

PROCESS OF PREPARING A SOIL CONDITIONER

FIELD OF THE INVENTION

The present invention relates to a process of preparing a soil conditioner.

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BACKGROUND OF THE INVENTION

Organic waste such as animal manure, domestic wastewater sludge and palm oil mill by-products is often used as a fertilizer. Generally, aerobic treatment such as composting is required to convert the nutrient into plant-usable forms before applying the product to the field. The aerobic process is very time-consuming and usually requires months to complete. Further, the treatment processes give out strong unpleasant odours, severely compromising the working environment. The product in the form of sludge is also difficult to apply in large scale.

Other types of wastes such as palm oil mill effluent undergo a sequence of aerobic and anaerobic digestions in a series of treatment ponds, which not only occupy a large space but also take months to complete the treatment before the water meets the environmental discharge limit. The waste itself contains a good amount of nutrient content that are beneficial to plants. However, in most cases, these nutrients are discarded with the final discharge into rivers and drainage systems.

Therefore, there is a need for an improved process to prepare fertilizers from nutrient-rich waste streams.

SUMMARY OF INVENTION

The present invention seeks to address at least one of the problems in the prior art, and provides a simple process of preparing soil conditioners. In general terms, the invention relates to a process of preparing a soil conditioner in which various kinds of wet waste can be recycled in whole in a short period of time and processed into a soil conditioner, preferably a solid soil conditioner.

The soil conditioner prepared from the process of the present invention may also be further processed into a slow-release fertilizer which has further advantages such as slow-release of nutrients thereby improving nutrient use efficiency (NUE) and reducing nutrient leaching and run-off.

The advantage of the process is that the process is able to prepare soil conditioners from nutrient-rich waste streams and sludge using a fast process while mitigating emission of foul odours. In particular, the process is a simple and low-cost process, as well as environmentally friendly since the process consumes low-energy.

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In a particular expression of the invention there is provided a process of preparing a soil conditioner according to claim 1. Embodiments may be implemented according to any of its dependent claims.

10 BRIEF DESCRIPTION OF FIGURES

Figure 1 illustrates the release of nutrients by commercial compound fertilizer A;

Figure 2 illustrates the release of nutrients by commercial compound fertilizer B;

Figure 3 illustrates the release of nutrients by the soil conditioner according to one embodiment of the present invention; and

15 Figures 4(A), (B) and (C) illustrate the release of nutrients of different forms of the soil conditioner according to one embodiment of the present invention.

DETAILED DESCRIPTION

The present invention provides a process of producing a pH regulated soil conditioner involving the treatment of liquid-containing waste. In particular, the process of the present invention converts a liquid or slushy waste into a solid soil conditioner in a short period of time. The liquid from the liquid-containing waste may be contained within the soil conditioner, thus avoiding the need for a drying step. In this way, the process is a low-cost and low energy consuming method as it avoids use of high temperatures for a drying step.

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According to a first aspect, there is provided a process of preparing a soil conditioner comprising mixing liquid-containing waste with a plaster to form a mixture.

30 In an embodiment of the invention, the process may further comprise adding a pH modifying agent to adjust the pH of the mixture to a pre-determined level.

For the purposes of the present invention, a soil conditioner is defined as a product which may be added to soil to improve the soil's physical qualities, particularly to provide nutrients for plants. The soil conditioner may be a fertilizer. The soil conditioner may be in any suitable form. For example, the soil conditioner may be in the form of slush,

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sludge, gel or solid form. According to a particular aspect, the soil conditioner may be in solid form.

Any suitable liquid-containing waste may be used for the purposes of the present invention. For the purposes of the present invention, a liquid-containing waste is defined as a waste which contains water or moisture. The liquid-containing waste may be in any form such as a sludge, slurry, suspension, solution or liquid water. According to a particular aspect, the liquid-containing waste may be selected from the group consisting of: compost, wastewater, wastewater sludge, manure, palm oil mill effluent, and a combination thereof. The wastewater sludge may be domestic wastewater sludge, industrial wastewater sludge, or a mixture thereof. The palm oil mill effluent may be in the form of palm oil mill effluent sludge.

Any suitable plaster may be used for the purposes of the present invention. For the purposes of the present invention, the plaster may be defined as a powdery material that may be mixed with water to form a paste which liberates heat and solidifies after setting for a period of time; alternatively or additionally, the plaster may be defined as a calcium precipitate formed by the reaction of a calcium precursor and another chemical (e.g. a precipitating agent), which liberates heat and solidifies after setting for a period of time. According to a particular aspect, the plaster may be, but not limited to, gypsum plaster, lime plaster, or a combination thereof. For example, the lime plaster may comprise calcium oxide or calcium hydroxide. In particular, the lime plaster may be hydrated lime, quicklime, burnt dolomite, or a combination thereof. According to a particular aspect, the plaster may be formed *in situ* by reacting a calcium precursor with another chemical (e.g. a precipitating agent) to form a calcium precipitate, which has the property of a plaster.

In a further embodiment of the invention, the process may further comprise mixing liquid-containing waste with a calcium precursor compound to form a precursor mixture and adding a precipitating agent to the precursor mixture to form the plaster and liquid-containing waste mixture. It will be understood that the process may make use of both plaster and materials to form plaster *in situ*. That is, in further embodiments of the invention, the precursor mixture may further comprise plaster.

For the purposes of the present invention, the calcium precursor may be defined as a calcium compound or mineral that can react with a precipitating agent to form insoluble or low-solubility calcium compounds. For example, the calcium precursor may be calcium oxide, calcium hydroxide, calcium carbonate, a combination thereof or a mineral

comprising one or more of calcium oxide, calcium hydroxide and calcium carbonate. For example, the calcium precursor may be in the forms of limestone powder, hydrated lime, dolomite powder, calcite powder, any calcium containing mineral that has a reactive calcium compound, or a combination thereof.

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According to a particular aspect, the process may further comprise adding an absorbent. In particular, the absorbent may be mixed with the plaster and calcium-containing chemical to improve the containment of the liquid from the liquid-containing waste in the mixture. Any suitable absorbent may be used for the purposes of the present invention.

10 For the purposes of the present invention, an absorbent is defined as a substance that is suitable for retaining a large amount of liquid. According to a particular aspect, the absorbent may be a polymer. The polymer may be any suitable polymer which has liquid-retaining properties. For example, the absorbent may be selected from the group consisting of: polyallylamine, polyacrylamide, copolymer of acrylate, acrylamide, 15 polysaccharide, derivatives thereof, and a combination thereof. According to a particular aspect, the absorbent may be an organic-inorganic composite comprising an absorbent polymer and an inorganic moiety. For example, the inorganic moiety may be selected from the group consisting of: clay, mineral, silica, and a combination thereof.

20 The liquid-containing waste, calcium precursor and plaster may be mixed in any suitable proportion. According to a particular aspect, the weight ratio of the calcium oxide equivalent or equivalents (CaOeq) to the liquid-containing waste may be 1:1-1:6. For the purposes of the present invention, CaOeq is defined as the total amount of calcium in the mixture calculated in the form of CaO that can react with the precipitating agent in a 25 manner similar to CaO to yield the same calcium precipitate, including those that already exist in a precipitated form. For example, 1 kg of gypsum plaster ($\text{CaSO}_4 \cdot \text{H}_2\text{O}$, Mw 145) has a CaOeq of 386 g. In particular, the weight ratio of CaOeq to liquid-containing waste may be 1:1.5-1:5.5, 1:2-1:5, 1:2.5-1:4.5, 1:3-1:4. A higher CaOeq to liquid-containing waste ratio favours fast solidification and higher mechanical strength of the product.

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The solid content in the liquid-containing waste may affect the solidification of the soil conditioner. In particular, a higher solid content in the liquid-containing waste may facilitate solidification of the soil conditioner. Accordingly, if the liquid-containing waste has low moisture content, less CaOeq may be added.

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Any suitable pH modifying agent may be used for the purposes of the present invention to adjust the pH of the mixture to a suitable pH for a specific application. In particular,

any suitable pH modifying agent which is able to adjust the pH of the mixture to a pre-determined level may be used. Even more in particular, the pre-determined level may be 4.5-10. For example, the mixture may have a high pH. Accordingly, the pH modifying agent may be an acidic chemical agent. The pH modifying agent may be added to adjust the pH by neutralising the high pH of the mixture. According to a particular aspect, the pH modifying agent may be selected from the group consisting of: sulphuric acid, bisulphate salt, sulphurous acid, sulfamic acid, bisulphite salt, phosphoric acid, acidic phosphate salt, citric acid, acidic citrate salt, oxalic acid, acidic oxalate salt, and a combination thereof. In particular, the pH may be adjusted to a pH of 4.5-10 in order to achieve solidification of the soil conditioner. If the pH is adjusted to a very acidic pH, the soil conditioner may be in a soft or slushy form. The pH value of the soil conditioner dictates the individual nutrient release rate. In particular, a higher pH may hinder the phosphorus release. A good balanced release of nutrients from the soil conditioner may be achieved at a pH of 6.3. A lower pH may be desirable with some acid tolerant plant species.

If a calcium precursor is used, a precipitating agent needs to be added to the mixture of liquid-containing waste and calcium precursor. Any suitable precipitating agent may be used for the purposes of the present invention to solidify the mixture. In particular, any precipitating agent that reacts with the calcium precursor to form a plaster may be used as the precipitating agent for the purposes of the present invention. In particular, the precipitating agent comprises, but is not limited to, sulphuric acid, sulphate salt, bisulphate salt, sulphurous acid, sulphite salt, bisulphite salt, sulfamic acid, phosphoric acid, phosphate salt, citric acid, citrate salt, oxalic acid, oxalate salt, and a combination thereof. More particularly, the precipitating agent comprises one or more of the group selected from sulphuric acid, sulphate salt, bisulphate salt, citric acid and citrate salts. In particular, the pH modifying agent and the precipitating agent added may be the same or the different. When the pH modifying agent is the same as the precipitating agent, it will be understood that only one of the two is required to be added to the mixture since the pH modifying agent and the precipitating agent are the same.

According to a particular aspect, the liquid content of the liquid-containing waste is contained within a solid matrix formed during the solidification of the mixture of liquid-containing waste and plaster. A certain percentage of the liquid may be lost through evaporation during the process. The advantage of the process of the present invention is that no further heating is required to reduce the liquid content of the liquid-containing

waste since the mixing of the final product is able to contain the liquid content. In this way, the overall process time is reduced and energy consumption is also reduced.

5 The physical integrity of the soil conditioner may be influenced by the amount of CaOeq in the mixture. In particular, a higher concentration of CaOeq in the mixture facilitates the solidification of the mixture, thereby improving the physical strength of the soil conditioner. *In situ* formation of the plaster enhances the solidification of the product and improves the physical strength of the product compared to adding a pre-prepared, powdered plaster (e.g. gypsum plaster) to form the mixture directly.

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The process may further comprise stirring the mixture for a pre-determined period of time to form a homogeneous plaster mixture and accelerate the precipitation of the calcium salt and absorption of the liquid comprised in the liquid-containing waste. The liquid comprised in the liquid-containing waste may be water. The pre-determined period
15 of time may be any suitable period of time. For example, the pre-determined period of time may be 15-300 seconds. In particular, the pre-determined period of time may be 20-280 seconds, 30-250 seconds, 40-220 seconds, 50-200 seconds, 60-190 seconds, 70-180 seconds, 80-160 seconds, 90-150 seconds, 100-140 seconds, 110-130 seconds, 120-120 second, 110-115 seconds.

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The process may further comprise adding a buffering agent. For the purposes of the present invention, a buffering agent is defined as a reagent with multiple dissociation states to maintain the acidity of a solution near a chosen value after the addition of a pH modifying agent. In particular, the buffering agent may stabilize the pH of the mixture.
25 Any suitable buffering agent may be used for the present invention. For example, the buffering agent may include, but is not limited to, various salts of citric acid, various salts of phosphoric acid, or a combination thereof.

According to a particular aspect, the process may further comprise adding a nutrient-
30 containing compound. The nutrient-containing compound may be any suitable compound which provides additional fertilizer nutrients to the soil conditioner. For example, the nutrient-containing compound may be any suitable compound, including but not limited to, muriate of potash (MOP) (potassium chloride), potassium bicarbonate, potassium carbonate, potassium sulphate, potassium silicate, potassium nitrate,
35 potassium hydrogen sulphate, monopotassium phosphate, dipotassium phosphate, tripotassium phosphate, ammonium chloride, ammonium bicarbonate, ammonium carbonate, ammonium phosphate, ammonium phosphate dibasic (DAP), ammonium

phosphate monobasic (MAP), urea, ammonium hydrogen sulphate, ammonium sulphate, ammonium nitrate, calcium nitrate, magnesium sulphate, calcium magnesium carbonate ($\text{CaMg}(\text{CO}_3)_2$) (dolomite), burnt dolomite, magnesium nitrate, magnesium oxide, boric acid, boron oxide, sodium tetraborate, disodium octaborate tetrahydrate, or a combination thereof. The magnesium sulphate may be in the form of Epsom salt or kieserite.

Any suitable amount of the nutrient-containing compound may be added to the mixture. In particular, the amount of the nutrient-containing compound added to the mixture may depend on the final nutrient rating desired for the soil conditioner. The nutrient rating desired may depend on which type of plant the soil conditioner is used for and/or the growing stage of the plant.

The nutrient-containing compound may be added at any stage of the process. In particular, the nutrient-containing compound may be added to the liquid-containing waste before mixing with the calcium precursor and/or the plaster. In particular, the nutrient-containing compound may be added at any suitable time so as not to hinder the formation of the calcium salt precipitates formed when the precipitating agent is added or the setting of the plaster. For example, the nutrient-containing compound may be added after the liquid-containing waste is mixed with the calcium precursor and/or plaster and after the pH is adjusted to the pre-determined level by the pH modifying agent.

According to another particular aspect, the nutrient-containing compound may be added to the calcium precursor and/or the plaster before the calcium precursor and/or the plaster are mixed with the liquid-containing waste, provided the nutrient-containing compounds do not hinder the formation of the calcium salt precipitates or the setting of the plaster. For example, urea may be mixed with the gypsum to form a homogeneous powder mixture before mixing with the liquid-containing waste.

According to another particular aspect, the pH modifying agent, precipitating agent and/or the buffering agent may be added to the liquid-containing waste before the addition of the calcium precursor and/or plaster. For example, sulphuric acid may be added to the liquid-containing waste followed by mixing with calcium oxide. Subsequently, the nutrient-containing compound may be added to the mixture.

According to another particular aspect, the pH modifying agent, precipitating and/or the buffering agent may be mixed with the nutrient-containing compound. This mixture may

then be added to the liquid-containing waste, calcium precursor and/or plaster mixture. For example, potassium hydrogen sulphate and/or citric acid may be mixed with the nutrient-containing compound to form a mixture. Subsequently, the mixture may be added to the pre-formed mixture of liquid-containing waste and calcium oxide.

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According to another particular aspect, the mixture may be mixed with biomass to improve its mechanical property and soil amendment property. The biomass may be added at any suitable time during the process. For example, the biomass may be added to the liquid-containing waste before the addition of the plaster and/or calcium precursor, or after mixing all the ingredients. The biomass may be any suitable biomass. For example, the biomass may be any suitable plant-based material which provides plant fiber to the soil conditioner. In particular, the biomass may be any suitable plant-based material, including but not limited to, compost, wood dust, grass, shredded empty fruit bunch, shredded mesocarp fiber, or a combination thereof. The biomass may further provide fertilizer nutrients to the soil conditioner.

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The process may further comprise casting the mixture into a mould to form a solid soil conditioner of any suitable shape and size. The casting may be by any suitable means. For example, the casting may be by, but not limited to, moulding, extrusion, or briquetting. According to a particular aspect, the soil conditioner may be cast into small blocks of a suitable surface area to volume ratio. In particular, when the soil conditioner has a suitable surface area to volume ratio, the soil conditioner may have slow-release properties. The advantage of a soil-conditioner with slow-release properties include increased nutrient use efficiency, improved crop yield and quality, reduced toxicity to plants, and less environmental impact by limiting nutrient leaching and run-off. As compared to other known methods of manufacturing slow-release soil conditioners such as those requiring coating technologies of a polymer or sulphur coating or those requiring aerobic and/or anaerobic treatment of organic waste, the present process is a simple and low-cost method for the reasons already mentioned above.

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The setting time of the soil conditioner product varies between 0.1 minute to 3 days. The following conditions will favour a fast setting: a high CaOeq in the mixture, use of *in situ* calcium salt precipitation instead of pre-formed plaster, low liquid containing waste to CaOeq ratio, high solid content in the liquid containing waste, neutral or basic pH.

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According to another aspect, the present invention provides a soil conditioner prepared from the process described above.

Whilst exemplary embodiments of the invention have been described in detail, many variations are possible within the scope of the invention as will be clear to a skilled reader.

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EXAMPLES

Example 1

27.0 litres of liquid-containing waste was mixed with 9.4 kg of calcium oxide powder (NSL Chemicals (M) Sdn Bhd) to form a mixture. The mixture was stirred at a speed of 100-150 rpm until a homogeneous suspension was formed. 6.8 kg of sulphuric acid (95%, BDH) and 9.9 kg of phosphoric acid (85%, Merck) were added to the mixture and the mixture was further stirred until a homogeneous mixture was obtained. A soil conditioner having a pH of 6.8 was prepared within 1 hour.

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Example 2

6.2 litres of liquid-containing waste was mixed with 1.4 kg of calcium oxide powder (NSL Chemicals (M) Sdn Bhd) and 0.15 kg of absorbent to form a mixture. The mixture was stirred at a speed of 100-150 rpm until a homogeneous suspension was formed. A mixture of 5.44 kg of potassium hydrogen sulphate (GCE), 4.14 kg of diammonium phosphate (Alfa Aesar), 1.55 kg of citric acid (BDH), 3.85 kg of ammonium nitrate (Sigma-Aldrich) and 2.26 kg of dolomite powder (15.9% MgO, 38.0% CaO) was added to the mixture and the mixture was further stirred until the mixture was well blended. The mixture was cast into a mould to form a solid soil conditioner with slow-release properties with a nutrient rating of 8.8-8.8-7.5-1.4 and a pH of 6.2.

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Example 3

8.5 litres of liquid-containing waste was mixed with 1.2 kg of calcium oxide powder (NSL Chemicals (M) Sdn Bhd) and 0.2 kg of absorbent to form a mixture. The mixture was stirred at a speed of 100-150 rpm until coagulation initiated. 1.5 litres of sulphuric acid (95%, BDH) was slowly added to the mixture and stirred continuously. Subsequently, a mixture of 2.7 kg of potassium sulfate (Alfa Aesar), 3.2 kg of diammonium phosphate (Alfa Aesar), 4.9 kg of ammonium sulphate (BDH) and 1.7 kg of dolomite powder (15.9% MgO, 38.0% CaO) was added to the mixture and the mixture was further stirred until the mixture was well blended. The mixture was cast into a mould to form a solid soil conditioner with a nutrient rating of 6.7-6.7-5.7-1.1 and a pH of 6.3.

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Example 4

167 litres of liquid-containing waste was mixed with 24.79 kg of calcium oxide powder (NSL Chemicals (M) Sdn Bhd), 3.06 kg of absorbent and 34.68 kg of dolomite powder (15.9% MgO, 38.0% CaO) to form a mixture. The mixture was stirred at a speed of 100-
5 150 rpm until coagulation initiated. 30.28 litres of sulphuric acid (95%, BDH) was slowly added to the mixture and stirred continuously. Subsequently, a mixture of 54.18 kg of potassium sulfate (Alfa Aesar), 63.23 kg of diammonium phosphate (Alfa Aesar), and 97.21 kg of ammonium sulphate (BDH) was added to the mixture and the mixture was further stirred until the mixture was well blended. The mixture was cast into a mould to
10 form a solid soil conditioner with a nutrient rating of 6.4-6.4-5.5-1.4 and a pH of 6.3.

Example 5

7.35 litres of liquid-containing waste was mixed with 3.08 kg of gypsum plaster ($\text{CaSO}_4 \cdot 1/2\text{H}_2\text{O}$) (Merck) to form a mixture. The mixture was stirred at a speed of 100-
15 150 rpm until a homogeneous suspension was formed. A mixture of 2.64 kg of potassium sulfate (Alfa Aesar), 3.08 kg of diammonium phosphate (Alfa Aesar), and 4.74 kg of ammonium sulphate (BDH) was added to the mixture and the mixture was further stirred until the mixture was well blended. The mixture was cast into a mould to form a solid soil conditioner with a nutrient rating of 6.8-6.8-5.8 and a pH of 7.7.

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Example 6

The soil conditioner prepared in example 3 was subjected to a slow-release test by submerging about 10 g of the soil conditioner in 200 mL of deionized water. Sampling was done every half hour and the water was replaced with fresh deionized water for the
25 next soaking period. As controls, two commercial compound fertilizers labeled as CF-A (Bluesky 15-9-20-2MgO-4S) and CF-B (Behn Meyer 12-12-17-2MgO-8S) were tested under the same procedure as the slow-release soil conditioner. The solvent extracts were analysed by total organic carbon/total nitrogen (TOC/TN) and inductively coupled plasma (ICP) for nitrogen (N), phosphorus (P) and potassium (K) concentrations. Acid
30 digestion of the soil conditioner and the two commercial fertilizers was done using concentrated nitric acid in a microwave digester to obtain the total nutrient content of the product. The release curves of the two control commercial compound fertilizers and the slow-release soil conditioner are shown in Figures 1, 2 and 3, respectively.

35 Example 7

The slow-release property of the soil conditioner of example 4 is directly related to the form of the soil conditioner. The lower the surface area to volume ratio, the slower the

release of the nutrients from the soil conditioner. This is shown in Figures 4(A) to 4(C) in which the solid soil conditioner of example 4 was cast into three different forms. Form 1 was a whole piece of 10 g of soil conditioner having dimensions of 3x3x1 cm; Form 2 was a 10 g piece of soil conditioner which was cut into four pieces, each piece having a dimension of 1.5x1.5x1 cm; and Form 3 was 10 g soil conditioner which was completely crushed into crumbs. From Figures 4(A) to 4(C), it can be seen that Form 1 showed the best slow-release properties.

CLAIMS

MCSLLP

1. A process of preparing a solid soil conditioner comprising:
mixing liquid-containing waste with a plaster to form a mixture; and
5 adding a pH modifying agent to adjust the pH of the mixture to a pH level of 4.5-10, thereby solidifying the mixture to form a solid soil conditioner.
2. The process according to claim 1, wherein the process further comprises mixing
liquid-containing waste with a calcium precursor compound to form a precursor mixture
10 and adding a precipitating agent to the precursor mixture to form the plaster and liquid-containing waste mixture.
3. The process according to claim 2, wherein the precursor mixture further
comprises plaster.
- 15 4. The process according to claim 2 or 3, wherein the calcium precursor is calcium oxide, calcium hydroxide, calcium carbonate, a combination thereof or a mineral comprising one or more of calcium oxide, calcium hydroxide and calcium carbonate.
- 20 5. The process according to any one of claims 2 to 4, wherein the precipitating agent comprises one or more of the group selected from: sulphuric acid, sulphate salt, bisulphate salt, sulphurous acid, sulphite salt, bisulphite salt, sulfamic acid, phosphoric acid, phosphate salt, citric acid, citrate salt, oxalic acid, oxalate salt.
- 25 6. The process according to claim 5, wherein the precipitating agent comprises one or more of the group selected from: sulphuric acid, sulphate salt, bisulphate salt, sulfamic acid, citric acid and citrate salt.
7. The process according to any preceding claim, wherein the liquid-containing
30 waste is selected from the group consisting of: compost, wastewater, wastewater sludge, manure, palm oil mill effluent, palm oil mill effluent sludge and a combination thereof.
8. The process according to any preceding claim, wherein the pH modifying agent is
selected from the group consisting of: sulphuric acid, bisulphate salt, sulphurous acid,
35 sulfamic acid, bisulphite salt, phosphoric acid, acidic phosphate salt, citric acid, acidic citrate salt, oxalic acid, acidic oxalate salt, and a combination thereof.

9. The process according to any preceding claim, wherein the process further comprises adding an absorbent.

5 10. The process according to claim 9, wherein the absorbent is selected from the group consisting of: polyallylamine, polyacrylamide, copolymer of acrylate, acrylamide, polysaccharide, derivatives thereof, and a combination thereof.

11. The process according to any preceding claim, wherein the process further
10 comprises adding a buffering agent.

12. The process according to claim 11, wherein the buffering compound is selected from the group consisting of: salts of citric acid, salts of phosphoric acid, and a combination thereof.

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13. The process according to any preceding claim, wherein the process further comprises adding a nutrient-containing compound.

14. The process according to claim 13, wherein the nutrient-containing compound is
20 selected from the group consisting of: muriate of potash (MOP), potassium bicarbonate, potassium carbonate, potassium sulphate, potassium silicate, potassium nitrate, potassium hydrogen sulphate, monopotassium phosphate, dipotassium phosphate, tripotassium phosphate, ammonium chloride, ammonium bicarbonate, ammonium carbonate, ammonium phosphate, ammonium phosphate dibasic (DAP), ammonium
25 phosphate monobasic (MAP), urea, ammonium hydrogen sulphate, ammonium sulphate, ammonium nitrate, calcium nitrate, kieserite, magnesium sulphate, dolomite, burnt dolomite, magnesium nitrate, magnesium oxide, boric acid, boron oxide, sodium tetraborate, disodium octaborate tetrahydrate, and a combination thereof.

30 15. The process according to any preceding claim, wherein the process comprises stirring the mixture for a pre-determined period of time.

16. The process according to any preceding claim, wherein the process further comprises adding biomass to the mixture.

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17. The process according to any preceding claim, wherein the process further comprises casting the mixture into a mould to form the solid soil conditioner.