salts and alkali earth metal salts is provided. The two salts can both be sodium salts, they can both be potassium salts, or they can both be calcium salts. In a further alternative, the composition can comprise two different metal salts in any combination. For example, the composition can comprise a sodium salt and a potassium salt. A further composition could comprise a sodium salt and a calcium salt.

[0037] Compositions according to the first or second preferred embodiments can comprise the salts, being alkali metal salts or alkali earth metal salts, in any suitable molar ratio. According to the second preferred embodiment, the molar ratio of the two salts can be within the range of approximately 30:70 to 70:30.

[0038] According to a third preferred embodiment, a method is provided for treating a waste stream comprising ammonia, the method including the step of contacting said waste stream with a composition comprising two or more salts, independently selected from alkali metal salts and alkali earth metal salts.

[0039] According to this embodiment, following contact of said waste stream with a composition comprising two or more salts, independently selected from alkali metal salts and alkali earth metal salts, ammonia dissolved in the waste stream is released as ammonia gas.

[0040] The method can be adjusted to optimize the release of ammonia gas and thus reduction of ammonia in the waste stream, by varying factors such as the amount of composition added to the waste stream, the temperature of the waste stream, agitation of the waste stream, and the duration of treatment.

EXAMPLES

[0041] Anhydrous sodium carbonate (106 g, 1 mol) was combined with anhydrous sodium bicarbonate (84 g, 1 mol) to provide an equimolar mixture (EM). Different amounts of EM were added to brine samples (250 mL) originating from a refinery. Duplicate samples were kept at ambient conditions (day time temperature of 20 – 22°C) for 3 days with occasional agitation. At the end of the treatment period, the samples were analysed for remaining dissolved ammonia. The results of four treatments plus the control (brine with no EM) are provided in Table 1. The

results presented in the table are the individual values of the duplicate samples. The pH of the waste water samples remained at or under 9.6 during the treatment.

[0042] Table 1.

Sample No. (250 ml)	Treatment (amount of EM)	Ammonia (mg/L) (ppm)
1	5 g	54
2	5 g	58
3	10 g	2.4
4	10 g	2.4
5	15 g	0.82
6	15 g	0.60
7	20 g	0.40
8	20 g	0.34
Control (brine)	No added EM	2300

[0043] From the above data, it can be seen that water contaminated with ammonia to a level of 2300 mg/L can be treated with a composition of the invention, according to a method of the invention, thereby reducing the level of dissolved ammonia down to a range of 58 to 0.34 (mg/L). The compositions of the invention therefore result in a significant reduction in the level of dissolved ammonia in a waste stream.

[0044] The invention thus provides relatively inexpensive and non-toxic compositions for the treatment of ammonia-containing waste streams.

[0045] In the present specification and claims (if any), the word 'comprising' and its derivatives including 'comprises' and 'comprise' include each of the stated integers but does not exclude the inclusion of one or more further integers.

[0046] The reference to any prior art in this specification is not, and should not be taken as an acknowledgement or any form of suggestion that the prior art forms part of the common general knowledge in the art in Australia or in any other country.

[0047] Reference throughout this specification to 'one embodiment' or 'an embodiment' means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention. Thus, the appearance of the phrases 'in one embodiment' or 'in an embodiment' in various places

throughout this specification are not necessarily all referring to the same embodiment. Furthermore, the particular features, structures, or characteristics may be combined in any suitable manner in one or more combinations.

[0048] In compliance with the statute, the invention has been described in language more or less specific to structural or methodical features. It is to be understood that the invention is not limited to specific features shown or described since the means herein described comprises preferred forms of putting the invention into effect. The invention is, therefore, claimed in any of its forms or modifications within the proper scope of the appended claims (if any) appropriately interpreted by those skilled in the art.

CLAIMS

1. A composition comprising two or more salts, independently selected from alkali metal salts and alkali earth metal salts.
2. The composition of claim 1, wherein the alkali metal salts are independently selected from sodium and potassium salts.
3. The composition of claim 2, wherein the alkali metal salts are independently selected from sodium carbonate, potassium carbonate, sodium bicarbonate, potassium bicarbonate, sodium aluminium sulphate, potassium aluminium sulphate, sodium oxalate and potassium oxalate.
4. The composition of any one of claims 1 to 3, comprising a mixture of sodium carbonate and sodium bicarbonate.
5. The composition of claim 1, wherein the alkali earth metal salts are calcium salts.
6. The composition of claim 5, wherein the alkali earth metal salts are independently selected from calcium carbonate, calcium hydroxide and calcium oxide.
7. A composition comprising two salts, independently selected from alkali metal salts and alkali earth metal salts.
8. The composition of claim 7, wherein the alkali metal salts are independently selected from sodium and potassium salts.
9. The composition of claim 8, wherein the alkali metal salts are independently selected from sodium carbonate, potassium carbonate, sodium bicarbonate, potassium bicarbonate, sodium aluminium sulphate, potassium aluminium sulphate, sodium oxalate and potassium oxalate.
10. The composition of any one of claims 7 to 9, comprising a mixture of sodium carbonate and sodium bicarbonate.
11. The composition of claim 7, wherein the alkali earth metal salts are calcium salts.
12. The composition of claim 11, wherein the alkali earth metal salts are independently selected from calcium carbonate, calcium hydroxide and calcium oxide.

13. The composition of any one of claims 7 to 12, wherein the ratio of the two salts falls within the ratio range of approximately 30:70 to approximately 70:30.
14. The composition of claim 13, wherein the ratio of the two salts is approximately 30:70.
15. The composition of claim 13, wherein the ratio of the two salts is approximately 40:60.
16. The composition of claim 13, wherein the ratio of the two salts is approximately 50:50.
17. A composition comprising approximately equimolar amounts of two salts, independently selected from alkali metal salts and alkali earth metal salts.
18. The composition of claim 17, wherein the alkali metal salts are independently selected from sodium and potassium salts.
19. The composition of claim 18, wherein the alkali metal salts are independently selected from sodium carbonate, potassium carbonate, sodium bicarbonate, potassium bicarbonate, sodium aluminium sulphate, potassium aluminium sulphate, sodium oxalate and potassium oxalate.
20. The composition of any one of claims 17 to 19, comprising an equimolar mixture of sodium carbonate and sodium bicarbonate.
21. The composition of claim 17, wherein the alkali earth metal salts are calcium salts.
22. The composition of claim 21, wherein the alkali earth metal salts are independently selected from calcium carbonate, calcium hydroxide and calcium oxide.
23. A method for treating a waste stream comprising ammonia, the method including the step of contacting said waste stream with a composition comprising two or more salts, independently selected from alkali metal salts and alkali earth metal salts.
24. The method of claim 23, further comprising the step of agitating the waste stream.
25. The method of claim 24, wherein the step of agitating the waste stream is undertaken after the step of contacting said waste stream with said composition.
26. The method of claim 24 or claim 25, wherein the step of agitating is achieved by bubbling a gas through the waste stream.
27. The method of claim 26, wherein the gas is selected from nitrogen or air.

28. The method of claim 23 or claim 24, further comprising the step of heating the waste stream.
29. The method of claim 28, wherein the step of heating the waste stream is undertaken before, after, or during, the step of contacting said waste stream with said composition.
30. The method of any one of claims 23 to 30, wherein the step of contacting said waste stream with said composition results in a reduction of the ammonia content of said waste stream.
31. The method of claim 31, wherein said waste stream remains in contact with said composition for a period of 1 to 5 days.
32. The method of claims 32, wherein said waste stream remains in contact with said composition for a period of 3 to 5 days.
33. The method of claim 23 or claim 24, further comprising the step of filtering the treated waste stream.
34. The method of claims 23 or claim 24, further comprising the step of decanting the treated waste stream.
35. The method of claim 23, wherein the alkali metal salts are independently selected from sodium and potassium salts.
36. The method of claim 35, wherein the alkali metal salts are independently selected from sodium carbonate, potassium carbonate, sodium bicarbonate, potassium bicarbonate, sodium aluminium sulphate, potassium aluminium sulphate, sodium oxalate and potassium oxalate.
37. The method of claim 35 or claim 36, wherein the composition comprises a mixture of sodium carbonate and sodium bicarbonate.
38. The method of claim 23, wherein the alkali earth metal salts are calcium salts.
39. The method of claim 38, wherein the alkali earth metal salts are independently selected from calcium carbonate, calcium hydroxide and calcium oxide.
40. The method of any one of claims 23 to 39, wherein the waste stream is an aqueous waste stream.

41. The method of any one of claims 23 to 39, wherein the waste stream is a non-aqueous waste stream.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2012/000927

A. CLASSIFICATION OF SUBJECT MATTER

C02F 101/16 (2006.01) C02F 101/38 (2006.01) C02F 1/70 (2006.01) C02F 1/68 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
 EPOQUE (EPODOC/WPI) : Keywords - Ammoni+, Reduc+, +earth_metal+, alkali+metal+, calcium, sodium, potassium and like terms and C02F1/IC/EC, C02F101/IC/EC, C08K13/00/IC/EC, C08K3/24/LOW/IC/EC, C08K3/30/IC/EC, C01D1/IC/EC, C01D5/IC/EC, C01D7/IC/EC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	



Further documents are listed in the continuation of Box C



See patent family annex

* Special categories of cited documents:	
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
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INTERNATIONAL SEARCH REPORT		International application No.
C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		PCT/AU2012/000927
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2005/0145563 A1 (BOYD et al.) 07 July 2005 abstract, page 5: paragraph [0040], paragraph[0037], page 8: paragraph [0076], page 4: paragraph[0028], page 11: paragraph[0114], example 7, page 12: paragraph [0128], pages 9-10: paragraph [0091]	1-4, 7-10, 13-40
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X	US 4559076 A (YOUNG) 17 December 1985 column 6: lines 15-21 and columns 4-5: example	1, 2, 7, 8, 13-19, 21, 22
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Y	abstract	41

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/AU2012/000927

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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End of Annex

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

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