APPARATUS FOR MANUFACTURING NITROGEN-CONCENTRATED LIQUID FERTILIZER USING LIVESTOCK MANURE, AND MANUFACTURING METHOD OF NITROGEN-CONCENTRATED LIQUID FERTILIZER USING THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority under 35 U.S.C. §119 to Korean Patent Application No. 10-2016-0020454, filed on February 22, 2016, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The following disclosure relates to an apparatus for manufacturing a nitrogen-concentrated liquid fertilizer using livestock manure, and a manufacturing method of a nitrogen-concentrated liquid fertilizer using the same, and more particularly, to an apparatus for manufacturing a liquid nitrogen fertilizer containing high concentration nitrogen using livestock manure, and a manufacturing method of a nitrogen-concentrated liquid fertilizer using the same.

BACKGROUND

[0003] Livestock manure, which is a solid or liquid material generated during the metabolic process of

livestock, is a high concentration organic material having biochemical oxygen demand (BOD) of 20,000 to 30,000 ppm or so. The livestock manure is a material beneficial or harmful to nature and human depending on a degree of management and utility thereof and is a management target in order to prevent environmental contamination by resource recovery or suitably treating the livestock manure.

[0004] The livestock manure contains large amounts of organic materials, nitrogen, and phosphorus, and generation amount thereof is increasing every year. Compost and liquid fertilizers have been respectively produced by resource recovery of the livestock manure, but the livestock manure has not been actively utilized due to large problems such as a low fertilizer value, an insufficient storage space, high transportation cost, and the like.

[0005] If it is possible to concentrate a nitrogen active ingredient in the livestock manure to produce a high-quality liquid fertilizer, this technology is expected to increase a fertilizer value, secure a storage space, and decrease transportation cost.

[0006] In detail, a nitrogen concentration technology of concentrating the nitrogen active ingredient is a significantly useful technology of producing a high-quality liquid fertilizer by decompressing the livestock manure at

a high temperature to recover nitrogen in the livestock manure together with vapor.

[0007] However, due to a high concentration of suspended solids caused by characteristics of the livestock manure, bubbles may be generated at the time of decompression at a high temperature, such that concentration efficiency may be deteriorated, and there is difficulty in an operation. That is, generation of the bubbles at the time of decompression at a high temperature causes stop of the operation due to backflow of the bubbles to a recovery device, and causes contamination of an operation device.

[0008] Further, in the case in which the livestock manure is treated at a relative low temperature and room pressure in order to avoid generation of bubbles, this process takes a long time, and a huge economic loss such as a heat loss, and the like, may be caused.

[0009] As the related art, a manufacture device of a liquid fertilizer has been disclosed in Korean Patent Laid-Open Publication No. 2011-0007551.

[Related Art Document]

[Patent Document]

Korean Patent Laid-Open Publication No. 2011-0007551

SUMMARY

[0010] An embodiment of the present invention is directed to providing a novel apparatus for manufacturing a high-concentration and high-quality liquid fertilizer by removing bubbles generated at the time of heating livestock manure under reduced pressure.

[0011] Another embodiment of the present invention is directed to providing a manufacturing method of a liquid fertilizer using the apparatus according to the present invention.

[0012] Meanwhile, other objects of the present invention that are not described will be additionally considered as long as these objects may be easily deduced from the following detailed description and the effects.

[0013] In one general aspect, an apparatus for manufacturing a nitrogen-concentrated liquid fertilizer includes: a reaction tank 100 heating livestock manure accommodated therein under reduced pressure to extract vapor containing a nitrogen active ingredient; a cooling part 200 condensing the vapor containing the nitrogen active ingredient extracted in the reaction tank 100 to discharge a condensate; a recovery tank 300 recovering the condensate discharged from the cooling part 200; and a control part 150 controlling a temperature and pressure of the reaction tank 100, wherein the reaction tank 100 includes a bubble filtration part 130 disposed at a central

portion thereof to remove bubbles of the livestock manure generated at the time of heating the livestock manure under the reduced pressure, the bubble filtration part 130 including a bubble filter 131 convexly protruding downwardly along a central axis k of the reaction tank 100.

[0014] The bubble filtration part 130 may further include a bubble overflow prevention vessel 132 disposed above the bubble filter 131 to be spaced apart from the bubble filter 131, wherein the bubble overflow prevention vessel 132 includes a plurality of opening parts h provided at a lower end of a circumferential surface thereof, and the nitrogen active ingredient introduced into the opening hole h being transferred to the cooling part 200.

[0015] The apparatus for manufacturing a nitrogen-concentrated liquid fertilizer may further include: a pump part 400 decompressing the inside of the reaction tank 100 which is connected with the pump part 400 through the cooling part 200 and the recovery part 300; and a heating part 110 disposed in a lower portion of the reaction tank 100 to heat the livestock manure, wherein the pump part 400 and the heating part 110 are controlled by the control part 150.

[0016] The control part 150 may independently control a temperature and pressure of each of the reaction tank 100 and the cooling part 200 so as to satisfy the following

Correlation Equations 1 and 2:

[0017] [Correlation Equation 1]

[0018] $30\ ℃ \leq \Delta T \leq 80\ ℃$

[0019] (here, $\Delta T = T2-T1$, T2 is an internal temperature of the reaction tank 100, and T1 is an internal temperature of the cooling part 200)

[0020] [Correlation Equation 2]

[0021] $0.3\ \text{bar} \leq P \leq 0.8\ \text{bar}$

[0022] (here, P is a pressure of each of the reaction tank 100 and the cooling part 200).

[0023] In another general aspect, there is provided a manufacturing method of a nitrogen-concentrated liquid fertilizer using the apparatus for manufacturing a nitrogen-concentrated liquid fertilizer described above.

[0024] The manufacturing method of a nitrogen-concentrated liquid fertilizer may use the apparatus for manufacturing a nitrogen-concentrated liquid fertilizer described above, and include a) controlling a temperature and pressure of the reaction tank 100 to heat the livestock manure under the reduced pressure; and b) removing bubbles generated in step a) to extract only a vapor containing the nitrogen active ingredient.

[0025] In the manufacturing method of a nitrogen-concentrated liquid fertilizer according to an exemplary embodiment of the present invention, the temperature and

the pressure may satisfy the following Correlation Equations 1 and 2:

[0026] [Correlation Equation 1]

[0027] $30\ ℃ \leq \Delta T \leq 80\ ℃$

[0028] (here, $\Delta T = T2-T1$, T2 is an internal temperature of the reaction tank 100, and T1 is an internal temperature of the cooling part 200)

[0029] [Correlation Equation 2]

[0030] $0.3\ \text{bar} \leq P \leq 0.8\ \text{bar}$

[0031] (here, P is a pressure of each of the reaction tank 100 and the cooling part 200).

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] FIG. 1 is a schematic view of an apparatus for manufacturing a nitrogen-concentrated liquid fertilizer according to a first exemplary embodiment of the present invention.

[0033] FIG. 2 is a cross-sectional view of a reaction tank 100 according to the first exemplary embodiment of the present invention.

[0034] FIG. 3 is a cross-sectional view of a bubble filtration part 130 according to the first exemplary embodiment of the present invention.

[0035] FIG. 4 is a plan view taken along line l-l' of FIG. 3, as viewed downwardly along a central axis k of the

reaction tank 100.

[0036] FIG. 5 is a graph illustrating total nitrogen concentrations of nitrogen-concentrated liquid fertilizers in Example 1 according to the present invention and Comparative Examples 1 and 2.

[Detailed Description of Main Elements]

10: first transfer pipe, 21: refrigerant injection pipe, 22: refrigerant discharge pipe, 30: second transfer pipe, 40: third transfer pipe

100: reaction tank, 100p: reaction tank circumference portion, 100q: reaction tank lower end portion, 101: raw material inlet, 102: upper cover, 106: reaction tank support, 107: reaction tank drain valve

110: heating part, 111: heater, 112: temperature sensor

120: valve part, 121: exhaust valve, 122: vapor discharge valve, 123: negative pressure meter

130: bubble filtration part, 130p: bubble filtration circumference portion, 131: bubble filter, 132: bubble overflow prevention vessel, 132p: prevention vessel circumference portion. 132q: prevention vessel lower end portion

150: control part

200: cooling part, 210: cooling chamber, 220: cooler

300: recovery tank, 301: recovery tank discharge valve

400: pump part

DETAILED DESCRIPTION OF EMBODIMENTS

[0037] Hereinafter, the present invention will be described in detail. The accompanying Examples and drawings to be described below are provided by way of example so that the idea of the present invention can be sufficiently transferred to those skilled in the art to which the present invention pertains. In addition, technical terms and scientific terms used in the present specification have the general meaning understood by those skilled in the art to which the present invention pertains unless otherwise defined, and a description for the known function and configuration obscuring the gist of the present invention will be omitted in the following description and the accompanying drawings. Meanwhile, terms used in the present specification are to explain exemplary embodiments rather than limiting the present invention. Unless explicitly described to the contrary, a singular form includes a plural form in the present specification. The term “comprise” and/or “comprising” used in the present specification will be understood to imply the inclusion of stated constituents, steps, operations and/or elements but not the exclusion of any other constituents, steps, operations and/or elements. Terms used in the present specification, 'first', ‘second’, etc.

can be used to describe various components, but the components are not to be construed as being limited to the terms. The terms used in the present specification are only used to differentiate one component from other components. Hereinafter, in order to assist in understanding of the present invention, like reference numerals designate like elements throughout the specification.

[0038] In describing the present invention, the term “liquid fertilizer”, which is a liquid state fertilizer, means a nitrogen-concentrated liquid fertilizer using livestock manure.

[0039] In an environmental point of view, it is preferable that chemicals such as a defoamer, an adsorbent, an acidity regulator, and the like, are not used in an apparatus for manufacturing a nitrogen-concentrated liquid fertilizer. The reason is that use of the defoamer may rather decrease nitrogen concentration efficiency.

[0040] Meanwhile, in an economic point of view, an apparatus for manufacturing a nitrogen-concentrated liquid fertilizer capable of increasing a value and facilitating storage and delivery of the liquid fertilizer by producing a liquid fertilizer in which nitrogen is highly concentrated is preferable.

[0041] Therefore, an apparatus for manufacturing a

liquid fertilizer capable of highly concentrating nitrogen without using the chemical such as the defoamer or the acidity regulator, and manufacturing the liquid fertilizer within a short time has been further required.

[0042] Hereinafter, the present invention will be described in more detail with reference to the accompanying drawings.

[0043] FIG. 1 is a schematic view illustrating an apparatus for manufacturing a nitrogen-concentrated liquid fertilizer according to the present invention. As illustrated in FIG. 1, the apparatus for manufacturing a nitrogen-concentrated liquid fertilizer includes a reaction tank 100 heating livestock manure under reduced pressure to extract vapor containing a nitrogen active ingredient, a cooling part 200 condensing the vapor containing the nitrogen active ingredient extracted in the reaction tank 100 to discharge a condensed condensate, a recovery tank 300 recovering a liquid condensate containing the nitrogen active ingredient, which is condensed while being cooled by a refrigerant in the cooling part 200, a pump part 400, and a control part 150 controlling a temperature and a pressure of the reaction tank 100, wherein the reaction tank 100 includes a bubble filtration part 130 removing bubbles of the livestock manure in the reaction tank 100.

[0044] In detail, the reaction tank 100 accommodates

the livestock manure, and a heater 111 installed in the reaction tank 100 heats the livestock manure. At the same time, the inside of the reaction tank 100 is decompressed by the pump part 400 which is connected with the reaction tank 100 through the cooling part 200 and the recovery tank 300.

[0045] Here, since the livestock manure is evaporated under reduced pressure in a high-temperature subatmospheric state, bubbles are generated together with the nitrogen active ingredient. The bubbles deteriorate concentration efficiency of the apparatus for manufacturing a nitrogen-concentrated liquid fertilizer, cause operation stop due to a back flow of the bubbles to a recovery device, and cause contamination of an operation device.

[0046] More specifically, FIG. 2 is a cross-sectional view illustrating the reaction tank 100 according to an exemplary embodiment of the present invention in detail. As illustrated in FIGS. 2 and 3, the reaction tank 100 includes a reaction tank circumference portion 100p, an upper cover 102 disposed above the reaction tank circumference portion 100p to be spaced apart from the reaction tank circumference portion 100p, a bubble filtration part 130 including a coupling portion j1 coupled between the reaction tank circumference portion 100p and the upper cover 102 and a bubble filtration circumference

portion 130p contacting an inner surface of the reaction tank circumference portion 100p, a raw material inlet 101 penetrating simultaneously through portions of the reaction tank circumference portion 100p and the bubble filtration circumference portion 130p and introducing the above-mentioned livestock manure into the reaction tank 100 therethrough, a heating part 110 heating the livestock manure while penetrating through another portion of a lower end of the reaction tank circumference portion 100p, a reaction tank lower end portion 100q extended from a lower portion of the reaction tank circumference portion 100p and convexly protruding downwardly in a central axis k direction of the reaction tank 100, a reaction tank drain valve 107 installed at a lowermost end of the reaction tank lower end portion 100q and discharging a contaminant in the reaction tank 100, and a reaction tank support 106 supporting the reaction tank.

[0047] In detail, the upper cover 102 may be coupled to the coupling portion j1 of the bubble filtration part 130 and an upper portion of the reaction tank circumference portion 100p by a screw method or welding method so that the inside of the reaction tank 100 is sealed.

[0048] In addition, the upper cover 102 may further include an outlet, a detection hole, or the like, disposed on the upper cover 102 to be spaced part from each other by

a predetermined interval.

[0049] The reaction tank 100 according to the exemplary embodiment of the present invention may further include a valve part 120 disposed on the upper cover 102. The valve part 120 includes an exhaust valve 121 and a vapor discharge valve 122 which are disposed on the above-mentioned outlet and are connected with the outlet, and a negative pressure meter 123 which is disposed on the above-mentioned detection hole and is connected with the detection hole.

[0050] In detail, the exhaust valve 121 is installed at an upper left portion of the upper cover 102 for adjustment of a pressure in the reaction tank 100 and safety in an emergency , and the vapor discharge valve 122 is installed at an upper central portion of the upper cover 102 in order to adjust an amount of vapor generated in the bubble filtration part 130. In this case, the nitrogen active ingredient is contained in the vapor.

[0051] Further, the negative pressure meter 123 is installed at an upper right portion of the upper cover 102, and a sensor member of the negative pressure meter 123 may penetrate through the detection hole disposed below the negative pressure meter to protrude into a bubble overflow prevention vessel 132. Therefore, the negative pressure meter 123 may sense a pressure in the above-mentioned

reaction tank 100 or the bubble overflow prevention vessel 132.

[0052] Further, the exhaust valve 121, the vapor discharge valve 122, and the negative pressure meter 123 are each independently connected to the control part 150. Therefore, the negative pressure meter 123 transmits a signal such as the pressure of the reaction tank 100, or the like, to the control part 150, and again, the control part 150 controls an open degree of the vapor discharge valve 122 depending on the pressure of the reaction tank 100.

[0053] The heating part 110 includes the heater 111 and a temperature sensor 112, and the heater 111 and the temperature sensor 112 are each disposed to penetrate different portions of the reaction tank circumference portion 100p. The heater 111 heats the livestock manure, and the temperature sensor 112 senses a temperature of the above-mentioned livestock manure.

[0054] In addition, the heating part 110 is electrically connected to the above-mentioned control part 150, and the control part 150 controls input and output of the heater 111 and the temperature sensor 112. That is, the temperature sensor 112 senses the temperature in the reaction tank 100 to transmit the sensed temperature to the control part 150 as an electric signal, and the control

part 150 controls output of the heater 111 to heat the livestock manure depending on the temperature of the reaction tank 100.

[0055] The bubble filtration part 130 is installed in the reaction tank 100, upper and lower portions of the bubble filtration part 130 are opened, and the bubbles of the livestock manure generated at the time of heating the livestock manure in the reaction tank 100 under the reduced pressure are removed in the bubble filtration part 130.

[0056] In detail, the bubble filtration part 130 will be described with reference to FIG. 3. FIG. 3 is a cross-sectional view illustrating the bubble filtration part 130 according to the exemplary embodiment of the present invention in detail. The bubble filtration part 130 includes the bubble filtration circumference portion 130p, a bubble filter 131 disposed at a central portion of the inside of the bubble filtration circumference portion 130p, and the bubble overflow prevention vessel 132 disposed above the bubble filter 131 to be spaced apart from the bubble filter 131.

[0057] In addition, the bubble filtration part 130 may further include the coupling portion j1 coupled to an upper portion of a prevention vessel circumference portion 132p of the bubble overflow prevention vessel 132 and an upper surface of the bubble filtration circumference portion 130p

to thereby be coupled to the upper cover 102 of the reaction tank 100 as described above, a first support portion j2 coupling the bubble filtration circumference portion 130p and the bubble filter 131 to each other to support the bubble filter 131, and a second support portion j3 disposed in a lower portion of the inside of the bubble filtration circumference portion 130p to prevent a lower portion of the bubble filtration circumference portion 130p from being deformed.

[0058] Further, the bubble filtration part 130 may have various shapes, and preferably, the bubble filtration part 130 may have a cylindrical shape which is the same as that of the reaction tank 100. In addition, a portion of the bubble filtration circumference portion 130p may be perforated so that the above-mentioned livestock manure may be introduced into the reaction tank 100 through the raw material inlet 101.

[0059] The bubble filtration part 130 has a structure capable of being detached and attached to thereby be easily washed and maintained.

[0060] The bubble filter 131 is attached to the first support portion j2 to thereby be extended, and is formed in a structure in which the bubble filter 131 convexly protrudes downwardly along the central axis k of the reaction tank 100. Therefore, the bubble filter 131 may

significantly increase a contact with the bubbles generated from the livestock manure to remove a larger amount of the bubbles.

[0061] As an example, a surface of the bubble filter 131 contacting the bubbles of the livestock manure may be entirely or partially formed in mesh form or a filter net in which a plurality of net knots are formed, but the present invention is not limited thereto.

[0062] As an example, the first and second support portions j2 and j3 have a structure in which the bubbles or vapor may easily pass through the first and second support portions j2 and j3, but the present invention is not limited thereto.

[0063] Further, the bubble filtration circumference portion 130p is connected to an inner circumference surface of the reaction tank 100, which may prevent vibration by the livestock manure evaporated under the reduced pressure in the above-mentioned reaction tank 100, and allows the nitrogen active ingredient to be more stably extracted under severe conditions of a high temperature and low pressure.

[0064] The bubble overflow prevention vessel 132 according to the exemplary embodiment of the present invention includes a prevention vessel circumference portion 132p, a prevention vessel lower end portion 132q

extended from a lower end of the prevention vessel circumference portion 132p to be concavely depressed upwardly along the central axis k of the reaction tank 100, and a plurality of opening parts h formed in the lower end of the prevention vessel circumference portion 132p to be spaced apart from each other by a predetermined interval.

[0065] In detail, the opening part h is formed to penetrate through the lower end of the prevention vessel circumference portion 132p in a circular or polygonal cross-sectional shape, but is not limited thereto. The vapor containing the nitrogen active ingredient as described above is introduced into the bubble overflow prevention vessel 132 through the opening part h and is transferred to the cooling part 200 through the valve part 120 and a first transfer pipe 10.

[0066] According to the present invention, in order to more rapidly extract the nitrogen active ingredient, the temperature of the reaction tank 100 may be further increased, and the pressure thereof may be further decreased. In this case, the vapor passing through the bubble filter 131 may generate micro bubbles due to violent collisions and binding between the vapors.

[0067] In this case, the prevention vessel lower end portion 132q is formed to be concavely depressed upwardly along the central axis k of the reaction tank 100, such

that the micro bubbles may be confined in a concave empty space positioned outside the prevention vessel lower end portion 132q. Further, in the case in which the micro bubbles are boiled up, the micro bubbles may be removed by allowing the micro bubbles to collide with the concave prevention vessel lower end portion 132q, and it is possible to prevent the micro bubbles from being introduced into the opening part h at once. Here, the empty space means an empty space formed between the lower end of the prevention vessel circumference portion 132p and the outside of the concave prevention vessel lower end portion 132q.

[0068] In addition, a radius of curvature of the prevention vessel lower end portion 132q is not particularly limited, but is preferably 200 mm to 250 mm, and more preferably 220 mm to 240 mm.

[0069] Further, a degree of removal of the micro bubbles may be changed depending on a shape, a size, the number, or arrangement of the opening part h. For example, a flow rate at a moment which the micro bubbles are introduced into the opening part h may be rapidly increased depending on the size and the number of opening part h. The micro bubbles accelerated by an increase in flow rate collide with the prevention vessel lower end portion 132q bent upwardly to thereby be easily removed, which is more

preferable to achieve the object of the present invention.

[0070] Referring to FIG. 4, which is a plan view taken along line l-l'of FIG. 3, as viewed downwardly along a central axis k of the reaction tank 100, illustrates that the vapor is introduced through the plurality of opening parts h.

[0071] A ratio of a maximum diameter Dmax or maximum width Wmax of the opening part h to a diameter of the bubble overflow prevention vessel 132 may be in a range of 0.5 to 50:100, preferably, 1 to 20:100, and more preferably 5 to 10:100, but is not particularly limited thereto.

[0072] In addition, a ratio of a minimum diameter Dmin or minimum width Wmin of the opening part h to the diameter of the bubble overflow prevention vessel 132 may be in a range of 0.1 to 10:100, preferably, 0.5 to 5:100, and more preferably 0.5 to 2:100, but is not limited thereto.

[0073] As described above, as the apparatus for manufacturing a nitrogen-concentrated liquid fertilizer according to the present invention includes the bubble filtration part 130, no matter how much bubbles are formed from the above-mentioned livestock manure under the severe process conditions of a high temperature and reduced pressure, the apparatus for manufacturing a nitrogen-concentrated liquid fertilizer has an advantage in that the bubbles may be rapidly removed, and bubbles containing

other ingredients except for the nitrogen active ingredient are blocked, such that the liquid fertilizer containing high-concentration nitrogen may be manufactured.

[0074] Meanwhile, the nitrogen active ingredient in the livestock manure in the reaction tank 100 may be extracted by the control part 150 as described above. In this case, since the reaction tank 100 is in a high temperature and subatmospheric (reduced) pressure state, a concentration of the extracted nitrogen active ingredient may be significantly increased depending on an internal environment of the reaction tank 100.

[0075] That is, in the apparatus for manufacturing a nitrogen-concentrated liquid fertilizer according to the exemplary embodiment of the present invention, the control part 150 may independently adjust a temperature of each of the reaction tank 100 and the cooling part 200 so as to satisfy the following Correlation Equation 1, and independently adjust a pressure of each of the reaction tank 100 and the cooling part 200 so as to satisfy the following Correlation Equation 2.

[0076] [Correlation Equation 1]

[0077] $30\ ℃ \leq \Delta T \leq 80\ ℃$

[0078] (Here, $\Delta T = T2-T1$, T2 is an internal temperature of the reaction tank 100, and T1 is an internal temperature of the cooling part 200.)

[0079] [Correlation Equation 2]

[0080] $0.3 \text{ bar} \leq P \leq 0.8 \text{ bar}$

[0081] (Here, P is a pressure of each of the reaction tank 100 and the cooling part 200.)

[0082] For example, in the case in which the reaction tank 100 and the cooling part 200 satisfy Correlation Equations 1 and 2, an operation time of the apparatus for manufacturing a liquid fertilizer according to the present invention is shortened within 3 hours, preferably, 1 hour. Further, in addition to a decrease in the operation time, a nitrogen concentration of the liquid fertilizer may be 0.5 % or more, preferably, 0.8 % to 1.0%, and more preferably, 1.0% to 1.2%, but the present invention is not limited to the operation time and the nitrogen concentration of the liquid fertilizer.

[0083] Further, in order to achieve the object of the present invention, ΔT of Correlation Equation 1 may be preferably 40 to 70℃, and more preferably, 45℃ to 65℃, but the present invention is not limited thereto.

[0084] More specifically, in order to achieve the object of the present invention, the internal temperature of the reaction tank 100 may be 40℃ or more, preferably 50℃ to 90℃, and more preferably, 60℃ to 70℃, but the present invention is not limited to the temperature range of the reaction tank 100.

[0085] Further, in order to achieve the object of the present invention, P of Correlation Equation 2 may be preferably 0.3 bar to 0.8 bar, and more preferably, 0.4 bar to 0.6 bar, but the present invention is not limited thereto.

[0086] In detail, in order to achieve the object of the present invention, an internal pressure of the reaction tank 100 may be a subatmospheric pressure, preferably, 0.8 bar or less, and more preferably 0.6 bar or less, but the present invention is not limited to the pressure range of the reaction tank 100.

[0087] Referring to FIG. 1 again, the vapor containing the nitrogen active ingredient extracted from the livestock manure in the reaction tank 100 according to the present invention is transferred to a heat exchanger 211 of the cooling part 200 through the first transfer pipe 10 connected to the valve part 120.

[0088] In detail, the cooling part 200 may include a cooling chamber 210 and a cooler 220. The cooling chamber 210 is connected to the cooler 220 by a refrigerant injection pipe 21 and a refrigerant discharge pipe 22. A low-temperature refrigerant cooled by the cooler 220 is introduced into the heat exchanger 211 to cool the vapor containing the nitrogen active ingredient in the heat exchanger 211. As an example, the refrigerant may be a

liquid including water or gas including inert gas.

[0089] In addition, the cooling part 200 may further include a temperature and pressure sensor (not illustrated), a pressure control valve (not illustrated), and the like, but the present invention is not limited thereto.

[0090] Meanwhile, the heat exchanger 211 rapidly cools the vapor containing the nitrogen active ingredient, extracted in the reaction tank 100 to form the above-mentioned condensate. The condensate is discharged to a second transfer pipe 30 which is connected with the heat exchanger 211. As an example, the heat exchanger 211 may be a wound tube, and contain a stainless steel material having excellent heat transfer efficiency.

[0091] The recovery tank 300 is connected with the heat exchanger 211 by the second transfer pipe 30 and recovers the condensate condensed in the heat exchanger 211. In this case, the condensate means the nitrogen-concentrated liquid fertilizer according to the present invention.

[0092] Further, the recovery tank 300 may include a recovery tank discharge valve 301 at a lower portion thereof, and the recovery tank discharge valve 301 discharges the liquid fertilizer recovered in the recovery tank 300 to the outside.

[0093] The pump part 400 is connected with the

recovery tank 300 through a third transfer pipe 40 to decompress the inside of the recovery tank 300. As the inside of the recovery tank 300 is decompressed, the vapor containing the nitrogen active ingredient extracted in the reaction tank 100 is introduced into the cooling part 200 through the first transfer pipe 10 due to a difference in pressure between the reaction tank 100 and the cooling part 200, and the condensate obtained by rapidly cooling the vapor containing the nitrogen active ingredient in the cooling part 200 is introduced into the recovery tank 300 through the second transfer pipe 30.

[0094] As an example, in the apparatus for manufacturing a nitrogen-concentrated liquid fertilizer, the reaction tank 100, the cooling part 200, the recovery part 300, and the pump part 400 are sequentially connected with each other, and a continuous injection device (not illustrated) of the livestock manure is coupled to the raw material inlet 101 of the reaction tank 100, such that the apparatus for manufacturing a nitrogen-concentrated liquid fertilizer also has an advantage in that the nitrogen-concentrated liquid fertilizer may be continuously manufactured.

[0095] Further, in the apparatus for manufacturing a nitrogen-concentrated liquid fertilizer, a recovery amount of the liquid fertilizer per time may be 100 mL/hr to 300

mL/hr. The recovery amount per time may be preferably 150 mL/hr to 250 mL/hr, and more preferably 200 mL/hr to 250 mL/hr, but the present invention is not limited thereto.

[0096] Therefore, the apparatus for manufacturing a nitrogen-concentrated liquid fertilizer according to the present invention may have a liquid fertilizer production rate increased by about 400% as compared to an apparatus for manufacturing a nitrogen-concentrated liquid fertilizer which does not include the bubble filtration part 130.

[0097]

[0098] Further, the present invention provides a manufacturing method of a nitrogen-concentrated liquid fertilizer using the apparatus for manufacturing a nitrogen-concentrated liquid fertilizer described above.

[0099] In detail, in a manufacturing method of a nitrogen-concentrated liquid fertilizer using an apparatus for manufacturing a nitrogen-concentrated liquid fertilizer including a reaction tank 100 heating livestock manure under reduced pressure to extract a nitrogen active ingredient in a gas state, a cooling part 200 supplying a refrigerant for condensing the nitrogen active ingredient extracted in the reaction tank 100, and a recovery tank 300 recovering a liquid condensate containing the nitrogen active ingredient condensed by heat exchange with the refrigerant in the cooling part 200, the manufacturing

method includes: a) controlling a temperature and pressure of the reaction tank 100 to heat the livestock manure under the reduced pressure; and b) removing bubbles generated in step a) to extract only the vapor containing the nitrogen active ingredient of the livestock manure. The manufacturing method may further include c) condensing the vapor containing the nitrogen active ingredient.

[00100] In detail, the bubbles formed in step b) may be removed by the above-mentioned bubble filtration part 130. The bubble filtration part 130 may include at least one of the bubble filter 131 convexly protruding downwardly along the central axis of the reaction tank 100, and the bubble overflow prevention vessel 132 disposed above the bubble filter 131 to be spaced apart from the bubble filter 131 along the central axis of the reaction tank 100.

[00101] Further, in the manufacturing method of a nitrogen-concentrated liquid fertilizer according to an exemplary embodiment of the present invention, the temperature and the pressure may satisfy the following Correlation Equations 1 and 2.

[00102] [Correlation Equation 1]

[00103] $30\ ℃ \leq \Delta T \leq 80\ ℃$

[00104] (Here, $\Delta T = T2-T1$, T2 is an internal temperature of the reaction tank 100, and T1 is an internal temperature of the cooling part 200.)

[00105] [Correlation Equation 2]

[00106] $0.3\ \text{bar} \leq P \leq 0.8\ \text{bar}$

[00107] (Here, P is a pressure of each of the reaction tank 100 and the cooling part 200.)

[00108] Hereinafter, Examples will be provided in order to describe the present invention in more detail. However, the present invention is not limited to the following Examples.

[00109] Example 1

[00110] 1 L of livestock manure was injected into an raw material inlet 101 of a reaction tank 100, and a temperature of the livestock manure in the reaction tank 100 was maintained at 60℃. A pressure in the reaction tank 100 was 0.6 bar, and an operation time of the reaction tank 100 was 3 hours. Bubbles formed in the reaction tank 100 were removed by a bubble filtration part 130.

[00111] Thereafter, vapor discharged from the reaction tank 100 was converted into a condensate through a cooling part 200. At this time, a temperature of the cooling part 200 was 10 to 15℃.

[00112] The condensate discharged from the cooling part 200 was recovered in a recovery tank 300, and a nitrogen-concentrated liquid fertilizer according to the present invention was discharged through a discharge valve 301 of the recovery tank 300.

[00113] A recovery amount and a nitrogen concentration of the nitrogen-concentrated liquid fertilizer are illustrated in the following Table 1.

[00114] A total nitrogen concentration of the nitrogen-concentrated liquid fertilizer was measured using UV1800 (Shimadzu, Japan) based on Total Nitrogen-UV/Visible Spectrometry-Oxidation Method.

[00115] Comparative Example 1

[00116] A liquid fertilizer was manufactured in the same manner in Example 1 except that there was no bubble filtration part 130 in the reaction tank 100.

[00117] Comparative Example 2

[00118] A liquid fertilizer was manufactured in the same manner in Example 1 except that there was no bubble filtration part 130 in the reaction tank 100, the temperature of the livestock manure in the reaction tank 100 was maintained at 40℃, and the operation time was 9 hours.

[00119] [Table 1]

	Recovery Amount (mL)	Total Nitrogen Concentration (mg/L)
Example 1	700	12,703
Comparative Example 1	100	5,741

Comparative Example 2	700	8,430

[00120] Referring to Table 1 and FIG. 5, the total nitrogen concentration of the liquid fertilizer manufactured in Comparative Example 1 in which there was no bubble filtration part 130 was 5,741 mg/L, which is about 45% or so of the total nitrogen concentration in Example 1. Particularly, the recovery amount of the liquid fertilizer manufactured in Comparative Example 1 was significantly decreased to about 14% or so of the recovery amount in Example 1.

[00121] Further, in Comparative Example 2 in which there was no bubble filtration part 130, but the temperature of the livestock manure was decreased by 20℃ and the operation time was increased 3 times as compared to Example 1, the recovery amount of the liquid fertilizer was equal to that in Example 1, but the total nitrogen concentration was still about 66% or so of that in Example 1, such that the liquid fertilizer in Comparative Example 2 was also unsatisfactory as a high-concentration liquid fertilizer.

[00122] In addition, in Comparative Example 1, in the case of rapidly increasing the temperature of the livestock manure in the reaction tank 100, bubbles were generated, such that when the bubbles flowed backward to the cooling

part 200 and the recovery tank 300, there was a need to stop operation and wash the cooling part 200 and the recovery tank 300. Therefore, a heat loss and a nitrogen loss may occur. On the contrary, in Example 1, since the bubbles were removed in the bubble filtration part 130, it was possible to rapidly increase the temperature, and the operation was easy.

[00123] As described above, the apparatus for manufacturing a nitrogen-concentrated liquid fertilizer according to the present invention may extract the nitrogen active ingredient of the livestock manure at a high concentration to provide the high-quality liquid fertilizer.

[00124] Further, the apparatus for manufacturing a nitrogen-concentrated liquid fertilizer according to the present invention may prevent backflow of the bubbles at the time of decompression at a high temperature, and prevent contamination of the operation device due to backflow of the bubbles.

[00125] In addition, the apparatus for manufacturing a nitrogen-concentrated liquid fertilizer according to the present invention does not require a long-term treatment process at a low temperature and atmospheric pressure due to a risk of bubble generation, and thus, it is possible to save electric energy and shorten a process time.

[00126] Further, the apparatus for manufacturing a

nitrogen-concentrated liquid fertilizer according to the present invention may remove the bubbles generated at the time of decompression at a high temperature, such that a nitrogen concentration process may be stably performed, such that an operation may be facilitated.

[00127] In addition, since the apparatus for manufacturing a nitrogen-concentrated liquid fertilizer according to the present invention may be applied to existing equipment as it is, an installation cost and time may be decreased.

[00128] Further, the apparatus for manufacturing a nitrogen-concentrated liquid fertilizer according to the present invention does not use digested liquid manure but uses a raw liquid of the livestock manure, an additional process is not required.

[00129] Furthermore, since the apparatus for manufacturing a nitrogen-concentrated liquid fertilizer does not use the chemicals such as sulfuric acid, a defoamer, and the like, the fertilizer value may be improved.

[00130] Meanwhile, although not specifically stated in the present specification, effects expected by the technical features of the present invention, that is, effects stated in the present specification and latent effects thereof should be treated as the effects stated in

the specification of the present invention.

[00131] Hereinabove, although the present invention is described by specific matters, exemplary embodiments, and drawings, they are provided only for assisting in the entire understanding of the present invention. Therefore, the present invention is not limited to the exemplary embodiments. Various modifications and changes may be made by those skilled in the art to which the present invention pertains from this description.

[00132] Therefore, the spirit of the present invention should not be limited to the above-described embodiments, and the following claims as well as all modified equally or equivalently to the claims are intended to fall within the scope and spirit of the invention.

WHAT IS CLAIMED IS:

1. An apparatus for manufacturing a nitrogen-concentrated liquid fertilizer comprising:

a reaction tank heating livestock manure accommodated therein under reduced pressure to extract vapor containing a nitrogen active ingredient;

a cooling part condensing the vapor containing the nitrogen active ingredient extracted in the reaction tank 100 to discharge a condensate;

a recovery tank recovering the condensate discharged from the cooling part; and

a control part controlling a temperature and pressure of the reaction tank,

wherein the reaction tank includes a bubble filtration part disposed at a central portion thereof to remove bubbles of the livestock manure generated at the time of heating the livestock manure under the reduced pressure,

the bubble filtration part including a bubble filter convexly protruding downwardly along a central axis of the reaction tank.

2. The apparatus for manufacturing a nitrogen-concentrated liquid fertilizer of claim 1, wherein the bubble filtration part further includes a bubble overflow

prevention vessel disposed to be spaced apart from the bubble filter,

the bubble overflow prevention vessel including a plurality of opening parts provided at a lower end of a circumferential surface thereof, and

the nitrogen active ingredient introduced into the opening parts being transferred to the cooling part.

3. The apparatus for manufacturing a nitrogen-concentrated liquid fertilizer of claim 1, further comprising:

a pump part decompressing the inside of the reaction tank 100 which is connected with the pump part through the cooling part and the recovery part; and

a heating part disposed in a lower portion of the reaction tank to heat the livestock manure,

wherein the pump part and the heating part are controlled by the control part.

4. The apparatus for manufacturing a nitrogen-concentrated liquid fertilizer of claim 1, wherein the control part independently controls a temperature and pressure of each of the reaction tank and the cooling part so as to satisfy the following Correlation Equations 1 and 2:

[Correlation Equation 1]

$30\ ℃ \leq \Delta T \leq 80\ ℃$

(here, $\Delta T = T2-T1$, T2 is an internal temperature of the reaction tank, and T1 is an internal temperature of the cooling part)

[Correlation Equation 2]

$0.3\ bar \leq P \leq 0.8\ bar$

(here, P is a pressure of each of the reaction tank and the cooling part).

5. A manufacturing method of a nitrogen-concentrated liquid fertilizer using the apparatus for manufacturing a nitrogen-concentrated liquid fertilizer of claim 1, the manufacturing method comprising:

a) controlling the temperature and pressure of the reaction tank to heat the livestock manure under the reduced pressure; and

b) removing bubbles generated in step a) to extract only the vapor containing the nitrogen active ingredient.

6. The manufacturing method of claim 5, wherein the temperature and pressure satisfy the following Correlation Equations 1 and 2:

[Correlation Equation 1]

$30\ ℃ \leq \Delta T \leq 80\ ℃$

(here, $\Delta T = T2-T1$, T2 is an internal temperature of the reaction tank, and T1 is an internal temperature of the cooling part)

[Correlation Equation 2]

$0.3\ \text{bar} \leq P \leq 0.8\ \text{bar}$

(here, P is a pressure of each of the reaction tank and the cooling part).