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(54) **Title**: PROCESS FOR PRODUCING FERTILIZER FROM ANIMAL MANURE

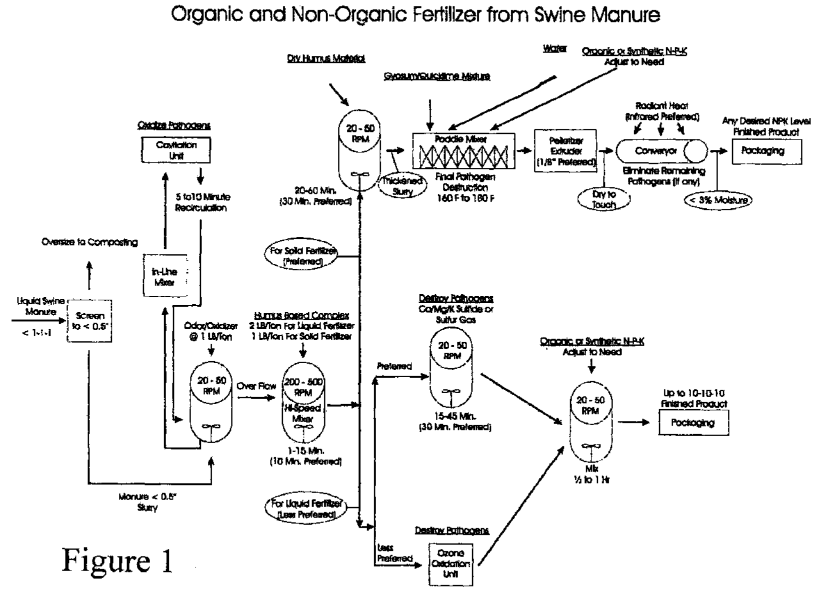

Figure 1

(57) **Abstract**: A process for the production of fertilizer derived from animal manure, such as livestock and/or poultry manure, is provided. The process includes adding an oxidizing composition to a slurry of animal manure and processing the slurry of oxidizing composition and animal manure in a device configured for inducing cavitation within the slurry. A process for treating a pathogen contaminated aqueous stream using an oxidizing composition and a cavitation unit is also provided. An oxidizing composition is added to the pathogen contaminated aqueous stream and the resulting oxidant-treated process stream is passed through a cavitation unit.

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PROCESS FOR PRODUCING FERTILIZER FROM ANIMAL MANURE

CROSS-REFERENCE TO RELATED PATENT APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application 61/459,936, filed 6/10/2011 and U.S. Provisional Patent Application 61/527,993, filed 8/26/2011, the entire contacts of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] Animal excrement is a chemical complex of biologically active material which is discharged by animals because their digestive systems do not efficiently utilize all components of their food intake. Depending on the structure of the animal's digestive system and its efficiency, the composition of excrement changes. The type and variety of food intake also affects the composition of the animal's excrement.

[0003] Historically, animal excrement, commonly call manure, has been used as a soil supplement in every human culture. In some cases application of the manure is direct without intermediate process. In other cases manures have been used as ingredients in the manufacture of compost.

[0004] Today, commercial farming techniques for livestock and poultry have increased the population density of the animals through the use of feedlots, chicken hatcheries, and other mass production means. The techniques are driven by the need for low cost, large-scale production. The result is that large quantities of manures are produced in a very restricted area, especially when compared to older technology, e.g., the family farm, where the disposal of the manure could be distributed over relatively large areas of land. The result is that the problem of managing large quantities of manures, extracting their beneficial properties, and preventing storage, transportation, and disposal from damaging the environment has substantially increased.

[0005] Normally, manures, which are chemical complexes, do not contain balanced nutrient components. Relative to a plant's demand for nitrogen, for example, most manures have an excess of phosphorus and potassium. These factors affect the efficient use of the material in agriculture. In particular, high phosphorus can damage aquifers through percolation, and affect rivers and lakes through runoff from the land that causes eutrophication. During storm events, overflow or breach of holding ponds releases pathogens and/or parasites resident in the manures including, for example, E.coli and helminths, a situation that can be further complicated by the routine use of antibiotics in the animal feed. Another practical problem associated with manures is the undesirable odor they typically emit. Such odors can range from highly organic in the case of swine to highly ammoniac in the case of chickens.

[0006] Much industry and academic research has focused on eliminating the undesirable side effects of using manures. In most cases, however, the reported solutions only solved one problem and/or were undesirable because costs were excessive. So industry has been unable to adopt a satisfactory technique that captures the benefits of manure, minimizes the undesirable side effects, and does so at an affordable cost.

SUMMARY OF THE INVENTION

[0007] The present application discloses a process for the production of a high efficiency organic fertilizer derived from animal manure, such as livestock and/or poultry manure. While the process may be exemplified herein in places using a description of a swine manure treatment, the process is also quite suitable for the treatment of other animal manure streams, e.g., other livestock manures and/or poultry manures, such as chicken or turkey manure streams. The process may accomplish one or more of the following objectives:

- To reduce or eliminate undesirable odors associated with storing and applying manure;
- To reduce or eliminate pathogens that could be transferred to humans and animals during routine agricultural use;
- To improve the ratio of the main nutrient elements for improved plant uptake;
- To control the mobility of the nutrient elements after application to the soil through a buffering process; and
- To produce a commercial fertilizer that can be applied using existing commercial farming equipment.

[0008] The present process includes adding an oxidizing composition to a slurry of animal manure and processing the slurry of oxidizing composition and animal manure in a device configured for inducing cavitation within the slurry. One suitable device for processing the slurry in such a manner is a cavitation unit such as the one depicted in Figures 2 and 3. The slurry of oxidizing composition and animal manure may be passed through an inline mixer before the cavitation operation in order to ensure that the slurry has a relatively homogenous composition and/or the particles in the slurry are well suspended during the cavitation operation. The process may be operated in a batch mode, but for larger scale operations it is typically advantageous to operate the process in a continuous mode, e.g., where the slurry of oxidizing composition and animal manure is continuously circulated through a loop containing the inline mixer and cavitation device and oxidized slurry is removed from the top of a mixing tank using an overflow outlet. The process may also include adding a humus based materials, either in the form of a humus-based complex (e.g., containing about 60-65 wt.% organic material which the remainder mineral) and/or a dry humus material. After addition of the humus based materials, a high calcium binding agent (e.g., gypsum and/or lime) may be added to the resulting process stream. If desired, after addition of the binding agent, the product may be pelletized using conventional pelletizing technology. The nutrient content of the final product may be adjusted as desired by adding other nutrient materials (e.g., N-P-K sources and/or trace mineral sources) to the materials being processed.

[0009] The cavitation units described in the present application can also be used as part of a method to treat other pathogen containing aqueous streams, which may or may not also includes particulate materials, e.g., aqueous streams which contain substantial amounts of undesired biological material such as algae, bacteria or other undesired pathogens. An oxidizing composition, which optionally contains surfactant, is added to the contaminated aqueous stream, which is then passed through a cavitation unit, such as the one described herein. In order to achieve desired degree of pathogen control, it may be advantageous to recirculate the mixture of oxidizing composition and aqueous stream a number of times (e.g., at least about 3 or 4 times) through the cavitation unit, e.g., by only drawing off a fraction of the flow exiting the cavitation unit and recirculating the remainder (which may constitute the majority of the exit stream) . After oxidizing the aqueous stream in the cavitation unit, the product stream may be treated to remove debris from the pathogenic material, e.g., by addition of a flocculating agent (such as a polymeric flocculating agent) and subsequent filtration.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Figure 1 is a schematic illustrating one embodiment of the present process for treating animal manure for conversion into either a solid or liquid fertilizer material.

[0011] Figure 2 is a schematic illustrating one embodiment of a cavitation unit suitable for use in the present method.

[0012] Figure 3 is depicts one example of a cavitation processor unit which can be used in the present method. As illustrated flow through the unit would occur from left to right. The dimensions shown are not in any absolute units, but instead depict relative dimensions of an exemplary processor unit.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Livestock or Poultry Manure Composition

[0013] Commercial swine waste typically comprises an average of 3 to 4 wt% solids, in some case higher, with the balance being water. Other livestock or poultry manure streams to be treated may have solids contents of up to about 25 – 30 wt.%. The majority of solids in animal manures are organic materials such as fat, protein, and cellulose. Total mineral content is normally less than 1 wt%. The result of this combination of material is a complex of organic matter that is highly active, and which continuously generates sulfur, ammonia, and organic odors. It is an excellent growth medium for bacteria and pathogens commonly found in the animal digestive tract. The complex is generally also an excellent habitat for parasitic worms such as helminths, insects, and other undesirable microfauna. Sometimes the manure also contains small amounts, 1 to 2 wt%, of straw which has been added to control the release of odors. Manure may exist in several forms, e.g., swine manure commonly exists as a slurry produced by water periodically added to the swine pens to clean them. Cattle manure is often a drier solid form due to exposure to air in feedlots. Generally, the Nitrogen-Phosphorus-Potassium (N-P-K) values of livestock and poultry manures is less than 1-1-1.

Initial Processing

[0014] The raw animal manure is commonly processed to remove all larger particles, e.g., particles > about 0.5 inches in size, from the slurry by, for example, a conventional screening process. This oversize material may then be set aside for additional processing for topical odor control and subsequent composting. The screened slurry may contain up to about 25 wt% solids, often about 5 to 20 wt%. Slurries having a solids content of about 10 to 15 wt% are quite suitable for treatment using the present process. As noted below, when the process is used to treat swine manure, the slurry may only have a solids content in the 3 to 5 wt% range.

[0015] The screened slurry is then typically processed to form a stabilized, generally homogeneous slurry that has been treated to kill or neutralize the majority of the parasites and/or pathogens present in the raw manure. This may be done with a combination of physical and chemical means. From the screening process, the screened slurry may be pumped to a mixing tank, where it is commonly combined with an oxidizing composition, which has an odor suppressing effect as well as helping to neutralize the parasites and/or pathogens which are commonly present. The mixer in the tank may be operated at a relatively low speed, for example, 20 to 50 rpm.

[0016] The oxidizing composition typically contains an oxidant, such as a percarbonate salt, hydrogen peroxide, sodium perborate, sodium hypochlorite or other peroxide material (e.g., organic peroxides, such as an organic percarboxylic acid, e.g., peracetic acid). The oxidizing composition may also contain a surfactant that is stable in the presence of the oxidant. For example, the oxidizing composition may include a fatty acyl sarcosinate salt and/or a fatty acid salt. In other embodiments, the screened slurry may be treated with ozone for odor suppression and oxidizing purposes. One example of a suitable oxidizing composition useful for the present process includes a mixture of sodium percarbonate, sodium lauroyl sarcosinate and sodium laurate. For example, the oxidizing composition may contain 30 to 60 wt% sodium percarbonate, 35 to 45 wt% sodium lauroyl sarcosinate, and 1 to 5 wt% sodium laurate. Oxidizing compositions such as those described above may be blended into the screened slurry at a weight ratio of about 1:1000 to 1:4000 (oxidizing composition: screened slurry). Variations in the composition and the desired degree of odor suppression may require other feed rates. The oxidizing function of the additive composition begins the process of destroying pathogens by generating hydroxyl radicals within the slurry.

[0017] From the mixing tank, the treated slurry may be pumped through an in-line mixer before the cavitation operation in order to ensure that the slurry has a relatively homogenous composition and/or that the particles in the slurry are well suspended during the cavitation operation. In some embodiments, the in-line mixer may be configured for producing sheer forces sufficient to separate the complexed fats, proteins, and cellulose present in the treated slurry to form a separated slurry.

[0018] From the in-line mixer, the slurry is processed though a device configured for inducing cavitation within the slurry. As the slurry passes through the cavitation device, bubbles are created that instantaneously implode. The implosion creates momentarily high temperatures, which, in combination with the hydroxyl radicals formed in the treated slurry through the action of the additive composition noted above, increase the rate of oxidization of remaining pathogens. An additional function of the cavitation is to break the unstable material in the slurry that creates gas containing undesirable odors. The slurry is commonly re-circulated through the mixing tank, in-line mixer, and cavitation device, often for approximately 5 to 10 minutes. In some embodiments, the slurry is continuously re-circulated through the mixing tank, in-line mixer, and cavitation device, while oxidized material is removed from the mixing tank, e.g., via an overflow port. The mixing tank may be so constructed that an overflow port feeds the oxidized slurry into the downstream equipment.

[0019] One embodiment of a cavitation device configured for inducing cavitation within the slurry suitable for use in the present method is depicted in Figure 2. Figure 3 is depicts one example of a cavitation processor unit within the cavitation unit, which also typically includes a downstream vibration damper. The cavitation unit may be operated in a mode (as illustrated in Figure 2) such that a substantial portion of the slurry being treated is recirculated one or more times through the cavitation processor unit. For example, the relative flows may be adjusted so that only about 5 to 20 percent of the volume of treated slurry passing through the processor unit is removed via the processor unit unit outlet with the remainder being recirculated through the recycle loop. This would result in the effective number of passes of the oxidant/slurry mixture through the cavitation processor unit being about 5 to 20 times (i.e., 20x where 5 volume percent of the volume of treated slurry is removed via the cavitation unit outlet and correspondingly 10x where 10 volume percent is removed). As illustrated, flow through would occur from left to right through the processor unit depicted in Figure 3. The unit is typically operated such that the back pressure of the inflow to the cavitation processor unit is at least about 80 psi, with back pressure of about 85-90 psi being quite common. While in operation, the cavitation induced in the cavitation processor unit can be adjusted by varying the flow rate into the processor unit – increasing the flow rate will have the effect of increasing the back pressure on the incoming slurry.

[0020] The oxidized slurry may then be introduced into a mixing tank and agitated with a high-speed mixer operating at, for example, up to 500 rpm (e.g., at 100 to 300 rpm, with mixing speeds of about 200 rpm being common). This helps to homogenize the slurry and tends to keep the very small particles in suspension. The oxidized slurry is often combined with a humus-based complex at, for example, a weight ratio of 1:1000 (humus-based complex : oxidized slurry) for production of liquid fertilizer or, for example, a weight ratio of 1:2000 for the production of solid fertilizer. The humus-based complex typically includes, for example, humic acid, fulvic acid, short chain protein(s), glucose or sorbitol based surfactant(s), vegetable oil(s), and/or trace elements, e.g., trace elements derived from seaweed. The oxidized slurry may be mixed with the humus-based complex for 1 to 15 minutes, with roughly 10 minutes typically being sufficient to achieve substantially complete homogenization. The resulting fertilizer feed stock may then be used to form either a liquid fertilizer product or a solid fertilizer product.

Further Processing to Produce a Fertilizer in Solid Form

[0021] The fertilizer feed stock resulting from the processing operations detailed above may be introduced into a low speed mixing tank (e.g., operating at about 20 — 50 rpm) where it may be combined with 1% — 25 wt% (10% - 15 wt% preferred) of a dry humus material, e.g., dry humus material derived from naturally occurring lignite and/or leonardite. The result of mixing for about 20 to 60 minutes (30 minutes preferred) is the creation of a substantially thickened composition, which is desirably characterized by a consistency similar to that of thick syrup.

[0022] The thickened composition resulting from the processing described above may then be pumped to another mixing device, such as a paddle mixer, for successive chemical input(s). Although, as will be appreciated by those in the art, a number of mixing/combining techniques may be utilized, a paddle mixer is desirable in order to create the correct consistency for subsequent processing and to avoid the feed stock sticking together and forming balls of feed stock that may not as readily be incorporated with the materials being added during this step.

[0023] In the initial stage of the paddle mixer, a gypsum/quicklime mixture is commonly added in order to reduce moisture content and to further suppress or destroy any remaining pathogens by heating the composition to a temperature between about 150°F and 180°F, with temperatures of about 150°F to 160°F commonly being achieved. The amount of gypsum/quicklime mixture employed is typically between 1% - 25 wt% of the composition (typically about 15 to 25 wt.%, often about 2o wt.%). As an example, the gypsum/quicklime mixture may include about 1 to 30 wt% gypsum (commonly about 10 wt%) and about 70 to 99 wt% quicklime (commonly about 90 wt%).

[0024] In a later stage of the paddle mixer, water (e.g., about 0.25 to 0.5 wt%) may be added to the partially dried composition depending on whether sufficient moisture is contained in the initial stage to fully activate the quicklime. The additional water reacts with the residual quicklime in an exothermic reaction which can facilitate maintaining the temperature of the slurry at at least about 150°F and in some embodiments at about 160°F to 180°F. This elevated temperature is intended to kill or suppress any pathogens that survived the previous oxidation and cavitation steps detailed above.

[0025] In a later stage of the paddle mixer operation, the N-P-K content of the mixture may be adjusted to meet the desired specifications of the final product. Because the initial N-P-K of the raw manure is very low, and because the mixture is now predominantly solid particles, any selected amount or combination of N, P, and K sources can be added to the composition to achieve a desired composition. If desired, wholly natural organic ingredients may be used if the fertilizer is to be certified Organic in accordance with the National Organic Program of the U.S. Department of Agriculture including, for example, dried animal blood (blood meal) may used as the source of nitrogen; hydrolyzed bone (bone meal) may be used as the source of phosphorus, and non-synthetic potassium sulfate (K2SO4) may be used as the source of potassium.

[0026] If the fertilizer is not to be certified as Organic, then organic and/or synthetic N, P, and K sources can be used, for example, ammonium nitrate (NH4NO3) may be the source of nitrogen, dipotassium phosphate (K2HPO4) may be the source of phosphorus, and synthetic potassium sulfate (K2SO4) may be the source of potassium.

[0027] Following the paddle mixer operation, the composition of the organic fertilizer is generally complete. If desired, the now dry product may be pelletizes, e.g., by extruding the dry product through a pelletizer sized to produce fertilizer pellets of a designated size, e.g., approximately 0.125" diameter pellets. Other sizes may be used if desired, but 0.125" gives a product generally compatible with conventional fertilizer spreading equipment and agricultural practices. At the completion of pelletizing, the product is commonly dry to the touch.

[0028] From the pelletizer, the organic fertilizer pellets may be moved by conveyor belt through a radiant heat dryer. Infrared heat is preferred, which can have the beneficial effect of eliminating any residual pathogens that may have escaped previous destruction steps. Other forms of radiant heat can also be used with the purpose of reducing the moisture content of the pellets to less than 2 to 5 wt% (3 wt% being common). After drying, the organic fertilizer is complete and the product is ready for packaging.

Further Processing to Produce a Fertilizer in Liquid Form

[0029] For some applications, it may be desirable to produce the livestock/poultry manure based fertilizer in liquid form. This could happen in very large commercial farming operations co-located with large livestock and/or poultry populations where it was desirable to minimize processing costs and where it was desirable to apply a liquid product by spraying. The fertilizer feed stock described above in paragraph is used as the input to produce the liquid fertilizer.

[0030] Despite the processing described above to produce the fertilizer feed stock, some pathogens may still exist in the fertilizer feed stock. These pathogens may be subjected to additional processing to destroy or neutralize them including, for example: Adding calcium, magnesium, and/or potassium oxide, or alternatively sulfur gas, to a mixing tank operated at 20 to 50 rpm, with a dwell time of 15 to 45 minutes (30 minutes preferred). This method is preferred because of its relatively low cost and relative safety.

[0031] Alternatively, an ozone oxidation unit may be used to destroy the remaining pathogens. This unit would be injected with ozone at a rate of 0.1 to 1.0 pounds per ton (0.8 pounds per ton preferred). Ozone, however, is less preferred due to the expense of the oxidation unit and also because ozone requiries special handling precautions and thus increased expense.

[0032] From either of the pathogen destruction steps in paragraph [0018], the treated fertilizer feed stock is pumped to the last mixing tank operating at a speed of 20 to 50 rpm where it resides for 1/2 to 1 hour. During this time the N-P-K values are adjusted to the desired levels up to, for example, a maximum of 10-10-10 using either organic N, 13, and K or synthetic N, P, or K depending on whether the product will be certified Organic or not. This is performed using the chemicals and/or compositions described above. Production of the liquid fertilizer product is now finished and it can be packaged as desired.

[0033] The desire to maximize the production of livestock and poultry at a minimum cost has created vast quantities of manure which are an environmental hazard, but also represents a resource that can sustainably and economically be converted to either a certified organic on non-certified fertilizer. The product may have one or more of the following the following advantages:

Undesirable odors associated with storing and applying livestock and/or poultry manure are reduced or eliminated;

Pathogens and undesirable organisms in the livestock and/or poultry manure that could be transferred to humans and animals during routine agricultural use are reduced or eliminated;

The ratio of the main nutrient elements is better balanced for improved plant uptake.

[0034] The mobility of the nutrient elements after application to the soil is controlled through a buffering or controlled release provided by the humus-based complex that modulates the absorption and transfer of nutrients to the soil so that the fertilizer does not wash away after the first rain. The organic structure provided in the fertilizer controls the cation and anion exchange in the soil so that the release of nutrients is gradual. Synthetic fertilizers, for example, can lose up to 70% of their nutrients to runoff, while fertilizers with substantial organic components may retain up to 90% of N-P-K in the soil. The result is that much less fertilizer containing organic components is required for a given crop than for a conventional fertilizer using synthetic N-P-K.

[0035] The solid form of the fertilizer can be applied using existing commercial fertilizer spreading equipment. The organic structure in the fertilizer affects the heat exchange capacity of the soil so that a lower temperature is maintained during daylight, and a higher temperature is maintained at night. This attribute is particularly important in areas with elevated daytime temperatures and cold nights such as dry desert environments. The net result is reduced stress on the plant.

[0036] The fertilizer typically contains numerous trace elements required for healthy plant life. These are normally not present in commercial synthetic fertilizers. Finally, the additional organic matter provided in the fertilizer may increase the level of biological activity in the soil, thus increasing the soil's resistance to granulation and dissipation by runoff and/or wind.

WHAT IS CLAIMED IS:

1. A process for the production of fertilizer derived from animal manure comprising:

(a) adding an oxidizing composition to an animal manure slurry to provide a treated slurry; and

(b) processing the treated slurry in a device configured for inducing cavitation within the treated slurry to provide an oxidized manure stream.

2. The process of claim 1, further comprising prior to the cavitation operation passing the treated slurry through an inline mixer to homogenize the treated slurry.

3. The process of claim 1, further comprising adding a humus based material to the oxidized manure stream.

4. The process of claim 3, wherein the humus based material comprises a humus-based complex and/or a dry humus material.

5. The process of claim 1, further comprising adding a high calcium binding agent to the oxidized manure stream to provide a binder-containing process stream.

6. The process of claim 5, further comprising pelletizing the binder-containing process stream.

7. The process of claim 1, further comprising adding nutrient material to the oxidized manure stream.

8. The process of claim 7, wherein the nutrient materials include an N-P-K source and/or a trace mineral source.

9. The process of claim 1, wherein the oxidizing composition comprises about 30 to 60 wt% sodium percarbonate, about 35 to 45 wt% sodium lauroyl sarcosinate and about 1 to 5 wt% sodium laurate.

10. The process of claim 1, wherein particles greater than about 0.5 inches in size have been removed from the animal manure slurry and the animal manure slurry has a solids content of no more than about 25 wt%.

11. The process of claim 10, further comprising:

prior to the cavitation operation passing the treated slurry through an inline mixer to homogenize the treated slurry;

adding a humus based material, a high calcium binding agent and nutrient material to the oxidized manure stream to provide a binder-containing process stream; and

pelletizing the binder-containing process stream.

12. The process of claim 1, wherein the oxidizing composition comprises (a) percarbonate salt, hydrogen peroxide, sodium perborate, sodium hypochlorite and/or peracetic acid and (b) surfactant which includes a fatty acyl sarcosinate salt and/or a fatty acid salt; and

the process further comprises humus based material and a high calcium binding agent to the oxidized manure stream.

13. A fertilizer material produced according to the process of any of claims 1 to 12.

14. A process for treating a pathogen contaminated aqueous stream comprising:

(a) adding an oxidizing composition to the pathogen contaminated aqueous stream to provide a oxidant-treated process stream; and

(b) passed the oxidant-treated stream through a cavitation unit to provide an oxidized aqueous stream.

15. The process of claim 14, wherein the pathogen contaminated aqueous stream includes particulate material.

16. The process of claim 14, further comprising removing particulate matter from the oxidized aqueous stream.

17. The process of claim 16, wherein removing particulate matter from the oxidized aqueous stream comprises adding a flocculating agent to the oxidized aqueous stream and filtering the flocculent treated oxidized aqueous stream.

18. The process of claim 14, wherein the oxidizing composition comprises surfactant.

19. The process of claim 14, further comprising recirculating the oxidant-treated process stream a number of times through the cavitation unit; and withdrawing a fraction of the flow exiting the cavitation unit as a take-off stream.

20. The process of claim 19, wherein a majority of the exiting flow is recirculated through the cavitation unit.

21. A treated aqueous process stream produced according to the process of any of claims 14 to 20.

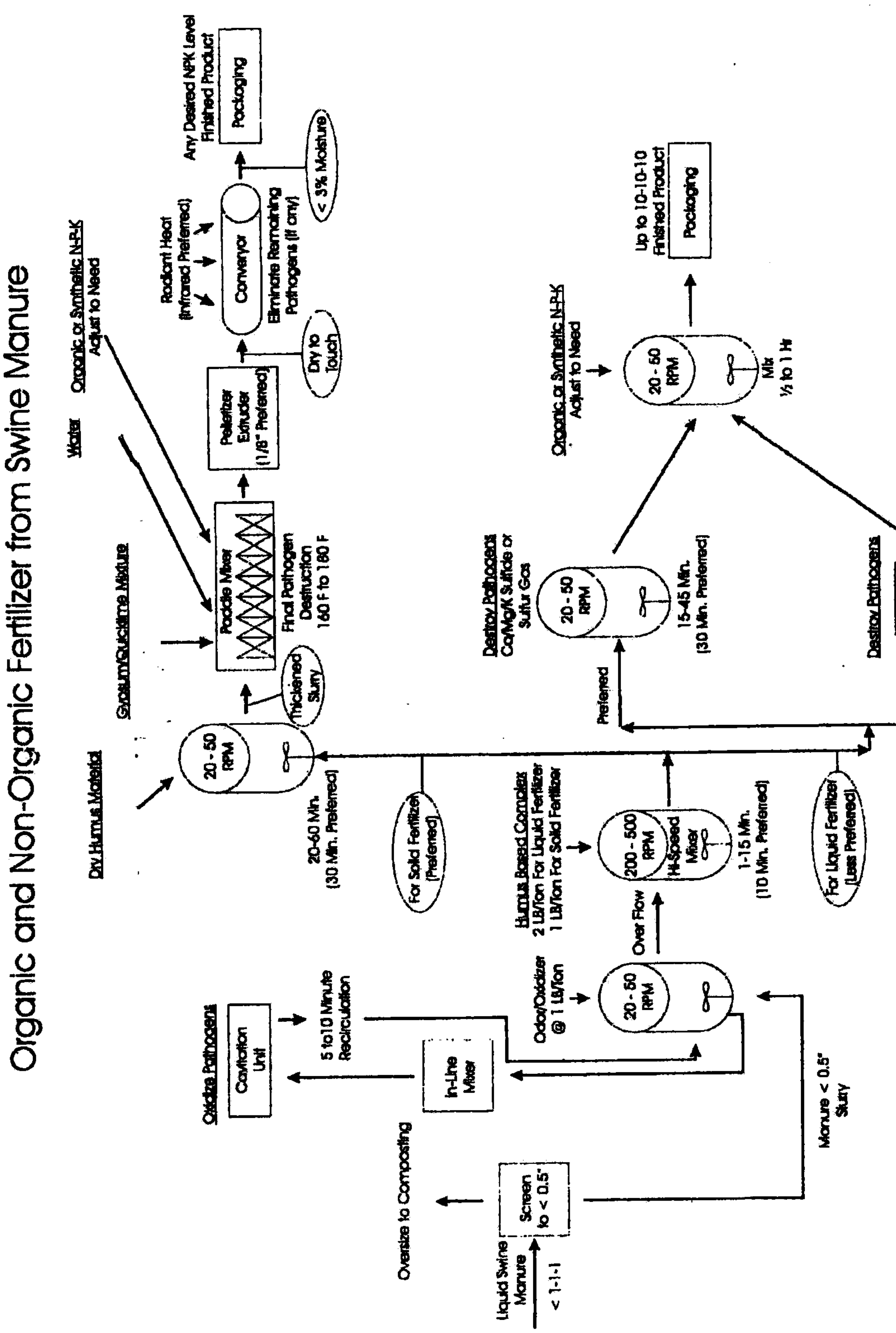
Organic and Non-Organic Fertilizer from Swine Manure
Liquid Swine Manure
< 1-1-1
Screen to < 0.5"
Oversize to Composting
Manure < 0.5" Slurry
In-Line Mixer
Oxidize Pathogens
Cavitation Unit
5 to 10 Minute Recirculation
Odor/Oxidizer @ 1 LB/Ton
20 - 50 RPM
Over Flow
Humus Based Complex
2 LB/Ton For Liquid Fertilizer
1 LB/Ton For Solid Fertilizer
200 - 500 RPM
Hi-Speed Mixer
1-15 Min. (10 Min. Preferred)
For Solid Fertilizer (Preferred)
For Liquid Fertilizer (Less Preferred)
Dry Humus Material
20 - 50 RPM
20-60 Min. (30 Min. Preferred)
Thickened Slurry
Gypsum/Quicklime Mixture
Water
Organic or Synthetic N-P-K
Adjust to Need
Paddle Mixer
Final Pathogen Destruction 160 F to 180 F
Pelletizer Extruder (1/8" Preferred)
Dry to Touch
Radiant Heat (Infrared Preferred)
Conveyor
Eliminate Remaining Pathogens (If any)
< 3% Moisture
Any Desired NPK Level Finished Product
Packaging
Preferred
Less Preferred
Destroy Pathogens
Ca/Mg/K Sulfide or Sulfur Gas
20 - 50 RPM
15-45 Min. (30 Min. Preferred)
Destroy Pathogens
Ozone Oxidation Unit
Organic or Synthetic N-P-K
Adjust to Need
20 - 50 RPM
Mix ½ to 1 Hr
Up to 10-10-10 Finished Product
Packaging

Figure 1

Cavitation Unit

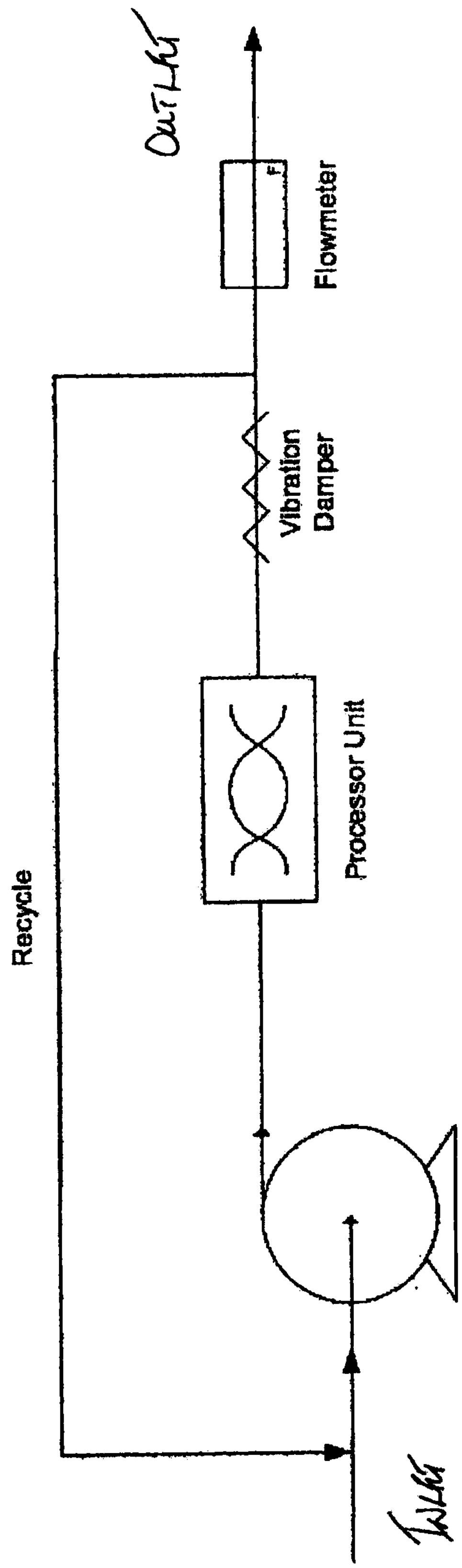

Figure 2

Figure 3