Advanced methane and ammonia recovery system

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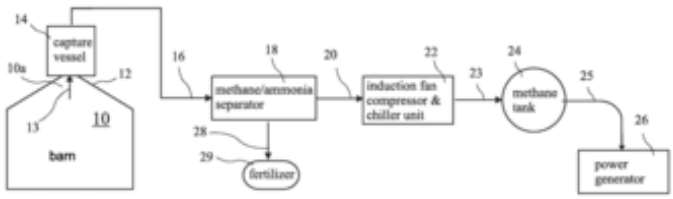
ABSTRACT

An advanced methane and ammonia recovery system processes gaseous waste from domestic livestock and poultry farms to reduce the green house gasses which are presently dumped into the environment and to produce useful material. The system includes a gas recovery system. The methane and ammonia recovery system captures ammonia and methane and converts the ammonia into fertilizer and methane into energy. The system is designed to substantially reduce the amount of green house gases introduced into the environment, while providing additional income to the domestic livestock and poultry farms

IMAGES (4)



DESCRIPTION

BACKGROUND OF THE INVENTION

[0001] The present invention relates to processing treatment of waste from domestic livestock and poultry operations and in particular to an integrated system for efficiently processing waste material from domestic livestock and poultry operations.

[0002] Domestic livestock and poultry operations in the United States produce a substantial portion of the food regularly consumed by the pubic. Unfortunately, these operations also produce significant waste

CLAIMS (10)

1. A gas recovery system comprising:

a barn;

a gas capture vessel residing at a peak of the barn for collecting gaseous waste;

a gas storage tank;

a compressor for moving the gaseous waste into the storage tank; and

a controllable fan for moving the gaseous waste from the gas capture vessel to the compressor.

2. The gas recovery system of claim 1, further including a first gas sensor residing in the gas capture vessel for sensing the presence of the gaseous waste in the gas capture vessel and electrically connected to the fan and turning the fan ON and OFF.

3. The gas recovery system of claim 2, further including a second gas sensor residing inside the gas capture vessel vertically spaced apart below the first gas sensor, wherein:

which must be dealt with, and significant odors not appreciated by local residents. Until the present time, no large scale systems have been developed to deal efficiently with green house gas created in the form of methane.

BRIEF SUMMARY OF THE INVENTION

[0003] The present invention addresses the above and other needs by providing an advanced methane and ammonia recovery system which processes gaseous waste from domestic livestock and poultry farms to reduce the green house gasses which are presently dumped into the environment and to produce useful material. The system includes a gas recovery system. The methane and ammonia recovery system captures ammonia and methane and converts the ammonia into fertilizer and methane into energy. The system is designed to substantially reduce the amount of green house gases introduced into the environment, while providing additional income to the domestic livestock and poultry farms.

[0004] In accordance with one aspect of the invention, there is provided a gas recovery system including a barn, a gas capture vessel, an ammonia/methane separator, a

the second gas sensor is for tuning the fan ON when the second gas sensor senses the presence of gaseous waste; and

the first gas sensor for turning the fan OFF when the first gas sensor does not sense the presence of the gaseous waste.

4. The gas recovery system of claim 3, wherein:

the gas capture vessel has a height between approximately 20 feet and approximately 25 feet and has a diameter between approximately eight feet and approximately ten feet;

the first gas sensor resided between approximately two feet and approximately four feet below a top of the gas capture vessel; and

the second gas sensor resided between approximately 2.5 feet and approximately four feet above a bottom of the gas capture vessel.

5. The gas recovery system of claim 2, further including:

an ammonia/methane separator receiving the gaseous waste from the gas capture vessel and separating ammonia from a flow of methane and other gasses; and

a compressor/chiller and membrane unit for receiving the flow of methane and other gases and separating the methane from the other gasses, wherein the methane is stored in the gas storage tank.

6. The gas recovery system of claim 5, further including a power generator receiving the methane stored in the gas storage tank and converting the methane to electrical power.

7. The gas recovery system of claim 3, wherein the fan resides on an intake of the compressor/chiller and membrane unit and draws the gaseous waste from the gas capture vessel, and through the ammonia/methane separator.

8. A gas recovery system comprising:

a barn;

a gas capture vessel having a height between approximately 20 feet and approximately 25 feet and having a diameter between approximately eight feet and approximately ten feet, the gas capture vessel residing at a peak of the barn for collecting gaseous waste;

a first methane sensor residing inside the gas capture vessel between approximately two feet and approximately four feet below a top of the gas capture vessel;

compressor/chiller and membrane unit, and a methane storage tank. The gas capture vessel has a height between approximately 20 feet and approximately 25 feet and a diameter between approximately eight feet and approximately ten feet, and resides at a peak of the barn for collecting gaseous waste. A first methane sensor resides inside the gas capture vessel between approximately two feet and approximately four feet below a top of the gas capture vessel and a second methane sensor resides inside the gas capture vessel vertically between approximately 2.5 feet and approximately four feet above a bottom of the gas capture vessel. A first ducting fluidly connects the gas capture vessel to the ammonia/methane separator and a second ducting fluidly connects the ammonia/methane separator and the compressor/chiller and membrane unit. A fan resides in the flow between the ammonia/methane separator and the compressor/chiller and membrane unit and controlled by the first methane sensor and the second methane sensor. A third ducting fluidly connects the compressor/chiller and membrane unit to the methane storage tank for

a second methane sensor residing inside the gas capture vessel between approximately 2.5 feet and approximately four feet above a bottom of the gas capture vessel;

an ammonia/methane separator;

a first ducting fluidly connecting the gas capture vessel and the ammonia/methane separator;

a compressor/chiller and membrane unit for separating methane gas from other gasses;

a second ducting fluidly connecting the ammonia/methane separator and the compressor/chiller and membrane unit;

a fan cooperating with the flow between the ammonia/methane separator and the compressor/chiller and membrane unit and controlled by the first methane sensor and the second methane sensor;

a methane storage tank; and

a third ducting fluidly connecting the compressor/chiller and membrane unit to the methane storage tank for carrying methane from the compressor/chiller membrane unit to the methane storage tank.

9. The gas recovery system of claim 8, further including a power generator receiving methane from the methane storage tank and converting the methane to electrical power.

10. A method for controlling a methane and ammonia recovery system, the method comprising:

turning to OFF a fan used to draw gaseous waste from a gas capture vessel through the gas recovery system;

entering a loop starting with testing if the fan is ON;

if the fan is ON, testing if a first gas sensor residing inside the gas capture vessel proximal to a top of the gas capture vessel is sensing the presence of the gaseous waste, and turning the fan to OFF if the first gas sensor is not detecting the presence of the gaseous waste;

if the fan is ON, testing if the first gas sensor is sensing the presence of the gaseous waste and leaving the fan ON if the first gas sensor is detecting the presence of the gaseous waste;

if the fan is OFF, testing if either or both the first gas sensor is not sensing the presence of the gaseous waste and a second gas sensor residing inside the gas capture vessel proximal to a bottom of the gas capture vessel is not sensing the presence of the gaseous waste and leaving the fan OFF if either or both gas sensors are not detecting the presence of the gaseous waste;

carrying methane from the compressor/chiller membrane unit to the methane storage tank. The compressor/chiller and membrane unit separates methane gas from other gasses and the methane gas stored in the methane storage tank may be used to power a generator.

and

if the fan is OFF, testing if both the first gas sensor is sensing the presence of the gaseous waste and the second gas sensor is sensing the presence of the gaseous waste and turning the fan ON if both gas sensors are detecting the presence of the gaseous waste.

[0005] In accordance with another aspect of the invention, there is provided a method for controlling a gas recovery system. The method includes the steps of initially turning to OFF a fan used to draw gaseous waste from a gas capture vessel through the gas recovery system. The system then enters a loop and tests if the fan is ON or OFF. If the fan is ON and if a first gas sensor residing inside the gas capture vessel proximal to a top of the gas capture vessel is sensing the presence of the gaseous waste, the fan remains ON. If the fan is ON and if the first gas sensor is not detecting the presence of the gaseous waste, the fan is turned OFF. If the fan is OFF, leaving the fan OFF if either or both the first gas sensor is not sensing the presence of the gaseous waste and a second gas sensor residing inside the gas capture vessel proximal to a bottom of the gas capture vessel is not sensing the presence of the gaseous waste. If the fan is OFF, turning the fan ON if both gas sensors are detecting the presence of the gaseous waste.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

[0006] The above and other aspects, features and advantages of the present invention will be more apparent from the following more particular description thereof, presented in conjunction with the following drawings wherein:

[0007] FIG. 1 is a block diagram of a methane and ammonia recovery system according to the present invention.

[0008] FIG. 2 depicts a barn with a gas capture vessel residing at a peak, and gas processing equipment.

[0009] FIG. 3 shows a perspective view of the gas capture vessel.

[0010] FIG. 4 shows a side view of the gas capture vessel.

[0011] FIG. 5 is a cross-sectional view of the gas capture vessel taken along line **5**-**5** of FIG. 4.

[0012] FIG. 6 is a method according to the present invention.

[0013] FIG. 7 depicts a small barn with the gas capture vessel residing at a peak, and gas processing equipment.

[0014] Corresponding reference characters indicate corresponding components throughout the several views of the drawings.

DETAILED DESCRIPTION OF THE INVENTION

[0015] The following description is of the best mode presently contemplated for carrying out the invention. This description is not to be taken in a limiting sense, but is made merely for the purpose of describing one or more preferred embodiments of the invention. The scope of the invention should be determined with reference to the claims.

[0016] An advanced methane and ammonia recovery system according to the present invention is shown in FIG. 1. A livestock or poultry barn, house, and/or enclosure **10** produces gaseous waste **13**. The gaseous waste**13** is collected by a gas capture vessel **14** residing at a peak **10** *a* of the barn **10**. The gaseous waste **13** is lighter than air and rises into the gas capture vessel **14**. The gaseous waste **13** is collected in the gas capture vessel **14** and carried by first ducting **16** to an ammonia/methane separator **18** (for example, an ammonia scrubber). The ammonia/methane separator **18** separates ammonia from other gasses (primarily methane) in the gaseous waste **13**. The ammonia, which is converted into ammonium sulfate, is carried by ammonia ducting **28** to an ammonium sulfate storage tank **29** for further drying into fertilizer.

[0017] The other gasses are carried by second ducting **20** to a compressor/chiller and membrane unit **22** where the methane is separated from oxygen and nitrogen. The separation is preferably done by selectively permeable

membrane(s). The compressor/chiller and membrane unit **22** preferably includes a fan to draw the gaseous waste**13** from the gas capture vessel **14** to the ammonia/methane separator**18** and from the ammonia/methane separator **18** to the compressor/chiller and membrane unit **22**. Methane captured by the compressor/chiller and membrane unit **22** is carried by a third ducting**23** to a methane storage tank **24**.

[0018] A perspective view of the gas capture vessel **14** is shown in FIG. 3, a side view of the gas capture vessel **14** is shown in FIG. 4, and a cross-sectional view of the gas capture vessel **14** taken along line **5**-**5** of FIG. 4 is shown in FIG. 5. The gas capture vessel **14** comprises a vertical cylindrical body **14** *a* and a frustoconical shaped top **14** *b* tapering to a peak where the duct **16** receives the gaseous waste **13** collected in the gas capture vessel **14**.

[0019] The cylindrical body **14** *a* has a height H**1** which is preferably between approximately 20 feet and approximately 25 feet tall and a diameter D**1**which is preferably between approximately eight feet and approximately ten feet, but may vary outside this range depending on the number of animals in the barn. Gas sensors S**1** and S**2** reside inside the cylindrical body **14** *a*. An upper gas sensor S**1** resides a second height H**2** below the top of the cylindrical body **14** *a* and a lower gas sensor S**2** resides a third height H**3** above the base of the cylindrical body **14** *a*. The gas sensors are preferably methane sensors, but may sense any gas present in the gaseous waste **13** in sufficient quantities to allow reliable sensing of the presence of the gaseous waste **13** in the gas capture vessel **14**. The height H**2** is preferably between approximately two feet and approximately four feet depending on the number of animals in the barn. The height H**3**is preferably between approximately 2.5 and approximately four feet, and is more preferably approximately four feet.

[0020] A method for controlling an operation of the gas recovery system is described in FIG. 6. The fan is initially turned to OFF at step **100** and a control loop is entered. If the fan is ON at step **102**, and if the first gas senor S**1** is detecting (i.e., S**1**=1) the presence of the gaseous waste **13**, the fan remains ON. If the fan is ON at step **102**, and if the first gas senor S**1** is not detecting (i.e., S**1**=0) the presence of the gaseous waste **13**, the fan is turned OFF at step **105**. If the fan is OFF at step **102**, and if both the first senor S**1** is detecting (i.e., S**1**=1) the presence of the gaseous waste **13** and the second senor S**2** is detecting (i.e., S**2**=1) the presence of the gaseous waste **13** at step**106**, the fan is turned ON at step **108**. If the fan is OFF at step **102**, and if either or both the first senor S**1** is not detecting (i.e., S**1**=0) the presence of the gaseous waste **13**, and the second senor S**2** is not detecting (i.e., S**2**=0) the presence of the gaseous waste **13** at step **106**, the fan remains OFF. In all cases, the control loop returns to step **102**.

[0021] A small barn **30** with the gas capture vessel **14** residing at a peak, and gas processing equipment is shown in FIG. 7. The gas produced in the small barn **30** may not be sufficient to make the system shown in FIGS. 1 and 2economically feasible. As a result, a small system comprising a fan/compressor unit **32** connected to the gas capture vessel **14** by the ducting **16**, and a gas storage tank **34** connected to the fan/compressor unit **32** by ducting**33**, is an alternative system. The gas stored in the tank **34** is periodically collected for processing at a remote location which services small farms in the local area.

[0022] While the invention herein disclosed has been described by means of specific embodiments and applications thereof, numerous modifications and variations could be made thereto by those skilled in the art without departing from the scope of the invention set forth in the claims.