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(54) **METHOD FOR TREATING HOG AND ANIMAL WASTE**

Publication Classification

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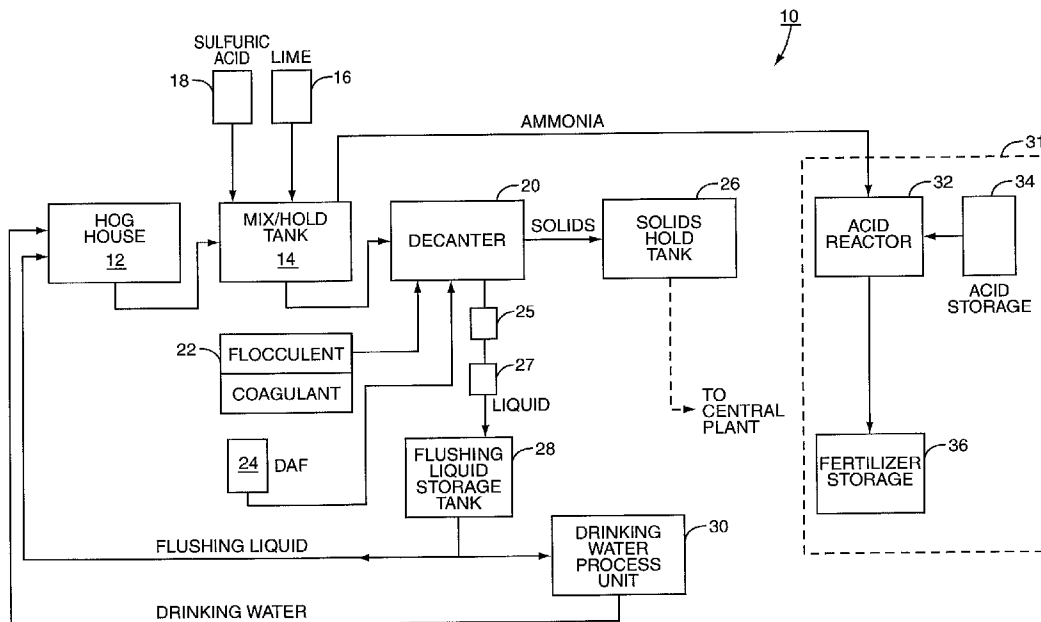
(57) **ABSTRACT**

An animal treatment method comprises flushing the animal waste from a barn to a holding tank where the waste is mixed with an alkaline solution to kill pathogens. After neutralization, the solution is separated into solids and liquids. The liquid is treated and recycled as flushing water to clean the barns and/or drinking water for the animals. The solids are separated into digested and undigested feed. The digested feed is further processed for use as a fertilizer and the undigested feed is processed for use as animal feed.

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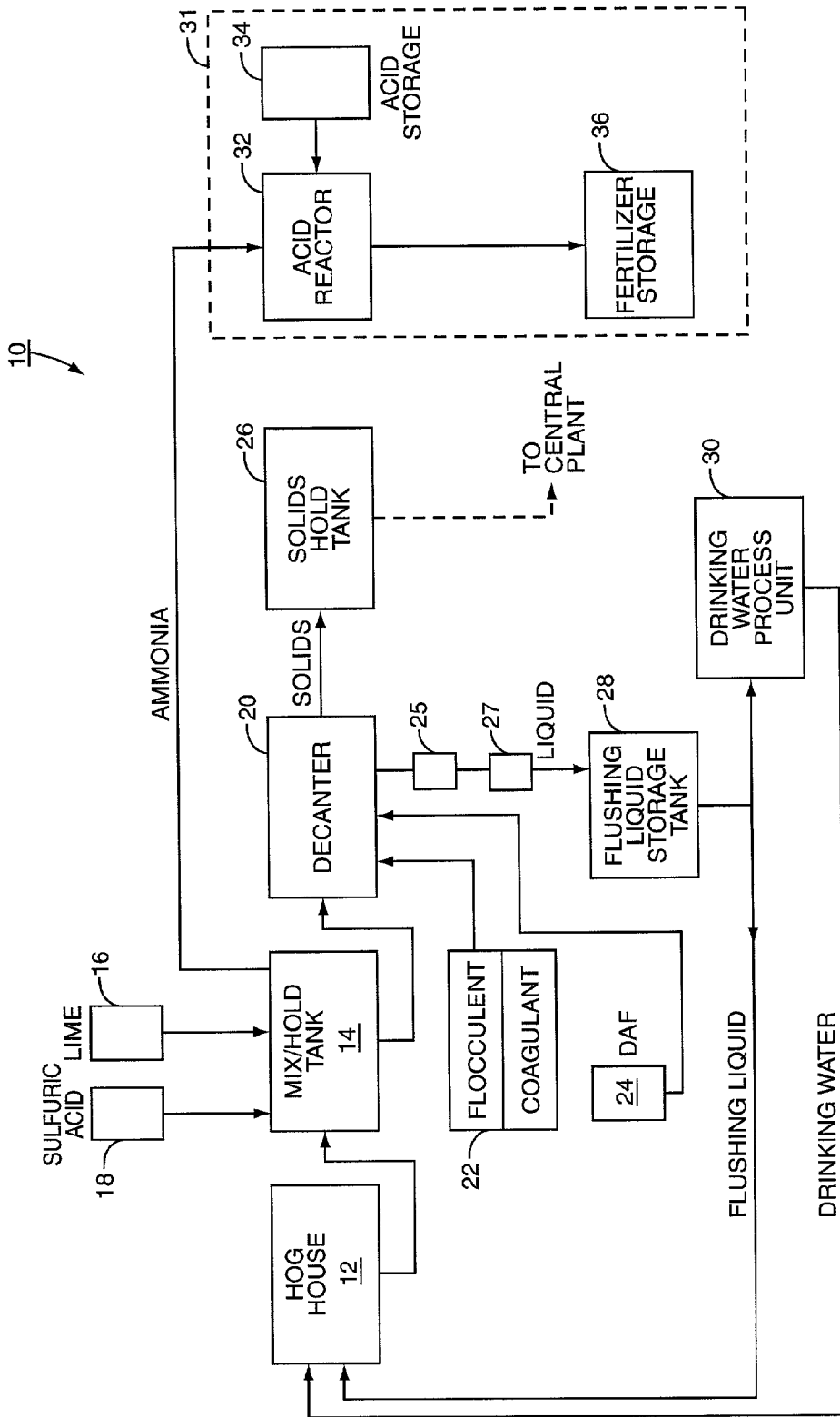


FIG. 1

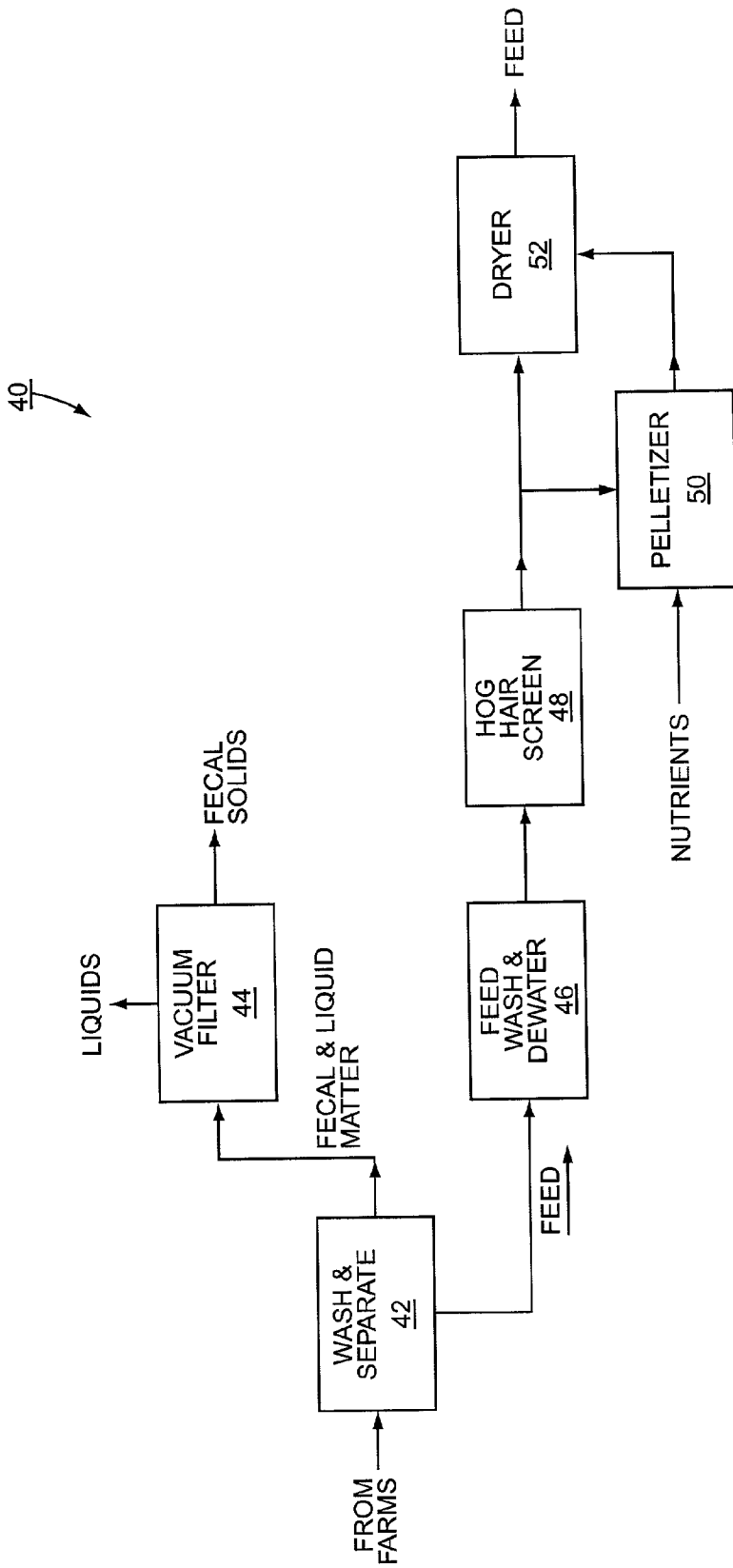


FIG. 2

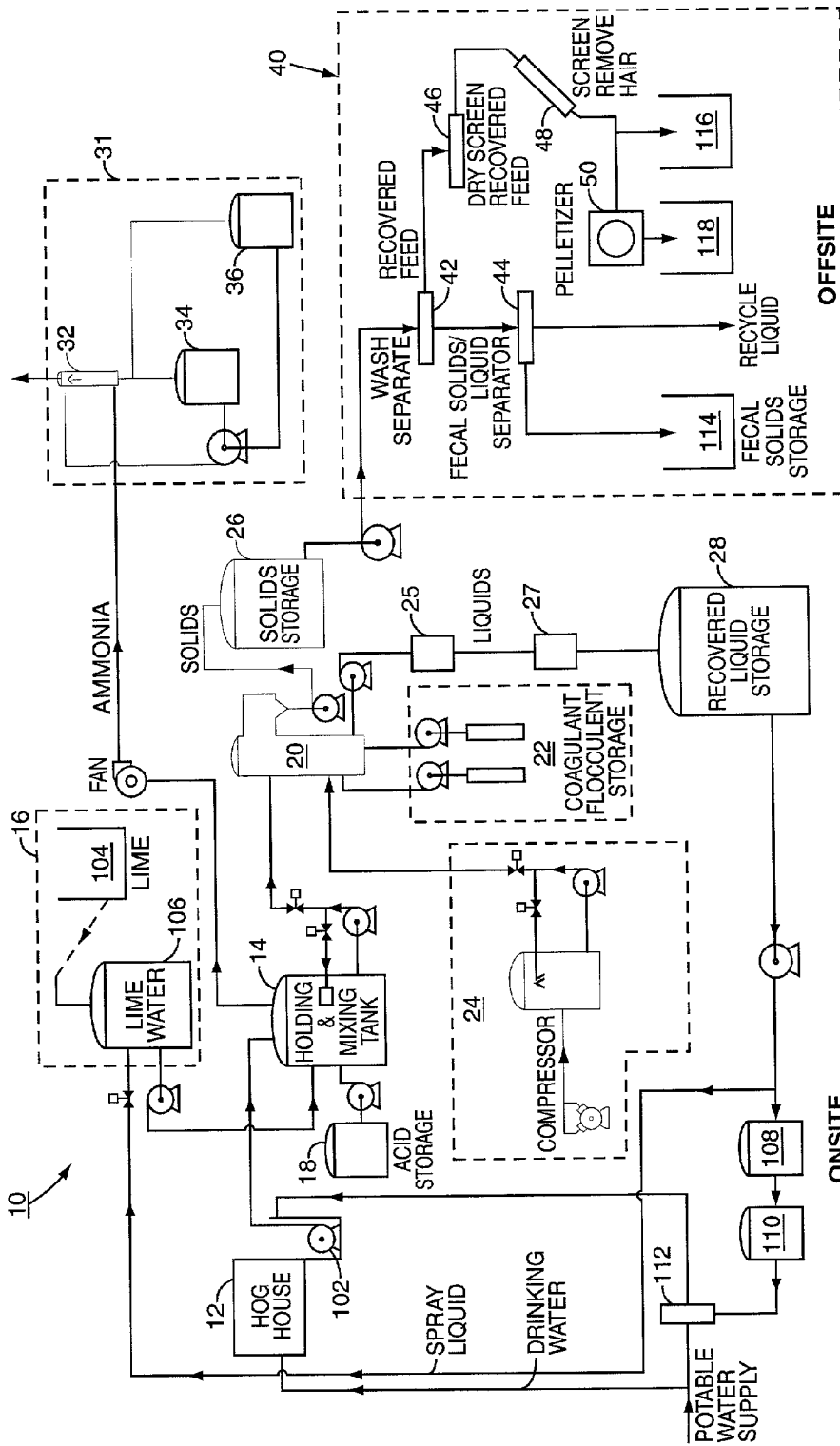


FIG. 3

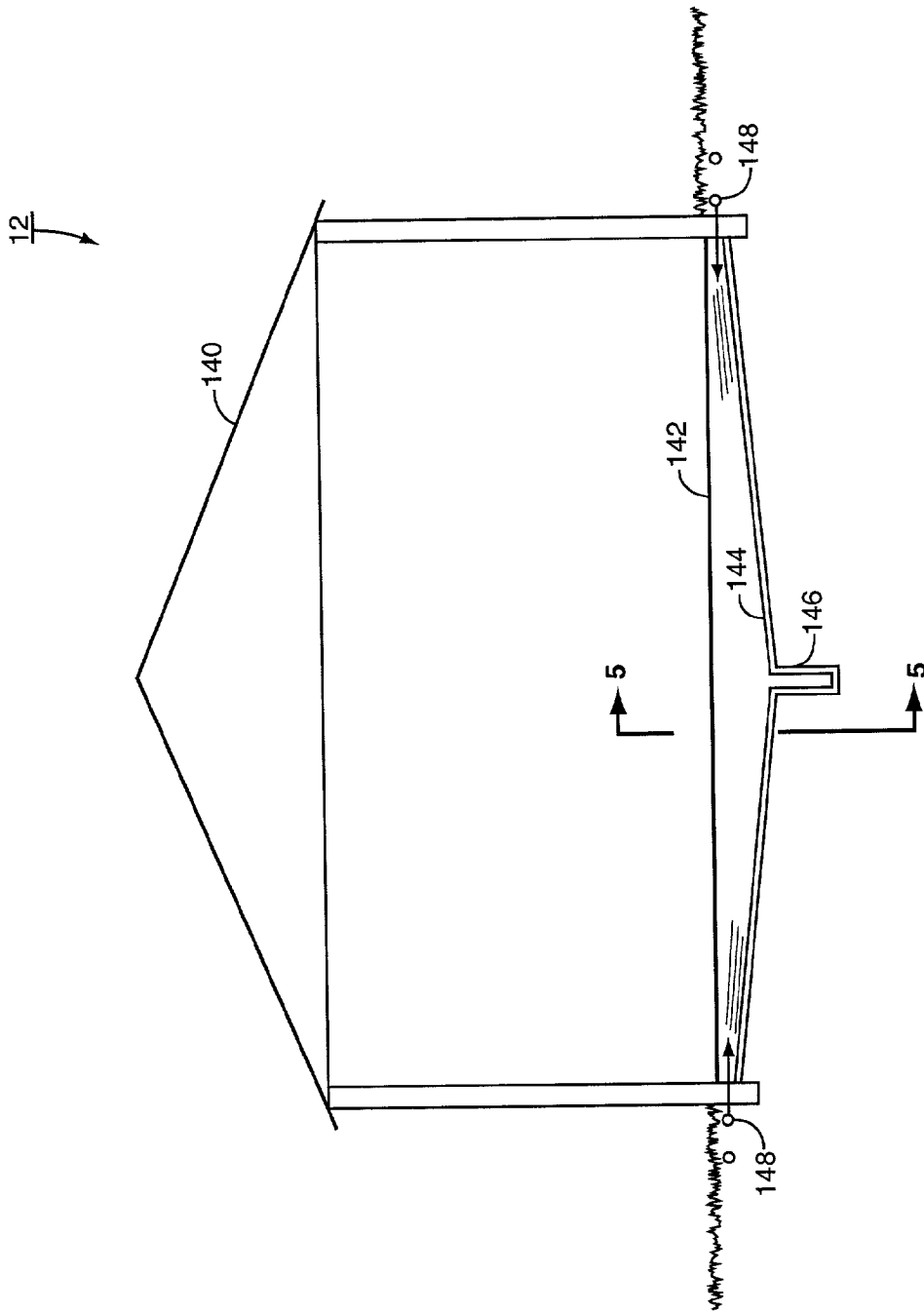


FIG. 4

12

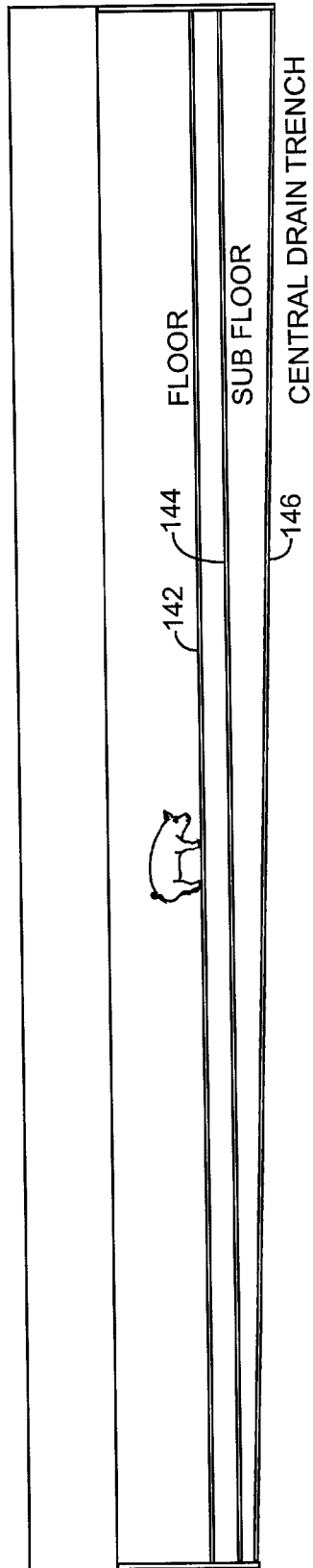


FIG. 5

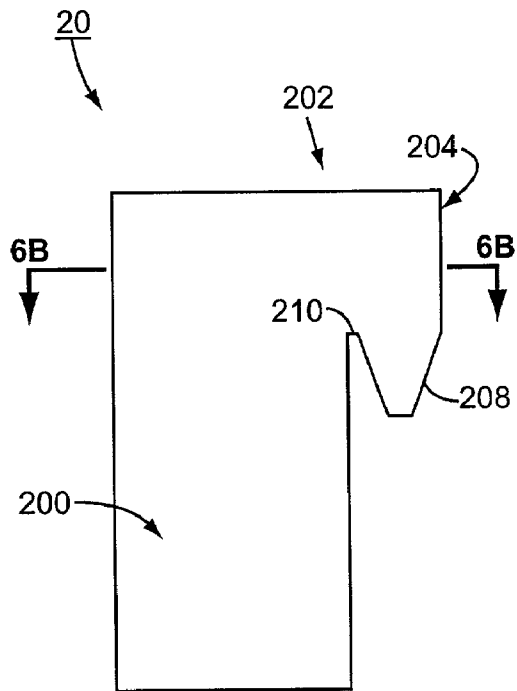


FIG. 6A

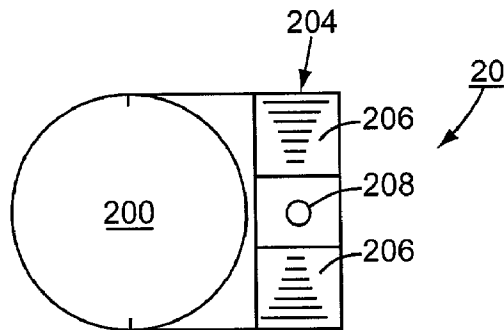


FIG. 6B

METHOD FOR TREATING HOG AND ANIMAL WASTE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention is related to treating animal waste, especially waste from hog houses.

[0003] 2. Description of the Related Art

[0004] A natural byproduct of tending animals is a certain amount of waste, including feces and urine. For factory farms that handle large numbers of animals, the amount of waste produced can be staggering. Hogs in particular are known for their copious waste production.

[0005] A typical hog barn or house is about one hundred sixty feet long and forty feet wide, housing about eight hundred hogs. Hog barns come in at least two forms. A first form comprises a sloped floor within the barn that is periodically flushed with water. The water flows around the feet of the hogs and washes waste down the slope within the hog barn into a holding area where it is then pumped or allowed to flow into a lagoon. A second form comprises a slotted floor with a two feet deep cavity thereunder. Approximately eighteen inches of lagoon water fills the cavity to suppress odor. Waste drops through the slots into the standing water. Periodically, the pool is flushed or drained into a lagoon, and the cavity is refilled from the lagoon.

[0006] These lagoons are subject to many problems. Fluid from the lagoons is typically sprayed over crops. The solid material may be allowed to decay in the pond or is spread out over a field. Naturally, this creates a rather unpleasant odor for the surrounding area. Further, storms may cause the lagoons to flood, releasing animal waste into the water table. As lagoons age, containing walls may rupture, or the soil forming the lagoon may allow the waste to leach through. In either case, waste and pathogens may find their way into the water table causing problems for municipalities and other people reliant upon that water.

[0007] North Carolina is one of the United States' largest pork producers and has been particularly affected by the use of the aforementioned lagoons. Farms may house from six to seven thousand hogs on an average sized farm. A large farm may house up to around 13,000 hogs and produce tons of waste daily. Entire counties are blanketed with a foul smelling miasma of hog waste, stagnant water, and unbathed hogs. Ammonia, hydrogen sulfide, and other noxious compounds contribute to this miasma. The problem has escalated to the point at which the North Carolina state legislature in 1997 announced a moratorium on the construction of new hog farms. This has caused some disturbance amongst the hog farmers who see their livelihood challenged. Thus, there is a need for alternative solutions to the traditional lagoon method of treating and processing hog waste.

SUMMARY OF THE INVENTION

[0008] The present invention comprises a method by which water is periodically flushed through an animal confinement area to wash away feces and urine within the animal confinement area. The effluent from the washing is placed in a mixing tank with a lime solution to form a waste mixture. The high alkalinity kills 99.999% of coliforms and

98% to 99.999% of virus pathogens in the effluent as well as breaks down the colloidal bonds of the solids in the waste mixture. Ammonia is removed from the mixing tank and is now reacted with acid to produce fertilizer. The now relative pathogen free waste mixture is concurrently brought down to a more neutral pH. The neutralized waste mixture is placed in a separator with coagulants and flocculants. Dissolved air in liquid is pumped into the waste mixture, pushing the solids to the top of the separator. The separator is decanted to remove the solids, leaving the liquid therein.

[0009] The liquid is filtered, treated, and stripped of residual ammonia before return to the animal confinement area. The majority of the fluid is used to flush the animal confinement area, although a portion may also be used to make potable water for the animals.

[0010] The solids are washed to separate fecal matter from undigested feed. The undigested feed may be processed for use as feed for animals again while the fecal matter is processed into fertilizer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. 1 is a digramatic view illustrating the method of the present invention of treating hog and animal waste.

[0012] FIG. 2 is a schematic illustration that illustrates a method of treating solids separated from hog waste.

[0013] FIG. 3 is a more detailed view of the basic components of a system for treating hog and animal waste according to the present invention.

[0014] FIGS. 4 and 5 illustrate an animal confinement area adapted for use with the present invention; and

[0015] FIGS. 6A & 6B illustrate an exemplary embodiment of the solid separator for use with the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0016] FIG. 1 illustrates a top-level schematic diagram of a system 10 for treating and processing hog waste. System 10 comprises one or more animal confinement areas, such as hog house 12, a mixing and holding tank 14, a decanter 20, a solids holding tank 26, a flushing liquid storage tank 28, a drinking water process unit 30, and an acid reaction process or fertilizer manufacturing unit 31. Water from the flushing liquid storage tank 28 is flushed through the hog house 12 periodically to remove animal waste therefrom. The mixture of water and waste is conveyed to the mixing and holding tank 14 where it is mixed with an alkaline solution from lime storage unit 16. The alkaline solution combines with the water and waste to form a waste mixture, which is mixed and held (still mixing) for approximately one to two hours. After that time acid from acid storage unit 18 is added to the waste mixture to neutralize the alkalinity of the waste mixture.

[0017] After neutralization, the waste mixture is conveyed to the decanter 20 where flocculants and coagulants are added from flocculent/coagulant storage unit 22. This causes the solids to separate substantially from the liquid of the waste mixture. To further separate the solids from the liquids, dissolved air from DAF unit 24 is bubbled through the decanter 20. At this point, the waste mixture is separated substantially into solids and substantially clear water. Water

is added to the decanter **20** to remove the solids therefrom into solids holding tank **26**. The remaining liquid within the decanter **20** is then stripped of ammonia in ammonia stripper **25**, filtered in filter **27**, and then dumped into the flushing liquid storage tank **28**. Some liquid from the flushing liquid storage tank **28** may be treated in the drinking water process unit **30** and used as drinking water for the animals within the hog house **12**. The majority of the fluid within the flushing liquid storage tank **28** is used to flush the hog house **12**.

[**0018**] Solids within the solids holding tank **26** are conveyed to a central plant. In an exemplary embodiment, a truck or similar vehicle performs said conveying.

[**0019**] When the alkaline solution is added to the mixing and holding tank **14**, ammonia is released from the urea within the waste mixture. This ammonia is captured and conveyed to acid reaction process or fertilizer manufacturing unit **31**. The ammonia is specifically conveyed to an acid reactor **32** and acid from acid storage unit **34** is mixed therewith. The ammonia reacts with the acid to form a fertilizer that is then conveyed into fertilizer storage unit **36**. Any ammonia remaining within the mixing and holding tank **14** is similarly reacted when acid from acid storage unit **18** is mixed with the waste mixture to neutralize the alkalinity thereof.

[**0020**] The solids collected from solids holding tank **26** are transferred to a central plant for further treatment and processing. This further treatment and processing is illustrated in **FIG. 2**. The solids from various farms are collected at the central plant **40** to achieve economies of scale. Note that it is possible that the central plant functions could be performed at an individual farm but may not be economical for smaller farms. The solids are initially washed and separated into 1) fecal matter and liquid which is diverted to a filter **44** and 2) undigested feed which is directed into a feed washing and dewatering stage **46**. The fecal matter and liquid are filtered by, for example, a vacuum filter **44** such that the liquid is separated from the fecal solids. The fecal solids may then be used as a fertilizer as needed or desired with or without further processing. The undigested feed is washed again in the feed washing and dewatering stage **46** after which the feed is screened to remove animal hair in screen **48**. After removing animal hair, some of the undigested feed may be pelletized with additional nutrients in pelletizer **50**. The nutrients are optional and depend on the nutrient content of the undigested feed. In either case, with or without pelletized, the undigested feed is dried in dryer **52** to approximately a 10% water content so as to inhibit fungal growth and is reused as feed for animals.

[**0021**] In an exemplary embodiment wherein the present invention is used to process hog waste, the undigested feed that is recycled is appropriate for feeding to cattle, sows, poultry, and fish farms.

[**0022**] A more detailed schematic is presented in **FIG. 3** with many of the elements illustrated in greater detail. A hog house **12** such as is further illustrated in **FIGS. 4 and 5** may contain approximately 800 hogs each producing a number of pounds of waste each day. Water is periodically flushed through the hog house **12** to remove waste from the hog house **12** into a sump area where sump pump **102** pumps the waste to the holding and mixing tank **14**. Please note that an emergency line may exist which allows waste to be routed to a conventional animal waste lagoon in certain situations,

but this is not an opponent way to treat waste, merely emergency override for the system.

[**0023**] An alkaline solution from the lime storage unit **16** is mixed with the waste to form a waste mixture. In an exemplary embodiment, the pH of the waste mixture is maintained at or above a pH of 11.0. Alternatively, lower pHs may be used, but may not be as efficacious. Specifically contemplated are pHs **10** and below as long as the pH is alkaline. The alkaline solution in an exemplary embodiment is formed by lime from lime storage unit **104** mixing with water from the flushing liquid storage unit **28** in lime water unit **106**. A static mixer (not shown) insures that the alkaline solution and the waste are well mixed to form the waste mixture. The alkaline solution breaks down the colloidal bonds of the solid waste; the urea in the waste reacts with the alkaline solution to release ammonia; and the high alkalinity kills most of the pathogens in the waste. Ammonia is drawn off mixing and holding tank **14** by a fan and conveyed to the acid reaction process unit **31**.

[**0024**] In an exemplary embodiment, the waste mixture is held in holding and mixing tank **14** for approximately 1 to 2 hours or until substantially all of the urea and solid fecal matter has been broken down. Acid from acid storage unit **18** is then introduced into the waste mixture to neutralize the alkalinity of the waste mixture. In an exemplary embodiment, the pH is reduced to approximately 7-8. In an exemplary embodiment the acid within the acid storage unit **18** is sulfuric acid, which reacts with the remaining ammonia within the mixing and holding tank **14** to form ammonium sulfate, a common fertilizer. Other acids are also contemplated. The neutralization of the waste mixture may be achieved relatively quickly on the order of five minutes. If a highly alkaline solution were pumped through the hog house **12**, the alkaline solution would react with the urine in the hog house **12** and release ammonia. This is undesirable. Neutralization of the solution eliminates or at least mitigates this risk.

[**0025**] After neutralization, the waste mixture is directed to the decanter **20**. Decanter **20** is explicated in greater detail with references to **FIGS. 6A and 6B**. Conventional coagulants and flocculents are added from flocculent/coagulant storage unit **22**. These react with the solids of the waste mixture. In an exemplary embodiment, the coagulant is a NALCO 8102 Coagulant and the flocculent is a NALCO 7767 flocculent. Note that if the waste mixture is not neutralized the volume of coagulants and flocculents that must be added to effectuate proper separation is greatly increased. Thus, while it is possible to introduce a highly alkaline waste mixture into the decanter **20**, such is not preferred.

[**0026**] After introduction of the coagulants and flocculents, the waste mixture substantially separates into a layer of solids floating on top of slightly murky water. To further clarify the liquid within the decanter **20**, a Dissolved Air Flootation (DAF) unit **24** and injects dissolved air into decanter **20**. This allows the air to float the solids to the top of decanter **20**. Alternatively, induced air may be used to float the solids. The waste mixture may remain in the decanter **20** on the order of twenty minutes or until substantial clarity is achieved in the liquid. Note that the layer of solids floating on top of the relatively clear liquid is comprised of digested and undigested feed. Additional liquid,

perhaps from flushing liquid storage unit **28**, is added to the decanter **20** to raise the level of water in decanter **20** such that the solids spill through spill way from whence they are pumped after being stripped of ammonia in ammonia strip **25** to solid storage unit **26**. The liquid within the decanter **20** is then drained or pumped into flushing liquid storage unit **28** for reuse within the system **10**. The majority of the flushing liquid within flushing liquid storage unit **28** is used to flush the hog house **12**, as well as provide water for the alkaline solution within lime storage unit **16**. Some portion of the liquid within the flushing liquid storage unit **28** may be processed into potable water for the animals within the hog house **12** to drink. To create this potable water, the water from the flushing liquid storage unit **28** is directed to a sand filter **108** and then through activated carbon filter **110**. A reverse osmosis filter **112** removes other impurities and may store salts in a waste storage unit (not shown). Clean water may be stored in a drinking water storage unit (not shown) for later use by the animals.

[0027] Ammonia from the mixing and holding tank **14** is, as noted, directed to the acid reaction unit **31**, and specifically to the acid reactor **32**. The ammonia is mixed with an appropriate acid from acid storage unit **34**. In an exemplary embodiment, the acid is nitric acid, phosphoric acid, or sulfuric acid. These three acids are particularly useful, as when they react with ammonia, they create common fertilizers, namely ammonium nitrate, ammonium phosphate, or ammonium sulfate respectively. The resulting fertilizer is, as noted, stored in fertilizer storage **36** for further processing, needed or desired.

[0028] As noted, central plant **40** may be co-located with the farm side system **10** if the farm has sufficient output to make it economical. Solids from solid storage unit **26** are transported to washing and separating stage **42** where the fecal matter is washed from the undigested feed. In an exemplary embodiment, the undigested feed remains on top of a screen, while the finer fecal matter is washed there-through. The fecal matter is conveyed to a filter **44** where the liquid is extracted therefrom. This liquid may be further treated and recycled as needed or desired. The now dry fecal matter may be then conveyed to the fecal solid storage unit **114** for use as a fertilizer or other purposes needed or desired.

[0029] The now washed recovered feed is then placed on another screen and washed again to remove the last traces of fecal matter therefrom. The washed feed is then dried to approximately 25% water. Collectively, this washing and dewatering is labeled feed wash and dewater stage **46**. The dewatered feed is then conveyed to a screen **48** and screened to remove animal hair. This is important where the undigested feed comes from hogs, as hog hair is particularly undesirable in feed.

[0030] Once screened, the undigested feed may be conveyed to a dryer to be dried to approximately 10% water and then conveyed to a loose feed storage unit **116**. Alternatively, the screened undigested feed may be conveyed to a pelletizer **50** where further nutrients may be optionally combined with the undigested feed and the combination, or the undigested feed alone, may be pelletized as is well understood. After pelletization, the newly made pellets are then dried to approximately 10% water and may be stored in pellet storage unit **118**.

[0031] An exemplary hog house **12** is illustrated in FIGS. **4** and **5**. Specifically, hog house **12** may comprise a roof **140**, a slatted floor **142**, a sloped subfloor **144** and a central drain trench **146**. Hogs stand on top of floor **142** and defecate as is normal. The waste falls through the slats within a floor **142** onto subfloor surface **144**. Periodically liquid flushing storage unit **28** flushes the waste on subfloor **144** down into central trench **146** which is further sloped so as to deposit the waste and liquid at the sump for handling by sump pump **102** as previously explained. In an exemplary embodiment, approximately $\frac{1}{5}$ of the jets **148** are actuated at any given time, thus flushing approximately $\frac{1}{5}$ of the subfloor **144** at a given time. Alternative arrangements are also possible where in a solid floor is flushed continuously or less frequently as needed or desired. While it is expected that the present system recovers a good portion of the water used, some losses will undoubtedly occur and make up water may be used in this flushing process or elsewhere within the system as needed or desired. It should be appreciated that flushing jets **148** are positioned around the circumference of the hog house **12** such that substantially all of the subfloor **144** may be flushed on a regular base.

[0032] FIGS. **6A** and **6B** illustrate decanter **20** in a simplified form. Decanter **20** may comprise a primary holding chamber **200** with a top **202**. Top **202** is of a diameter greater than the holding chamber **200**. Further, top **202** comprises a drain chamber **204**. Drain chamber **204** comprises a pair of slanted sidewalls **206** that lead to drain aperture **208**. Solids are floated upwardly to a ledge **210** of the top of **202**, and then directed through the drain aperture **208**.

[0033] The present invention may, of course, be carried out in other specific ways than those herein set forth without departing from the scope and characteristics of the present invention. Present embodiments are therefore to be construed in all aspects as illustrative and not restrictive and all changes coming within the meaning and equivalency range of the appended claims are intended to be embraced therein.

1. A method of treating animal waste, comprising:
 - removing animal waste from an animal confinement area;
 - passing the animal waste to a holding tank;
 - mixing an alkaline composition with the animal waste in the holding tank to create a waste mixture;
 - removing ammonia from the holding tank;
 - transferring the waste mixture to a solids separator;
 - separating the waste mixture into solids and a liquid; and
 - after separating the solids, returning the liquid to the animal confinement area for reuse.
2. The method of claim 1 wherein mixing an alkaline composition with the animal waste comprises mixing a lime solution with a pH over 11 with the animal waste.
3. The method of claim 1 further comprising combining the ammonia from the holding tank with an acid to form fertilizer.
4. The method of claim 1 further comprising separating undigested feed from said solids for reuse.
5. The method of claim 1 further comprising filtering the liquid prior to reuse to produce potable water.

6. The method of claim 1 including maintaining the pH of the animal waste at 10 or higher within the holding tank for a selected time period.

7. The method of claim 6 including maintaining the pH of the animal waste at 11 or higher within the holding tank for a selected time period.

8. The method of claim 6 including neutralizing the animal waste after the animal waste has been maintained at a pH of 10 or higher for the selective time period.

9. The method of claim 1 including holding the waste mixture in the holding tank and breaking down the urea and solid fecal matter.

10. The method of claim 1 including returning at least a portion of the liquid separated from the waste mixture to the animal confinement area and utilizing the portion of liquid to flush animal waste from the animal confinement area.

11. The method of claim 10 including continuously recycling the separated liquid to the animal confinement area for flushing animal waste from the animal confinement area.

12. The method of claim 1 wherein separating the waste mixture into solids and a liquid comprises transferring the waste mixture from a holding tank to a solids separator and adding a flocculant and a coagulant to the waste mixture and wherein in the solids separator, the solids of the waste mixture move upwardly and overflow the solids separator while the liquid is drained from the solids separator.

13. The method of claim 1 wherein the separated liquid is directed to a storage tank where the separated liquid is held and ultimately used to flush and clean the animal confinement area.

14. The method of claim 1 including directing the ammonia from the holding tank and mixing the ammonia with an acid to form a fertilizer material.

15. The method of claim 14 wherein the acid mixed with the ammonia is taken from the group including nitric acid, phosphoric acid, and sulphuric acid.

16. The method of claim 4 wherein separating undigested feed from said solids includes separating fecal and liquid matter from the solids so as to leave the undigested feed and then treating and processing the undigested feed such that the undigested feed can be fed to animals.

17. A method of treating hog waste, comprising:

- mixing hog waste from a hog barn with an alkaline solution in a mixing tank to form a waste mixture;
- removing ammonia from the mixing tank;
- separating the waste mixture into solids and a liquid;
- separating said solids into digested and undigested feed; and

returning a portion of said liquid to said hog barn for flushing waste from said hog barn.

18. The method of claim 17 wherein separating said solids into digested and undigested feed comprises screening in a rotary filter said solids.

19. The method of claim 18 further comprising screening out animal hair from said undigested feed.

20. The method of claim 17 further comprising utilizing said digested feed to form fertilizer.

21. The method of claim 17 further comprising utilizing said ammonia to form fertilizer.

22. The method of claim 17 wherein separating solids from the waste mixture comprises adding a flocculent and a coagulant to said waste mixture in a solids decanter.

23. A method of recycling hog waste, comprising:

- removing solid waste from a hog confinement area;
- treating said solid waste;
- separating digested feed from undigested feed in the solid waste; and
- creating feed stock from said undigested feed.

24. The method of claim 23 further comprising screening animal hair from said undigested feed.

25. The method of claim 23 wherein treating said solid waste comprises mixing said solid waste with an alkaline solution.

26. The method of claim 25 further comprising separating liquids from said solid waste.

27. The method of claim 23 wherein removing solid waste from the hog confinement area comprises flushing hog waste from the hog confinement area.

28. The method of claim 23 further comprising reusing water flushed from the hog confinement area to flush waste from the hog confinement area.

29. The method of claim 23 further comprising processing the digested feed into fertilizer.

30. A decanter, comprising:

- a holding area for receiving a base solution of animal waste and lime;
- a DAF inlet positioned in said holding area for directing water super-saturated with compressed gas through said holding area; and
- a spill path positioned near a top portion of said holding area for permitting solid waste to spill over said spill path and to separate solid waste from liquid waste in said holding area.

* * * * *