

Description

Title of The Invention

HYDROTHERMAL TREATMENT SYSTEM

5 Field of The Invention

[0001]

The present invention relates to a hydrothermal treatment system for producing gas from waste containing organic matter.

10 Background of The Invention

[0002]

Systems which: use high-temperature and high-pressure steam to hydrothermally react and solubilize (hydrothermal treatment) waste containing organic matter such as municipal solid waste which is comprised of kitchen waste (food waste) from households, paper and plant matter waste, livestock manure, and sludge; perform separation of the hydrothermally treated waste containing organic matter (hydrothermal treatment product) to obtain liquid such as a solution or slurry (hydrothermal treatment liquid); and perform gas production by utilizing the hydrothermal treatment liquid by means of microorganisms or bacteria, e.g., methane fermentation, have been developed (e.g., Patent Documents 1, 2). In order to separate the hydrothermal treatment liquid from the hydrothermal treatment product in this system, for example, a screen or a screw press as described in Patent Document 3 can be used.

25 References Cited

Patent Literatures

[0003]

Patent Document 1: JP 2009-119378 A

Patent Document 2: JP 2019-181397 A

30 Patent Document 3: JP 2011-200836 A

Summary of The Invention

Technical Problem

[0004]

35 In general, waste containing organic matter which is collected by a garbage truck or waste containing organic matter stored in a waste pit of a garbage disposal facility contains: organic matter which contributes to gas production, organic matter which does not contribute or hardly contributes to

gas production (for example: plastic), and inorganic matter such as metal and glass which are not completely removed and still remain in the waste. The ratio of organic matter to inorganic matter in the waste containing organic matter, the ratio of kitchen waste (food waste) to paper waste in the organic matter

5 fraction, the ratio of organic matter which contributes to gas production to the organic matter which almost does not contribute to gas production (i.e., ratio among organic contents in a predetermined amount of waste containing organic matter), and so forth, vary, depending on the region, season, day, and time.

[0005]

10 Furthermore, generally, regardless of the ratio among the organic contents in the waste containing organic matter, a predetermined amount of the waste containing organic matter is hydrothermally treated in the hydrothermal treatment device for a certain period of time (a predetermined period of time) which is determined in advance, and when the predetermined period of time
15 elapses, the hydrothermal treatment is terminated, and the hydrothermal treatment product is taken out from the hydrothermal treatment device. Because of this, the properties of the discharged hydrothermal treatment product vary depending on the ratio among the organic contents in the waste containing organic matter. For example, a sand-like or powdery hydrothermal treatment
20 product having a low water content may be obtained, or a muddy or liquid hydrothermal treatment product having a high water content may be obtained.

[0006]

On the other hand, when gas is produced using microorganisms or bacteria, for example, methane production by means of methane fermentation
25 by utilizing the hydrothermal treatment liquid as feedstock, it is desirable that the fragmented organic matter contained in the hydrothermal treatment product be in the hydrothermal treatment liquid as much as possible. Therefore, a pressure-type screw press as described in Patent Document 3 is preferably used to separate the hydrothermal treatment liquid from the hydrothermal treatment
30 product. However, it is not preferable to apply pressure to the hydrothermal treatment product with low water content (for example: sand-like hydrothermal treatment product) using the screw press because it increases power consumption and may even lead to failure of the screw press.

[0007]

35 Furthermore, when gas is produced by microorganisms or bacteria by utilizing hydrothermal treatment liquid, the concentration of fragmented organic matter contained in the hydrothermal treatment liquid is an important factor for achieving higher gas production efficiency. However, since the

concentration of the organic matter in the hydrothermal treatment product greatly varies, from the hydrothermal treatment product with high water content to the hydrothermal treatment product with low water content, it is difficult to achieve stable gas production in a gas production device such as a methane fermentation device.

[0008]

Here, the objective of the present invention is to provide a hydrothermal treatment system which can stably produce gas regardless of the ratio among the organic contents contained in the waste containing organic matter.

Solution to The Problem

[0009]

A hydrothermal treatment system of the present invention includes: a hydrothermal treatment device configured to perform a hydrothermal reaction of waste containing organic matter; an adjustment tank configured to wet a hydrothermal treatment product obtained from the hydrothermal reaction; a first transport device configured to transport the hydrothermal treatment product wetted in the adjustment tank; a pressure-separation device configured to apply pressure to the hydrothermal treatment product transported by the first transport device to separate the hydrothermal treatment product into hydrothermal treatment liquid and residue; a solubilization tank configured to store and heat up the hydrothermal treatment liquid separated by the pressure-separation device; a second transport device configured to transport the hydrothermal treatment liquid which is heated up and solubilized in the solubilization tank back to the adjustment tank; and a gas production device configured to produce gas by utilizing the hydrothermal treatment liquid stored in the solubilization tank, wherein the second transport device transports the hydrothermal treatment liquid back to the adjustment tank when a concentration of organic matter contained in the hydrothermal treatment liquid stored in the solubilization tank is less than a predetermined concentration which is a concentration of the organic matter suitable for gas production using microorganisms or bacteria, and transports the hydrothermal treatment liquid to the gas production device when the concentration of the organic matter is equal to or more than the predetermined concentration.

Advantageous Effects of The Invention

[0010]

According to the present invention, stable gas production can be performed regardless of the ratio among the organic contents contained in the waste containing organic matter.

Brief Description of The Drawings

[0011]

FIG. 1 is a schematic diagram illustrating a hydrothermal treatment system according to an embodiment.

FIG. 2 is a schematic diagram illustrating an example of a second facility of the hydrothermal treatment system according to the embodiment.

Description of The Embodiments

[0012]

A hydrothermal treatment system of the present invention will be described below with reference to the drawings. The configuration and so forth described below are mere examples, and there is no intention to exclude various modifications and applications of the technologies which are not explicitly described. The configuration and so forth described below can be variously modified and implemented without deviating from the essential constituent elements and the essence of the present invention.

[0013]

FIG. 1 shows a schematic diagram illustrating a hydrothermal treatment system 1 of the present embodiment. The hydrothermal treatment system 1 is a system in which waste containing organic matter is hydrothermally reacted with high-temperature and high-pressure steam and solubilized (hereinafter referred to as "hydrothermal treatment"); and liquid (hereinafter referred to as "hydrothermal treatment liquid") such as a solution, mixed liquid, or a slurry separated from the hydrothermally treated waste containing organic matter (hereinafter referred to as "hydrothermal treatment product") is utilized for gas production using microorganisms or bacteria.

The hydrothermal treatment system 1 includes at least a hydrothermal treatment device 10, an adjustment tank 11, a first transport device 21, a pressure-separation device 12, a solubilization tank 13, a second transport device 22, and a gas production device 14.

The whole configuration of the hydrothermal treatment system 1 illustrated in FIG. 1 will be described in detail below.

[0014]

The hydrothermal treatment device 10 is a device which performs hydrothermal treatment of waste containing organic matter. Some examples of the waste containing organic matter fed to the hydrothermal treatment device 10 are kitchen waste (food waste) discharged from households, woody waste, livestock excreta, and sludge. The waste containing organic matter collected by a garbage truck or stored in a waste pit of a garbage disposal facility may be directly fed to the hydrothermal treatment device 10, or may be fed to the hydrothermal treatment device 10 after removing the inorganic matter. Kitchen waste (food waste), paper waste, and plant waste containing organic matter which is suitable for gas production may be selectively extracted from the waste containing organic matter, and then those kitchen waste (food waste), paper waste, and plant waste may be fed to the hydrothermal treatment device 10. The hydrothermal treatment device 10 can also perform the hydrothermal treatment to treat a disposable diaper, for which disposal has recently been problematic in care facilities for the elderly and so forth.

As it will be revealed later, regarding the hydrothermal treatment system 1, although the hydrothermal treatment is performed multiple times wherein the ratio among the organic contents in a predetermined amount of waste containing organic matter for each time of hydrothermal treatment greatly varies, the gas production device 14 to be described later can stably produce gas.

The hydrothermal treatment device 10 performs the hydrothermal treatment for a predetermined period of time, and the hydrothermal treatment product is discharged from the hydrothermal treatment device 10 and then stored in the adjustment tank 11.

[0015]

The adjustment tank 11 is a device which wets the hydrothermal treatment product discharged from the hydrothermal treatment device 10 to adjust the properties of the hydrothermal treatment product. The expression "wet" the hydrothermal treatment product not only means wetting the hydrothermal treatment product with water or liquid, but also means immersing the hydrothermal treatment product in water or liquid.

The hydrothermal treatment product stored in the adjustment tank 11 is wetted by injecting the hydrothermal treatment liquid stored in the solubilization tank 13 to be described later. In addition to the hydrothermal treatment liquid, tap water (not illustrated) or recycled water to be described later may be injected appropriately into the adjustment tank 11.

An agitation device may be installed in the adjustment tank 11 to agitate and mix the hydrothermal treatment product stored in the adjustment tank 11 and the injected or poured liquid or water. If the agitation device is installed, the properties of the hydrothermal treatment product in the adjustment tank 11 can be adjusted in a short period of time. For example, when the hydrothermal treatment product stored in the adjustment tank 11 is in a sand-like form, the hydrothermal treatment product can be converted into a slurry form in a short period of time by operating the agitation device while pouring or injecting liquid or water.

The agitation device may be any device such as that for air agitation or mechanical agitation as long as the hydrothermal treatment product stored in the adjustment tank 11 and the injected or poured liquid or water can be agitated.

[0016]

The hydrothermal treatment device 10 and the adjustment tank 11 are the equipment which perform hydrothermal treatment of the waste containing organic matter, and wet and store the hydrothermal treatment product obtained by the hydrothermal treatment, respectively; and they are components of a first facility 2 which performs a first stage treatment in the hydrothermal treatment system 1.

As will be described later, equipment which uses pressure to separate the hydrothermal treatment product stored in the first facility 2 and to obtain the hydrothermal treatment liquid (hereinafter referred to as "pressurized separation"); and solubilizes the hydrothermal treatment liquid obtained by the pressurized separation is a second facility 3 which performs a second stage treatment in the hydrothermal treatment system 1. Equipment for producing gas by utilizing the hydrothermal treatment liquid solubilized in the second facility 3 is a third facility 4 which performs a third stage treatment in the hydrothermal treatment system 1.

[0017]

The first transport device 21 is a device which transports the hydrothermal treatment product wetted in the adjustment tank 11 in the first facility 2 to the second facility 3.

When the first facility 2 and the second facility 3 are installed close to each other, for example, when the first facility 2 and the second facility 3 are installed in the same site or in adjacent sites with the distance between the first facility 2 and the second facility 3 being less than about 500 m, the first transport device 21 is preferably a pipeline. This pipeline connects the

adjustment tank 11 in the first facility 2 and the pressure-separation device 12 in the second facility 3 and is equipped with a crushing pump for pressure-feeding the hydrothermal treatment product whose properties have been adjusted in the adjustment tank 11, to the pressure-separation device 12.

- 5 Generally, a pipeline is configured by connecting multiple pipes to form one path.

In this case, the hydrothermal treatment product stored in the adjustment tank 11 in the first facility 2 is transported to the pressure-separation device 12 in the second facility 3 through the pipeline while being crushed by the
 10 crushing pump. Since the hydrothermal treatment product can be crushed into a smaller size by the crushing pump while being transported, a load on the pressure-separation device 12 (for example: a screw press) to be described later can be decreased.

[0018]

- 15 Hereinafter, when two out of these facilities: the first facility 2, the second facility 3, and the third facility 4, are installed "close to each other", it means that the two facilities are installed at the same site or different sites with the distance between the two facilities being less than about 500 m.

[0019]

- 20 On the other hand, when the first facility 2 and the second facility 3 are installed far from each other, the first transport device 21 is preferably an automobile equipped with a storage tank and so forth (for example: a vacuum car and so forth). For example, if the first facility 2 and the second facility 3 are installed while being separated from each other by 500 m or more, they can
 25 be regarded as being installed "far from each other" regardless of whether they are in the same site or different sites. In this case, the hydrothermal treatment product stored in the adjustment tank 11 in the first facility 2 is loaded on the automobile and conveyed to the pressure-separation device 12 in the second facility 3, and the conveyed hydrothermal treatment product is then fed to the
 30 pressure-separation device 12.

[0020]

This automobile may be an automobile driven by a person, or may be an automatic driving automobile whose driving is controlled not by a person but by a computer such as artificial intelligence (AI).

- 35 The hydrothermal treatment system 1 may be equipped with a central control room and a person who controls the driving of the automobile by means of remote monitoring using a monitoring camera. In this case, when the monitoring cameras are installed in the equipment, devices, and facilities in the

hydrothermal treatment system 1, the remote monitoring can be performed from the central control room, thus, the safety of the operation of the hydrothermal treatment system 1 can be improved.

Moreover, the hydrothermal treatment system 1 can be configured in such a manner so that the operation of each equipment, devices, and facilities included in the hydrothermal treatment system 1 can be controlled from the central control room. Furthermore, the operation of the hydrothermal treatment system 1 can be fully automated by using AI.

[0021]

Hereinafter, when two out of these facilities: the first facility 2, the second facility 3, and the third facility 4, are installed "far from each other", it means that the two facilities are installed at the same site or different sites with the distance between the two facilities being equal to or more than about 500 m.

In addition, hereinafter, when the term "automobile" is used, the automobile may be an automobile driven by a person or may be an automobile with automatic driving. The automobile may be an automobile which is controlled or operated by a person using remote monitoring.

[0022]

The pressure-separation device 12 in the second facility 3 is a device which applies pressure to the hydrothermal treatment product transported from the adjustment tank 11 in the first facility 2 using the first transport device 21, separates the hydrothermal treatment product into the hydrothermal treatment liquid and residue (a remaining matter obtained after separating the hydrothermal treatment liquid from the hydrothermal treatment product). The hydrothermal treatment liquid is also referred to as a suitable fermentation feedstock, and the residue is also referred to as an unsuitable fermentation feedstock.

For example, as illustrated in FIG. 2, the pressure-separation device 12 may have a configuration in which a rotary drum screen 12A is configured in a preceding stage and a screw press 12B is configured in a following stage. The rotary drum screen 12A may be, for example, a perforated metal drum screen device described in JP 6384015 B granted to Mitsubishi Heavy Industries Environmental & Chemical Engineering Co., Ltd. The screw press 12B may be, for example, a dewatering system described in FIG. 13 of JP 6734496 B granted to Mitsubishi Heavy Industries Environmental & Chemical Engineering Co., Ltd.

Since the recovery rate of the hydrothermal treatment liquid and the removal rate of the unsuitable fermentation feedstock are affected by the water content, the viscosity, and other properties of the hydrothermal treatment product, the aperture size, the opening ratio, the screw pitch (the distance
5 between the screw and an outlet), and so forth of the pressure-separation device 12 are carefully set. The dewatering system illustrated in FIG. 13 of JP 6734496 B has an aperture size which can be changed depending on a change in the property of the hydrothermal treatment product, and therefore, is suitable for the pressure-separation device 12. In response to a change in property of the
10 hydrothermal treatment product, the pressure-separation device 12 may have, for example, an adjustable internal pressure by adjusting the outlet size.

Furthermore, different from the illustration shown in FIG. 2, the pressure-separation device 12 may be configured as a single unit consisting of the screw press only.

15 [0023]

Regarding the pressure-separation device 12 shown in FIG. 2, the hydrothermal treatment product transported from the adjustment tank 11 in the first facility 2 using the first transport device 21 is firstly fed to the rotary drum screen 12A. Then, in the rotary drum screen 12A, some of the hydrothermal
20 treatment liquid is separated from the hydrothermal treatment product. Next, the remaining hydrothermal treatment product discharged from the rotary drum screen 12A is fed to the screw press 12B.

Therefore, unlike in a case where the rotary drum screen 12A is not installed in the preceding stage (a case when the pressure-separation device 12
25 is a single unit consisting of the screw press only), in the present case, the amount of the hydrothermal treatment product which is to be pressed and separated into the hydrothermal treatment liquid and the residue by the screw press 12B in the following stage is in a reduced amount instead of the total amount of the hydrothermal treatment product transported using the first
30 transport device 21. Thus, regarding the pressure-separation device 12 shown in FIG. 2, the power consumption of the screw press 12B can be reduced (power saving).

The hydrothermal treatment liquid separated by the rotary drum screen 12A and the hydrothermal treatment liquid separated by the screw press 12B
35 are collected and stored in the solubilization tank 13 in the second facility 3.
[0024]

The solubilization tank 13 in the second facility 3 is a device which stores, heats up, and solubilizes the hydrothermal treatment liquid separated by

the pressure-separation device 12. The heating temperature can be, for example, about 40°C to 60°C.

By solubilizing the hydrothermal treatment liquid in the solubilization tank 13, suspended solids (hereinafter referred to as "SS") suspended in the hydrothermal treatment liquid turn into dissolved solids (hereinafter referred to as "DS") dissolved in the hydrothermal treatment liquid. Thus, the amount of SS in the total amount of solids (Total Solids, hereinafter referred to as "TS"; $TS = SS + DS$) contained in the hydrothermal treatment liquid stored in the solubilization tank 13 decreases. Therefore, it can be said that the solubilization tank 13 is a device which reduces the amount of SS, increases the amount of DS, and promotes acid fermentation of the hydrothermal treatment liquid.

Generally, in terms of the gas production using microorganisms or bacteria, it is preferable to have a large amount of organic DS in the TS. TS, SS, or DS of the hydrothermal treatment liquid stored in the solubilization tank 13 can be measured by a dedicated measuring device (not illustrated).

Similar to the adjustment tank 11, an agitation device may be installed in the solubilization tank 13 to agitate the hydrothermal treatment liquid stored in the solubilization tank 13 and to promote the solubilization of the hydrothermal treatment liquid.

[0025]

The second transport device 22 is a device that: when the concentration of the organic matter contained in the hydrothermal treatment liquid stored in the solubilization tank 13 in the second facility 3 is less than a predetermined concentration (for example: TS is about 10% and DS is about 6%), transports the hydrothermal treatment liquid from the solubilization tank 13 back to the adjustment tank 11 in the first facility 2, and when the predetermined concentration is achieved (including a case where the concentration is approximately equal to or more than the predetermined concentration; the predetermined concentration may be a range of concentration, for example, TS of about 10% to 12%, and DS of about 6% to 8%), transports the hydrothermal treatment liquid from the solubilization tank 13 to the gas production device 14 in the third facility 4.

Based on a result of the measurement by the measuring device described above, the second transport device 22 may be configured to automatically select one destination, either the adjustment tank 11 or the gas production device 14, and transport the hydrothermal treatment liquid stored in the solubilization tank 13 to the selected transport destination.

The predetermined concentration is set to a concentration of organic matter suitable for gas production using microorganisms or bacteria in the gas production device 14 to be described later. At the predetermined concentration, the hydrothermal treatment liquid stored in the solubilization tank 13 is acidic with the pH value being less than 7, preferably equal to or less than 5.

[0026]

Similar to the first transport device 21, when the first facility 2 and the second facility 3 are installed close to each other, the second transport device 22 is preferably a pipeline. This pipeline connects the adjustment tank 11 in the first facility 2 and the solubilization tank 13 in the second facility 3, and is equipped with a pump for pressure-feeding the hydrothermal treatment liquid from the solubilization tank 13 to the adjustment tank 11.

On the other hand, when the first facility 2 and the second facility 3 are installed far from each other, the second transport device 22 is preferably an automobile equipped with a storage tank and so forth (for example: a vacuum car and so forth). In this case, the hydrothermal treatment liquid is conveyed from the solubilization tank 13 to the adjustment tank 11 using the automobile.

In any case, the hydrothermal treatment liquid is circulated between the first facility 2 and the second facility 3 using the second transport device 22.

[0027]

When the second facility 3 and the third facility 4 are installed close to each other, the second transport device 22 is preferably a pipeline. This pipeline connects the solubilization tank 13 in the second facility 3 and the gas production device 14 in the third facility 4, and is equipped with a pump for pressure-feeding the hydrothermal treatment liquid in the solubilization tank 13 to an inlet of the gas production device 14.

[0028]

When the first facility 2, the second facility 3, and the third facility 4 are installed close to each other, the second transport device 22, for example, may be equipped with a switching device installed in the middle of a pipeline connecting the solubilization tank 13 in the second facility 3 and the adjustment tank 11 in the first facility 2; and the switching device is also connected with another pipeline which branches to the inlet of the gas production device 14 in the third facility 4.

Based on the concentration of the organic matter contained in the hydrothermal treatment liquid stored in the solubilization tank 13 in the second facility 3 as described above, by using the switching device, the second transport device 12 can alternatively select the destination and the conveying

pipeline which is any one of the following pipelines: the pipeline connecting the solubilization tank 13 in the second facility 3 and the adjustment tank 11 in the first facility 2; or the other pipeline described above.

[0029]

5 On the other hand, when the second facility 3 and the third facility 4 are installed far from each other, the second transport device 22 is preferably an automobile equipped with a storage tank and so forth (for example: a vacuum car and so forth). In this case, by using the automobile, the hydrothermal treatment liquid is conveyed from the solubilization tank 13 to the gas
10 production device 14 and fed to the inlet of the gas production device 14.

 When the first facility 2 and the second facility 3 are installed close to each other, and the second facility 3 and the third facility 4 are installed far from each other, the second transport device 22 may be: a pipeline for transporting the hydrothermal treatment liquid between the first facility 2 and
15 the second facility 3, and an automobile for transporting the hydrothermal treatment liquid between the second facility 3 and the third facility 4. In other words, the second transport device 22 may include two types of transport devices which are a pipeline and an automobile.

 Similarly, when the first facility 2 and the second facility 3 are installed
20 far from each other, and the second facility 3 and the third facility 4 are installed close to each other, the second transport device 22 may be: an automobile for transporting the hydrothermal treatment liquid between the first facility 2 and the second facility 3, and a pipeline for transporting the hydrothermal treatment liquid between the second facility 3 and the third
25 facility 4.

[0030]

 The second transport device 22 transports the hydrothermal treatment liquid stored in the solubilization tank 13 in the second facility 3 back to the adjustment tank 11 in the first facility 2 until the concentration of the organic
30 matter contained in the hydrothermal treatment liquid reaches the predetermined concentration described above.

 Thus, the hydrothermal treatment product stored in the adjustment tank 11 in the first facility 2 can be wetted, so that the hydrothermal treatment product can be easily transported by the first transport device 21 and the power
35 consumption of the pressure-separation device 12 in the second facility 3 can be reduced.

[0031]

In addition, because the hydrothermal treatment liquid transported back from the solubilization tank 13 in the second facility 3 to the adjustment tank 11 in the first facility 2 is heated up in the solubilization tank 13, the hydrothermal treatment liquid can be injected into the adjustment tank 11 at one of the following temperature conditions: it is maintained at the heated temperature, or it is maintained at a temperature which is slightly lower than that of hydrothermal treatment liquid temperature due to natural heat dissipation and so forth but higher than room temperature.

In this case, the hydrothermal treatment liquid transported back can contribute to the adjustment of the properties of the hydrothermal treatment product by, for example, promoting the solubilization of at least some part of the hydrothermal treatment product stored in the adjustment tank 11.

[0032]

Furthermore, in the hydrothermal treatment system 1, the hydrothermal treatment is performed multiple times sequentially, and even if the ratio among the organic contents in the waste containing organic matter to be hydrothermally treated by the hydrothermal treatment device 10 in the first facility 2 varies for each time which leads to a great variation in the concentration of the organic matter contained in the hydrothermal treatment liquid obtained from each hydrothermal treatment batch, due to the transporting back as described above, the concentration of the organic matter contained in the hydrothermal treatment liquid stored in the solubilization tank 13 can be stabilized by circulating the hydrothermal treatment liquid between the first facility 2 and the second facility 3.

When the concentration of the organic matter contained in the hydrothermal treatment liquid stored in the solubilization tank 13 reaches the predetermined concentration, the hydrothermal treatment liquid which reaches the predetermined concentration is transported to the gas production device 14 by the second transport device 22. Therefore, the concentration of the organic matter contained in the hydrothermal treatment liquid fed to the gas production device 14 is always almost constant and has less variation, and the hydrothermal treatment liquid contains a large amount of the organic matter contributing to the gas production. Thus, the gas production device 14 can stably produce the gas.

[0033]

In a common gas production device in which gas is produced by microorganisms or bacteria by utilizing hydrothermal treatment liquid as a

feedstock, solubilization and acid fermentation need to be performed inside the device.

However, in the hydrothermal treatment system 1, when the concentration of the organic matter contained in the hydrothermal treatment liquid stored in the solubilization tank 13 reaches the predetermined concentration in the solubilization tank 13, the solubilization and acid fermentation have already taken place and it is in suitable condition for gas production. Therefore, in the gas production device 14, the solubilization step and the acid fermentation step which occur in the common gas production device can be omitted, thus, the gas can be rapidly produced compared with a common gas production device.

[0034]

The gas production device 14 in the third facility 4 is a device in which gas is produced by microorganisms or bacteria by utilizing the hydrothermal treatment liquid stored in the solubilization tank 13 in the second facility 3. The gas production device 14 may be any device in which gas is produced by microorganisms or bacteria by utilizing the hydrothermal treatment liquid as a feedstock, and it may be a methane fermentation device which produces methane gas by means of methane fermentation, or a device which produces gas such as hydrogen. The gas production device 14 heats up the hydrothermal treatment liquid and produces gas.

[0035]

The configuration described above is at least included in the hydrothermal treatment system 1. As illustrated in FIG. 1, the hydrothermal treatment system 1 may further include the following devices and facilities.

[0036]

A waste liquid treatment device 15 is a device which purifies waste liquid (for example: digestate) discharged from the gas production device 14 in which gas production takes place, to generate recycled water. The waste liquid treatment device 15 is, for example, a device which performs nitrification and denitrification, or in other words, a device which performs biological treatment of the waste liquid.

The recycled water generated in the waste liquid treatment device 15 by purifying the waste liquid from the gas production device 14 can be supplied to the adjustment tank 11 in the first facility 2 through a supply path 19 by means of a pipeline.

Immediately after starting up the operation of the hydrothermal treatment system 1, the hydrothermal treatment system 1 cannot transport the

hydrothermal treatment liquid back to the adjustment tank 11 and cannot wet the hydrothermal treatment product stored in the adjustment tank 11 using the hydrothermal treatment liquid because the hydrothermal treatment liquid in the solubilization tank 13 in the second facility 3 is not yet stored. Therefore, in this case, the hydrothermal treatment system 1 can wet the hydrothermal treatment product stored in the adjustment tank 11 by supplying the recycled water from the waste liquid treatment device 15 to the adjustment tank 11, so that the conveyance of the hydrothermal treatment product by the first transport device 21 and the operation of the pressure-separation device 12 in the second facility 3 can be smoothly performed immediately after the starting up the operation of the hydrothermal treatment system 1.

When the above-mentioned transporting back cannot be performed, in the hydrothermal treatment system 1, the hydrothermal treatment product can be wetted by injecting tap water into the adjustment tank 11. However, it is desirable to use the recycled water instead of tap water in order to lower the cost and improve the performance efficiency of the hydrothermal system 1. [0037]

A third transport device 23 is a device which transports the gas produced by the gas production device 14 in the third facility 4 to a gas utilization facility 16 described below.

When the gas production device 14 and the gas utilization facility 16 are installed close to each other, the third transport device 23 is preferably a pipeline. This pipeline connects the gas production device 14 and the gas utilization facility 16, and transports the gas produced in the gas production device 14 to the gas utilization facility 16.

On the other hand, when the gas production device 14 and the gas utilization facility 16 are installed far from each other, the third transport device 23 is preferably an automobile (truck) equipped with a loading platform for loading a gas cylinder or an automobile having a gas tank mounted thereon.

In this case, the gas cylinder or the gas tank, loaded or mounted on the automobile, is filled with the gas produced by the gas production device 14, and the gas can be transported to the gas utilization facility 16.

[0038]

The gas utilization facility 16 is a facility which utilizes the gas produced by the gas production device 14 in the third facility 4. The gas utilization facility 16 is, for example, a power plant which produces steam using heat generated by burning the gas in a boiler and rotates a steam turbine with the steam to generate electric power. The gas utilization facility 16 may be

a power plant equipped with a gas turbine, a gas engine, or a fuel cell, or a facility which reforms the gas to produce city gas.

When the gas utilization facility 16 is a power plant equipped with a gas engine, the gas utilization facility 16 is generally equipped with a heat recovery device for exhaust gas produced by the gas engine. The heat recovery device can generate hot water by utilizing the exhaust gas.

[0039]

When the gas utilization facility 16 is a power plant which generates electric power by using a steam turbine, and at least one of the following facilities: the first facility 2, the second facility 3, and so forth is installed close to the gas utilization facility 16, waste steam, which is high-temperature steam that has been used for electric power generation in the steam turbine in the gas utilization facility 16, can be used in any of the following facilities which is close to the gas utilization facility 16: the first facility 2, the second facility 3, and so forth.

For example, when the gas utilization facility 16 equipped with a steam turbine is installed close to the first facility 2, the gas utilization facility 16 and the first facility 2 may be connected to each other by a pipeline, and the waste steam may be transported to the hydrothermal treatment device 10 in the first facility 2 through the pipeline. The high-temperature and high-pressure steam to be used in the hydrothermal treatment device 10 can be all from this waste steam or only some of it.

In addition, when the gas utilization facility 16 equipped with a steam turbine is installed close to the second facility 3, the gas utilization facility 16 and the second facility 3 may be connected to each other by a pipeline, and the waste steam may be transported to the solubilization tank 13 in the second facility 3 through the pipeline. The waste steam is used for heating up the hydrothermal treatment liquid stored in the solubilization tank 13.

Furthermore, when the gas utilization facility 16 equipped with a steam turbine is installed close to the third facility 4, the gas utilization facility 16 and the third facility 4 may be connected to each other by a pipeline, and the waste steam may be transported to the gas production device 14 in the third facility 4 through the pipeline. The waste steam is used for heating up the hydrothermal treatment liquid stored in the gas production device 14.

[0040]

In addition, when the gas utilization facility 16 equipped with a gas engine is installed close to the second facility 3, the gas utilization facility 16 and the second facility 3 may be connected to each other by a pipeline, and the

hot water generated by the heat recovery device described above may be transported to the solubilization tank 13 in the second facility 3 through the pipeline. The hot water is used for heating up the hydrothermal treatment liquid stored in the solubilization tank 13. The gas utilization facility 16 and the third facility 4 may be connected to each other by a pipeline, and the hot water may be transported to the gas production device 14 in the third facility 4 through the pipeline. The hot water is used for heating up the hydrothermal treatment liquid stored in the gas production device 14.

[0041]

As described above, when the gas utilization facility 16 is equipped with a steam turbine, the waste steam discharged from the steam turbine can be used as a heat source in the hydrothermal treatment system 1, and when the gas utilization facility 16 is equipped with a gas engine, the hot water generated by the heat recovery device can be used as a heat source in the hydrothermal treatment system 1, therefore, it can lower the cost and improve the performance efficiency of the hydrothermal treatment system 1.

[0042]

A fourth transport device 24 is a device which transports the residue which is separated by the pressure-separation device 12 in the second facility 3 to the waste incineration facility 17 described below.

When the second facility 3 and the waste incineration facility 17 are installed close to each other, the fourth transport device 24 is preferably a conveyor which connects a residue discharge port of the pressure-separation device 12 and a waste pit of the waste incineration facility 17, and transports the residue discharged from the pressure-separation device 12 to the waste pit.

On the other hand, when the second facility 3 and the waste incineration facility 17 are installed far from each other, the fourth transport device 24 is preferably an automobile such as a truck or a garbage truck. In this case, the residue discharged from the pressure-separation device 12 can be loaded on or stored in a truck bed or a garbage truck and transported to the waste incineration facility 17.

[0043]

The waste incineration facility 17 is a facility for incinerating waste using an incinerator, and it can also incinerate the residue discharged from the pressure-separation device 12 in the second facility 3. In the waste incineration facility 17, heat generated from the incinerator is used to produce high-temperature and high-pressure steam in a boiler and this high-temperature and

high-pressure steam is used to move the steam turbine so that the electric power can be generated.

When the first facility 2 or the second facility 3 is installed close to the waste incineration facility 17, waste steam, which is high-temperature steam that has been used for electric power generation in the steam turbine in the waste incineration facility 17, can be used in the first facility 2, the second facility 3 or the third facility 4 which is close to the waste incineration facility 17.

For example, when the waste incineration facility 17 is installed close to the first facility 2, the waste incineration facility 17 and the first facility 2 may be connected to each other by a pipeline, and the waste steam may be transported to the hydrothermal treatment device 10 in the first facility 2 through the pipeline. The high-temperature and high-pressure steam to be used in the hydrothermal treatment device 10 can be all from this waste steam or only some of it. In addition, when the waste incineration facility 17 is installed close to the second facility 3, the waste incineration facility 17 and the second facility 3 may be connected to each other by a pipeline, and the waste steam may be transported to the solubilization tank 13 in the second facility 3 through the pipeline. The waste steam is used for heating up the hydrothermal treatment liquid stored in the solubilization tank 13.

As described above, since the waste steam of the waste incineration facility 17 can be effectively used as a heat source in the hydrothermal treatment system 1, it can lower the cost and improve the performance efficiency of the hydrothermal treatment system 1.

[0044]

The hydrothermal treatment system 1 may be a system including none, one, two, or three out of these three devices/facilities: (1) the waste liquid treatment device 15, (2) the third transport device 23 and the gas utilization facility 16, or (3) the fourth transport device 24 and the waste incineration facility 17.

Reference Signs List

[0045]

- 1 Hydrothermal treatment system
- 2 First facility
- 3 Second facility
- 4 Third facility
- 10 Hydrothermal treatment device

- 11 Adjustment tank
- 12 Pressure-separation device
- 12A Rotary drum screen
- 12B Screw press
- 5 13 Solubilization tank
- 14 Gas production device
- 15 Waste liquid treatment device
- 16 Gas utilization facility
- 17 Waste incineration facility
- 10 19 Supply path
- 21 First transport device
- 22 Second transport device
- 23 Third transport device
- 24 Fourth transport device

Claims

[Claim 1]

A hydrothermal treatment system comprising:

a hydrothermal treatment device configured to perform a hydrothermal reaction of waste containing organic matter;

an adjustment tank configured to wet a hydrothermal treatment product obtained from the hydrothermal reaction;

a first transport device configured to transport the hydrothermal treatment product wetted in the adjustment tank;

a pressure-separation device configured to apply pressure to the hydrothermal treatment product transported by the first transport device to separate the hydrothermal treatment product into hydrothermal treatment liquid and residue;

a solubilization tank configured to store and heat up the hydrothermal treatment liquid separated by the pressure-separation device;

a second transport device configured to transport the hydrothermal treatment liquid which is heated up and solubilized in the solubilization tank back to the adjustment tank; and

a gas production device configured to produce gas by utilizing the hydrothermal treatment liquid stored in the solubilization tank, wherein

the second transport device transports the hydrothermal treatment liquid back to the adjustment tank when a concentration of organic matter contained in the hydrothermal treatment liquid stored in the solubilization tank is less than a predetermined concentration which is a concentration of the organic matter suitable for gas production using microorganisms or bacteria, and transports the hydrothermal treatment liquid to the gas production device when the concentration of the organic matter is equal to or more than the predetermined concentration.

[Claim 2]

The hydrothermal treatment system according to claim 1, further comprising a waste liquid treatment device configured to generate recycled water from waste liquid discharged from the gas production device, wherein

the recycled water generated by the waste liquid treatment device is supplied to the adjustment tank.

[Claim 3]

The hydrothermal treatment system according to claim 2, further comprising:

a third transport device configured to transport the gas produced by the gas production device; and

a gas utilization facility which utilizes the gas transported by the third transport device.

[Claim 4]

The hydrothermal treatment system according to claim 3, further comprising:

a fourth transport device configured to transport the residue separated by the pressure-separation device; and

a waste incineration facility configured to incinerate the residue transported by the fourth transport device.

[Claim 5]

The hydrothermal treatment system according to claim 4, wherein the gas utilization facility or the waste incineration facility is equipped with a steam turbine, and

steam which has been used for electric power generation in the steam turbine is supplied to the hydrothermal treatment device or the solubilization tank.

[Claim 6]

The hydrothermal treatment system according to claim 5, wherein when the hydrothermal treatment device and the adjustment tank are installed close to the pressure-separation device and the solubilization tank, the first transport device is a pipeline equipped with a crushing pump and the second transport device is a pipeline equipped with a pump, and

when the hydrothermal treatment device and the adjustment tank are installed far from the pressure-separation device and the solubilization tank, the first transport device and the second transport device are both an automobile.

[Claim 7]

The hydrothermal treatment system according to claim 6, wherein when the gas production device and the gas utilization facility are installed close to each other, the third transport device is a pipeline,

when the gas production device and the gas utilization facility are installed far from each other, the third transport device is an automobile,

when the waste incineration facility is installed close to the pressure-separation device and the solubilization tank, the fourth transport device is a conveyor, and

when the waste incineration facility is installed far from the pressure-separation device and the solubilization tank, the fourth transport device is an automobile.

[Claim 8]

The hydrothermal treatment system according to any one of claims 1 to 7, wherein

the pressure-separation device is equipped with a rotary drum screen in a preceding stage and a screw press in a following stage, and

the solubilization tank stores the hydrothermal treatment liquid separated by the rotary drum screen and the hydrothermal treatment liquid separated by the screw press.