

ABSTRACT

A water purification composition and a method of preparing the same are disclosed. The water purification composition comprises of quartz particles having iron hydroxide and aluminium salt coated thereon, wherein the iron hydroxide and aluminium salt are formed *in-situ* by reacting an iron salt with aluminium hydroxide, the coated quartz particles heat stabilized by calcination. A method of removing arsenic from water using water purification composition is also disclosed.

Fig. 1

4 JUN 2013

WE CLAIM:

1. A water purification composition comprising quartz particles having iron hydroxide and aluminium salt coated thereon, wherein the iron hydroxide and aluminium salt are formed *in-situ* by reacting an iron salt with aluminium hydroxide, the coated quartz particles heat stabilized by calcination.
2. A water purification composition as claimed in claim 1, wherein the iron salt is selected from ferrous sulphate, ferric chloride or ferric nitrate.
3. A water purification composition as claimed in claim 1, wherein the iron salt and aluminium hydroxide are reacted in stoichiometric amounts.
4. A water purification composition as claimed in claim 1, wherein greater than stoichiometric amounts of aluminium hydroxide are reacted with stoichiometric amounts of iron salt.
5. A method for preparing a water purification composition comprising:

coating quartz particles with iron hydroxide and aluminium salt, wherein the iron hydroxide and aluminium salt are formed *in-situ* by reacting an iron salt with aluminium hydroxide;

drying and calcining the coated quartz particles to obtain heat stabilized coated quartz particles.
6. A method for preparing a water purification composition as claimed in claim 5, wherein the iron salt is selected from ferrous sulphate, ferric chloride or ferric nitrate.

7. A method for preparing a water purification composition as claimed in claim 5, wherein the iron salt and aluminium hydroxide are reacted in stoichiometric amounts.
8. A method for preparing a water purification composition as claimed in claim 5, wherein greater than stoichiometric amounts of aluminium hydroxide are reacted with stoichiometric amounts of iron salt.
9. A method for preparing a water purification composition as claimed in claim 5, wherein drying is carried out at a temperature of 120°C.
10. A method for preparing a water purification composition as claimed in claim 5, wherein drying is carried out for a time period of 2 hours.
11. A method for preparing a water purification composition as claimed in claim 5, wherein calcining is carried out at a temperature of 550°C.
12. A method for preparing a water purification composition as claimed in claim 5, wherein calcining is carried out for a time period of 5 hours.
13. A method of removing arsenic from water comprising:
 - passing water through manganese green sand to convert arsenite to arsenate;
 - and
 - further passing the water through a water purification composition capable of removing arsenate, the water purification composition comprising quartz particles having iron hydroxide and aluminium salt coated thereon, wherein the iron hydroxide and aluminium salt are formed *in-situ* by reacting an iron salt with aluminium hydroxide, the coated quartz particles are heat stabilized by calcination.

14. A method of removing arsenic from water as claimed in claim 13, further comprising passing the water through a water purification composition capable of removing arsenate, the water purification composition comprising quartz particles having iron hydroxide and aluminium salt coated thereon, wherein the iron hydroxide and aluminium salt are formed in-situ by reacting an iron salt with aluminium hydroxide, the coated quartz particles are heat stabilized by calcination.

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The present disclosure provides a water purification composition and method for preparing the same. The present disclosure also provides a method of removing arsenic from water.

BACKGROUND

Arsenic is a naturally occurring element in the earth's crust and can be found in many natural ecosystems. Various industrial activities such as smelting, petroleum refining, pesticide and herbicide manufacturing, glass and ceramic production generate arsenic containing wastewater. The presence of arsenic in natural waters may originate from geochemical reactions, industrial waste discharges or agricultural use of pesticides containing arsenic.

Arsenic is toxic to animals and plants, and thus, its introduction to water by natural processes or human activities is of potential health, environmental and ecological concern. Hyperpigmentation, skin cancer, liver cancer, circulatory disorders, and other ailments have been attributed to the presence of arsenic in drinking water. In natural water arsenic is found as an anion with two oxidation states i.e. As (III) and As (V).

The United States Environmental Protection Agency (USEPA) has identified arsenic as a group A “known” carcinogen. In response to the associated health concerns, the USEPA, in January 2001, lowered the maximum contaminant level (MCL) in drinking water to 10 µg/L (=10 ppb).

Several methods and compositions for reducing arsenic concentration have been studied and are being used currently. These methods include coagulation and precipitation using ferric chloride and sulfate, ion exchange, reverse osmosis and adsorption using activated carbon. However, these methods are inefficient in removing arsenic to an acceptably low level for drinking purposes. Further, such methods are expensive as they

require large amounts of chemicals and/or electricity thus making it unaffordable for many households.

Therefore, there is a need for an inexpensive and effective water purification composition for removal of contaminants including arsenic from water. There is also a need for an easy to perform method for preparing said water purification composition.

SUMMARY

A water purification composition is disclosed. The water purification composition comprises of quartz particles having iron hydroxide and aluminium salt coated thereon, wherein the iron hydroxide and aluminium salt are formed *in-situ* by reacting an iron salt with aluminium hydroxide, the coated quartz particles heat stabilized by calcination.

A method for preparing a water purification composition is also disclosed. The method comprises of coating quartz particles with iron hydroxide and aluminium salt, wherein the iron hydroxide and aluminium salt are formed *in-situ* by reacting an iron salt with aluminium hydroxide and drying and calcining the coated quartz particles to obtain heat stabilized coated quartz particles.

A method of removing arsenic from water is also disclosed. The method comprises of passing water through manganese green sand to convert arsenite to arsenate and further passing the water through a water purification composition capable of removing arsenate, the water purification composition comprising quartz particles having iron hydroxide and aluminium salt coated thereon, wherein the iron hydroxide and aluminium salt are formed *in-situ* by reacting an iron salt with aluminium hydroxide, the coated quartz particles are heat stabilized by calcination.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1: illustrates method of removing arsenic from water in accordance with an embodiment.

DETAILED DESCRIPTION

For the purpose of promoting an understanding of the principles of the invention, reference will now be made to embodiments and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended, such alterations and further modifications in the disclosed process, and such further applications of the principles of the invention therein being contemplated as would normally occur to one skilled in the art to which the invention relates.

It will be understood by those skilled in the art that the foregoing general description and the following detailed description are exemplary and explanatory of the invention and are not intended to be restrictive thereof.

Reference throughout this specification to “one embodiment” “an embodiment” or similar language 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, appearances of the phrase “in one embodiment”, “in an embodiment” and similar language throughout this specification may, but do not necessarily, all refer to the same embodiment.

The present disclosure provides a method for preparing a water purification composition and a water purification composition thereof. The method comprises of coating quartz particles with iron hydroxide and aluminium salt, wherein the iron hydroxide and aluminium salt are formed *in-situ* by reacting an iron salt with aluminium

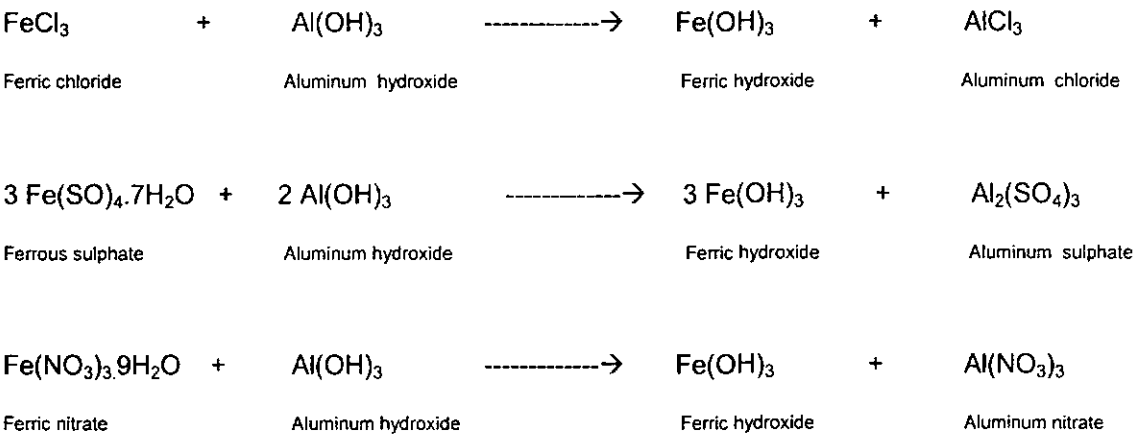
hydroxide. The method further comprises of drying and calcining the coated quartz particles to obtain heat stabilized coated quartz particles.

In accordance with an embodiment, the iron salt is selected from ferrous sulphate, ferric chloride or ferric nitrate.

In accordance with an embodiment, the iron salt and aluminium hydroxide are reacted in stoichiometric amounts. By way of example, 495 gms of ferric nitrate is reacted with 95.5 gms of aluminium hydroxide.

In accordance with an alternate embodiment, greater than stoichiometric amounts of aluminium hydroxide are reacted with stoichiometric amounts of iron salt. It is advantageous to keep aluminium hydroxide slightly in excess to ensure conversion of iron salt to iron hydroxide.

In accordance with an embodiment, the iron salt and aluminium hydroxide are reacted in distilled water to facilitate *in-situ* formation of iron hydroxide and aluminium salt. By way of example following reactions result in *in-situ* formation of iron hydroxide and aluminium salt, depending on iron salt used:



In accordance with an embodiment, drying is carried out at a temperature of 120°C.

In accordance with an embodiment, drying is carried out for a time period of 2 hours.

In accordance with an embodiment, calcining is carried out at a temperature of 550°C.

In accordance with an embodiment, calcining is carried out for a time period of 5 hours.

In accordance with an aspect, calcining of the coated quartz particles facilitates heat stabilization of the coated quartz particles, such that the heat stabilized coated quartz particles exhibits no or reduced leaching of iron hydroxide or aluminium salt when water is passed there through. Calcining facilitates densification and pore size reduction of the coated quartz particles due to increase in compaction and decrease in porosity. Calcining also provides structural strength and stability to the coated quartz particles.

Experiment conducted by using non-calcined coated quartz particles indicated a leaching of iron and aluminium into the treated water. On the other hand, sintering the coated quartz particles will likely occur in fusion between silicon and alkali metal oxides resulting in formation of glassy silicate or slag products in which case pore mouths will be closed and porosity lost.

The present disclosure also provides a water purification composition comprising quartz particles having iron hydroxide and aluminium salt coated thereon. The iron hydroxide and aluminium salt are formed *in-situ* by reacting an iron salt with aluminium hydroxide. The coated quartz particles are heat stabilized by calcination.

In accordance with an embodiment, the iron salt is selected from ferrous sulphate, ferric chloride or ferric nitrate.

In accordance with an embodiment, the iron salt and aluminium hydroxide are reacted in stoichiometric amounts.

In accordance with an alternate embodiment, greater than stoichiometric amounts of aluminium hydroxide are reacted with stoichiometric amounts of iron salt. It is advantageous to keep aluminium hydroxide slightly in excess to ensure conversion of iron salt to iron hydroxide.

In accordance with an aspect, the water purification composition exhibits no or reduced leaching of iron hydroxide or aluminium salt when water is passed there through. By way of example, passing of approximately 1500 litres of water through a column packed with 50 grams of the water purification composition results in no leaching of iron hydroxide and aluminium salt.

In accordance with an embodiment, the water purification composition is capable of removing arsenic, fluoride, phosphate, bromide, silicate and heavy metals from water.

In accordance with an embodiment, the water purification composition may be used in a pH range of 5-12 of input water.

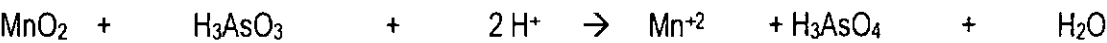
The present disclosure also provides a method of removing arsenic from water. The method comprises of passing water through manganese green sand to convert arsenite to arsenate and further passing the water through a water purification composition capable of removing arsenate, the water purification composition comprising quartz particles having iron hydroxide and aluminium salt coated thereon, wherein the iron hydroxide and aluminium salt are formed *in-situ* by reacting an iron salt with aluminium hydroxide. The coated quartz particles are heat stabilized by calcination.

In accordance with an embodiment, the method further comprises of passing the water through a water purification composition capable of removing arsenate, the water purification composition comprising quartz particles having iron hydroxide and aluminium

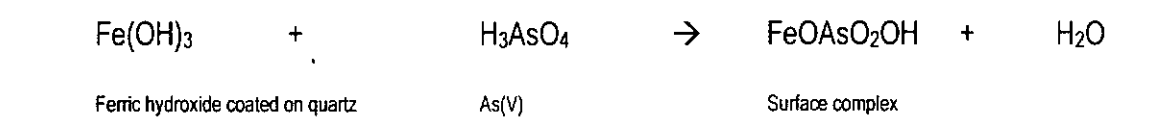
salt coated thereon, wherein the iron hydroxide and aluminium salt are formed *in-situ* by reacting an iron salt with aluminium hydroxide. The coated quartz particles are heat stabilized by calcination.

In accordance with an aspect, *in-situ* formation of iron hydroxide and aluminium salt facilitates adsorption of arsenate from water in an efficient manner thereby resulting in reduction in arsenic levels to acceptable limits. *In-situ* formed iron hydroxide in nascent form is very active and has higher affinity for arsenate and like ions.

In accordance with an aspect, manganese green sand facilitates oxidation of As(III) to As(V) in accordance with the following reaction:



In accordance with an embodiment, passing of water through the water purification composition facilitates adsorption of arsenate on water purification composition. By way of example, water having pH in a range of 6.5-7.5 is passed through the water purification composition to effect formation of a complex in accordance with the following reaction:



The complex formed is adsorbed on surface of the water purification composition. The complex formed is a bulky molecule that is retained by the water purification composition during molecular level filtration thereby allow arsenic free water to pass through the adsorbent bed.

In accordance with an aspect, the water purification composition exhibits no or reduced leaching of iron hydroxide or aluminium salt when water is passed there through.

The following example(s) of method for preparing a water purification composition and a water purification composition thereof are exemplary and should not be understood to be in any way limiting.

Example 1:

495 grams of ferric nitrate is added to 400 ml distilled water to obtain a solution. Followed by addition of 95.5 grams of aluminium hydroxide to facilitate *in-situ* formation of ferric hydroxide and aluminium nitrate. 500 grams of quartz particles are then added and mixed with the mixture obtained in the preceding step. Thus obtained mixture is then dried in a hot air oven at a temperature of 120 °C for a time period of 2 hours to remove moisture. The dried mixture is then subjected to calcination in a furnace at a temperature of 550 °C for a time period of 5 hours to obtain heat stabilized coated quartz particles.

Example 2:

82 grams of ferric chloride is added to 200 ml distilled water with stirring to obtain a solution. Followed by slow addition of 82 grams of aluminium hydroxide to the solution to facilitate *in-situ* formation of ferric hydroxide and aluminium chloride. 500 grams of quartz particles are then added and mixed with the mixture obtained in the preceding step. Thus obtained mixture is then dried in a hot air oven at a temperature of 120 °C for a time period of 2 hours to remove moisture. The dried mixture is then subjected to calcination in a furnace at a temperature of 550 °C for a time period of 5 hours to obtain heat stabilized coated quartz particles.

Example 3:

487 grams of ferrous sulphate is added to 250 ml distilled water with stirring to obtain a solution. Followed by slow addition of 137 grams of aluminium hydroxide to the

solution to facilitate *in-situ* formation of ferrous hydroxide and aluminium sulphate. 500 grams of quartz particles are then added and mixed with the mixture obtained in the preceding step. Thus obtained mixture is then dried in a hot air oven at a temperature of 120 °C for a time period of 2 hours to remove moisture. The dried mixture is then subjected to calcination in a furnace at a temperature of 550 °C for a time period of 5 hours to obtain heat stabilized coated quartz particles.

Example 4:

Experiments are conducted on bench scale single stage filtration using column packed with 50 gm of water purification composition as an adsorbent bed. Sand layer of 10 gm below the adsorbent bed and 10 gm above the adsorbent bed is placed to hold the adsorbent bed intact. Additionally, 10 gm manganese greensand is placed at the entry point for contacting contaminated input water to facilitate oxidation of As(III) to As(V). Figure 1 illustrates the flow of water in such single stage filtration.

Furthermore, experiments are also conducted in two stage filtration using columns packed with 25 gm each of water purification composition as an adsorbent bed. The output water from first stage is the input water for the second stage.

The output water obtained from the single and two stage filtration is analyzed using E Merck standard kit for arsenic analysis. Results are tabulated below:

Table 1: Column bed studies for arsenic removal from contaminated water

S. No.	Filter bed (quantity of water purification composition packed	Flow rate Lit/hr	Cumulative volume water	Arsenic input	Arsenic output

	in column)		passed (Lit)		
1.	F1 (25gm)	2.6	96	200 µg / Litre	25 µg / Litre
	F2 (25gm)	2.8	96	F1 output water	10 µg / Litre
2.	FS1 (25gm)	2.6	33	200 µg / Litre	10 µg / Litre
	FS2 (25gm)	2.9	33	FS1 output water	05 µg / Litre
3.	FN1 (25gm)	2.4	33	200 µg / Litre	10 µg / Litre
	FN2 (25gm)	2.8	33	FN1 output water	05 µg / Litre
4.	FCI 1 (50gm)	3.0	1416	200 µg / Litre	10 µg / Litre

Wherein:

F1 indicates filter bed packed with the water purification composition obtained by reacting ferric chloride and aluminum hydroxide.

F2 indicates filter bed packed with the water purification composition obtained by reacting ferric chloride and aluminum hydroxide.

FS1 indicates filter bed packed with the water purification composition obtained by reacting ferrous sulphate and aluminum hydroxide.

FS2 indicates filter bed packed with the water purification composition obtained by reacting ferrous sulphate and aluminum hydroxide.

FN1 indicates filter bed packed with the water purification composition obtained by reacting ferric nitrate and aluminum hydroxide.

FN2 indicates filter bed packed with the water purification composition obtained by reacting ferric nitrate and aluminum hydroxide.

FCI 1 indicates filter bed packed with the water purification composition obtained by reacting ferric chloride and aluminum hydroxide.

SPECIFIC EMBODIMENTS ARE DESCRIBED BELOW

A water purification composition comprising quartz particles having iron hydroxide and aluminium salt coated thereon, wherein the iron hydroxide and aluminium salt are formed *in-situ* by reacting an iron salt with aluminium hydroxide, the coated quartz particles heat stabilized by calcination.

Such water purification composition(s), wherein the iron salt is selected from ferrous sulphate, ferric chloride or ferric nitrate.

Such water purification composition(s), wherein the iron salt and aluminium hydroxide are reacted in stoichiometric amounts.

Such water purification composition(s), wherein greater than stoichiometric amounts of aluminium hydroxide are reacted with stoichiometric amounts of iron salt.

FURTHER SPECIFIC EMBODIMENTS ARE DESCRIBED BELOW

A method for preparing a water purification composition comprising coating quartz particles with iron hydroxide and aluminium salt, wherein the iron hydroxide and aluminium salt are formed *in-situ* by reacting an iron salt with aluminium hydroxide, drying and calcining the coated quartz particles to obtain heat stabilized coated quartz particles.

Such method(s), wherein the iron salt is selected from ferrous sulphate, ferric chloride or ferric nitrate.

Such method(s), wherein the iron salt and aluminium hydroxide are reacted in stoichiometric amounts.

Such method(s), wherein greater than stoichiometric amounts of aluminium hydroxide are reacted with stoichiometric amounts of iron salt.

Such method(s), wherein drying is carried out at a temperature of 120°C.

Such method(s), wherein drying is carried out for a time period of 2 hours.

Such method(s), wherein calcining is carried out at a temperature of 550°C.

Such method(s), wherein calcining is carried out for a time period of 5 hours.

FURTHER SPECIFIC EMBODIMENTS ARE DESCRIBED BELOW

A method of removing arsenic from water comprising passing water through manganese green sand to convert arsenite to arsenate and further passing the water through a water purification composition capable of removing arsenate, the water purification composition comprising quartz particles having iron hydroxide and aluminium salt coated thereon, wherein the iron hydroxide and aluminium salt are formed *in-situ* by reacting an iron salt with aluminium hydroxide, the coated quartz particles are heat stabilized by calcination.

Such method(s), further comprising passing the water through a water purification composition capable of removing arsenate, the water purification composition comprising quartz particles having iron hydroxide and aluminium salt coated thereon, wherein the iron hydroxide and aluminium salt are formed *in-situ* by reacting an iron salt with aluminium hydroxide, the coated quartz particles are heat stabilized by calcination.

INDUSTRIAL APPLICABILITY

The method of making a water purification composition described above is easy to perform and cost effective. The water purification composition described above is capable of effective removal of arsenic from water. Additionally, the water purification composition described above has high affinity for fluoride, phosphate, bromide, silicate and heavy metals thus showing synergistic effect during purification of water. The water purification composition exhibits no leaching of iron hydroxide or aluminium salt when water is passed there through.

Furthermore, the method of removing arsenic from water as described above is easy to perform and economical as there is no requirement of electricity. The said method can be easily scaled down to meet individual household requirements or scaled up to meet community requirements.

WE CLAIM:

1. A water purification composition comprising quartz particles having iron hydroxide and aluminium salt coated thereon, wherein the iron hydroxide and aluminium salt are formed *in-situ* by reacting an iron salt with aluminium hydroxide, the coated quartz particles heat stabilized by calcination.
2. A water purification composition as claimed in claim 1, wherein the iron salt is selected from ferrous sulphate, ferric chloride or ferric nitrate.
3. A water purification composition as claimed in claim 1, wherein the iron salt and aluminium hydroxide are reacted in stoichiometric amounts.
4. A water purification composition as claimed in claim 1, wherein greater than stoichiometric amounts of aluminium hydroxide are reacted with stoichiometric amounts of iron salt.
5. A method for preparing a water purification composition comprising:

coating quartz particles with iron hydroxide and aluminium salt, wherein the iron hydroxide and aluminium salt are formed *in-situ* by reacting an iron salt with aluminium hydroxide;

drying and calcining the coated quartz particles to obtain heat stabilized coated quartz particles.
6. A method for preparing a water purification composition as claimed in claim 5, wherein the iron salt is selected from ferrous sulphate, ferric chloride or ferric nitrate.

7. A method for preparing a water purification composition as claimed in claim 5, wherein the iron salt and aluminium hydroxide are reacted in stoichiometric amounts.
8. A method for preparing a water purification composition as claimed in claim 5, wherein greater than stoichiometric amounts of aluminium hydroxide are reacted with stoichiometric amounts of iron salt.
9. A method for preparing a water purification composition as claimed in claim 5, wherein drying is carried out at a temperature of 120°C.
10. A method for preparing a water purification composition as claimed in claim 5, wherein drying is carried out for a time period of 2 hours.
11. A method for preparing a water purification composition as claimed in claim 5, wherein calcining is carried out at a temperature of 550°C.
12. A method for preparing a water purification composition as claimed in claim 5, wherein calcining is carried out for a time period of 5 hours.
13. A method of removing arsenic from water comprising:
 - passing water through manganese green sand to convert arsenite to arsenate;
 - and
 - further passing the water through a water purification composition capable of removing arsenate, the water purification composition comprising quartz particles having iron hydroxide and aluminium salt coated thereon, wherein the iron hydroxide and aluminium salt are formed *in-situ* by reacting an iron salt with aluminium hydroxide, the coated quartz particles are heat stabilized by calcination.

14. A method of removing arsenic from water as claimed in claim 13, further comprising passing the water through a water purification composition capable of removing arsenate, the water purification composition comprising quartz particles having iron hydroxide and aluminium salt coated thereon, wherein the iron hydroxide and aluminium salt are formed in-situ by reacting an iron salt with aluminium hydroxide, the coated quartz particles are heat stabilized by calcination.

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