

Decentralized organic waste recycling system in the form of container

Field of Technology

The utility model relates to a decentralized recycling system for organic wastes in the form of a container, which belongs to the field of organic waste recycling technology.

Background Art

With the world's population growth and rapid development, kitchen waste accounts for about 30% to 40% of the overall municipal solid wastes in every country. In Hong Kong, China, for example, there are about 3,600 tons of kitchen waste alone generated per day. If all of the kitchen waste is disposed of by land filling, a lot of land will be consumed; if it is disposed of by incineration, a lot of energy will be consumed because of the higher moisture content and lower calorific value of food in Asia. Therefore, how to recycle the huge kitchen waste into a useful resource is a worldwide issue.

The anaerobic digestion process is one of the recycling methods to treat kitchen waste. This is because the organic matter in the waste can be turned into biogas and then utilized as an energy resource, and the digestate can also be turned into compost or environmentally friendly feed after subsequent processing. However, this process has many limitations.

Firstly, Hong Kong, China, as a gourmet metropolis, will have various types of kitchen waste for recycling and are not allowed to limit the type and quality of kitchen waste to be recycle. For example, a normal Hong Kong-style restaurant will have a lot of rice in the kitchen waste and a vegetarian restaurant will have a lot of vegetables. Moreover, the recycled kitchen waste is usually mixed with inert objects, which can be a major challenge for kitchen waste pre-treatment.

Secondly, the current method of collecting kitchen waste is mainly by trucking the kitchen waste in the garbage cans, which is disadvantageous in that the long storage time makes the odor breeding. Meanwhile, the delivery system requires consumption of human and material resources, and thus is less efficient due to a low degree of automation.

Thirdly, the anaerobic digestion process requires a large land area, which makes it generally difficult to find suitable sites in cities to build centralized kitchen waste recycling systems. If it is built in the suburbs, the cost will be increased in terms of transportation. Therefore, there is a need for further breakthroughs in the technology and design of kitchen waste recycling and treatment systems.

Therefore, there is an urgent need in the field to provide a new decentralized organic waste recycling system in the form of a container.

Summary of the utility model

In view of the above-mentioned disadvantages and shortcomings, the utility model is to provide a decentralized organic waste recycling system in the form of a container.

For the above purpose, the utility model provides a decentralized organic waste recycling system in the form of a container, wherein the decentralized organic waste recycling system in the form of a container comprises a pre-treatment unit, an environmentally friendly feed production unit and a methane generation and utilization unit, which are connected in sequence;

the pre-treatment unit comprises an automatic organic waste sorting machine;

the environmentally friendly feed production unit comprises a slurry storage device, an ultrasonic treatment machine, an integrated bioreactor, a sludge heating cylinder, a sludge dryer and a pelletizer;

the methane generation and utilization unit comprises a methane production bioreactor, a bag filter, a hydraulic sealing device, a gas purifier, a biogas tank and a biogas generator;

wherein the automatic organic waste sorting machine is installed at the sites where kitchen waste is produced for pre-treatment of kitchen waste, and the slurry storage device has a material outlet connected to the material inlet of the ultrasonic treatment machine; the ultrasonic treatment machine has a material outlet connected to the material inlet of the integrated bioreactor; the integrated bioreactor has a sludge outlet connected to the material inlet of the sludge heating cylinder; the sludge heating cylinder has a material outlet connected to the material inlet of the sludge dryer; the sludge dryer has a material outlet connected to the material inlet of the pelletizer; the integrated bioreactor has a nutrient

solution outlet connected to the material inlet of the methane production bioreactor; the methane production bioreactor has a liquid outlet connected to the material inlet of the bag filter; the bag filter has a material outlet connected to the material inlet of the integrated bioreactor; the methane production bioreactor has a gas outlet connected to the material inlet of the hydraulic sealing device; the hydraulic sealing device has a material outlet connected to the material inlet of the gas purifier; the gas purifier has a material outlet connected to the material inlet of the biogas tank; the biogas tank has a material outlet connected to the material inlet of the biogas generator; and the biogas generator is used to power the decentralized organic waste recycling system in the form of a container.

In a specific embodiment of the above decentralized organic waste recycling system in the form of a container, the environmentally friendly feed production unit further comprises an oil storage cylinder, which has an inlet connected to the waste grease outlet of the integrated bioreactor.

In a specific embodiment of the above decentralized organic waste recycling system in the form of a container, the environmentally friendly feed production unit further comprises a hot oil cylinder and a hot oil pump, and the material inlet and material outlet of the hot oil pump are connected to the material outlet and material inlet of the hot oil cylinder respectively, for supplying the required hot oil to the sludge dryer.

In a specific embodiment of the above decentralized organic waste recycling system in the form of a container, the methane generation and utilization unit further comprises a hot water tank having a material outlet connected to the material inlet of the methane production bioreactor, and a generator used to power the hot water tank.

In a specific embodiment of the above decentralized organic waste recycling system in the form of a container, the methane generation and utilization unit further comprise several buffer tanks having inlets connected to the liquid outlet of the methane production bioreactor and/or the material outlet of the bag filter respectively.

In a specific embodiment of the above decentralized organic waste recycling system in the form of a container, the system further comprises a base tank, an acid tank, and a pH adjustment device which has inlets connected to the nutrient solution outlet of the integrated bioreactor, and also to the outlets of the base tank and acid tank respectively, and

the pH adjustment device has an outlet connected to the material inlet of the methane production bioreactor.

In a specific embodiment of the above decentralized organic waste recycling system in the form of a container, the sludge dryer, the hot oil cylinder, the hot oil pump, the generator, the sludge heating cylinder and the hot water tank are disposed at the upper layer of the container.

In a specific embodiment of the above decentralized organic waste recycling system in the form of a container, the bag filter, the biogas tank, the gas purifier, the buffer tanks, the base tank, the acid tank, the ultrasonic treatment machine, the pH adjustment device and the hydraulic sealing device are disposed at the lower layer of the container.

In a specific embodiment of the above decentralized organic waste recycling system in the form of a container, the system further comprises a central odor treatment device disposed outside the container for centralized processing of exhaust gases generated by the pre-treatment unit, the environmentally friendly feed production unit and the methane generation and utilization unit.

In a specific embodiment of the above decentralized organic waste recycling system in the form of a container, the system further comprises an automatic control device that can automate the entire system.

The decentralized organic waste recycling system in the form of a container provided by the utility model comprises the pre-treatment unit, the environmentally friendly feed production unit and the methane generation and utilization unit, wherein the pre-treatment unit can be installed distributedly at the sites where kitchen waste is produced, such as shopping malls, restaurants, schools, etc. The environmentally friendly feed production unit and the methane generation and utilization unit can be installed distributedly in the form of a container installed in various urban areas. The container is divided into two layers, an upper layer where the processes requiring heat are disposed and a lower layer, where devices such as the bag filter, the biogas tank, the gas purifier, the buffer tanks, the base tank, the acid tank, the ultrasonic treatment machine, the pH adjustment device and the hydraulic sealing device that need to be placed in the cooler location are disposed for safety reason, in order to avoid the hot processes in the upper layer affecting the methane storage.

Larger equipment, such as the integrated bioreactor, the methane production bioreactor, the slurry storage device and the central odor treatment device can be placed outside the container.

The pre-treatment unit is installed distributedly at the sites where kitchen waste is produced, such as shopping malls, restaurants, schools, etc. This eliminates the long waiting time for food collection, reduces odor breeding and improves environmental sanitation. Upon collection, the kitchen waste can be pre-treated in the pre-treatment unit, where the organic part of the waste is ground and separated from other non-organic materials, and the ground organic material is converted into a slurry, which is then transported away in a tanker truck. This simplifies the transport process and reduces the transport burden.

The environmentally friendly feed production unit and the methane generation and utilization unit are installed distributedly in the form of a container in suitable places in various urban areas, wherein the environmentally friendly feed production unit is mainly disposed at the upper layer of the container. After the tanker truck transports the slurry to the container system in the urban area to which it belongs, the slurry is first stored in the slurry storage device. After that, the slurry is processed by ultrasonic waves in the ultrasonic treatment machine, so that the slurry is evenly mixed. The slurry is then acidified and hydrolyzed in an integrated bioreactor, and then separated by gravity to extract the high protein sludge. Finally, the sludge goes through a sludge heating cylinder, a sludge dryer and a pelletizer to form an environmentally friendly feed. At the same time, the waste oil, which can be manufactured into biodiesel, in the slurry is separated in the integrated bioreactor and stored in the storage cylinder.

In the integrated bioreactor, in addition to the extracted high protein sludge and the waste oil, a organic acid-rich nutrient solution can be obtained. Methane is produced from this nutrient solution by the methane production bioreactor. Electricity is then generated through a biogas generator to power the system. The effluent water is filtered through the bag filter and recycled in other units.

The main devices included in each unit of the decentralized organic waste recycling system in the form of a container of the present invention are further described in detail below.

Pre-treatment unit

The pre-treatment unit of the system comprises an automatic organic waste sorting machine, which works as follows: the waste is first mixed with some cellulose-rich fillers (such as grain hulls, wood chips, straw, etc.), and is stirred clockwise and counterclockwise by a stirring paddle inside the machine cylinder so that the organic portion in the waste is partially ground, preferably to a particle diameter of less than 2 mm. Water is sprayed through a spraying device inside the machine cylinder to wash out the finely ground organic matter. After treatment of the automatic organic waste sorting machine, the organic portion of the waste becomes homogeneous slurry and flows out to the storage tank. Preferably, the homogeneous slurry has a solids content of 5-10%. Large pieces of hard-to-degrade or non-degradable waste such as animal bones, wooden chopsticks, disposable plastic tableware, and the like remain in the tank of the machine. A cleaning step for the tank is performed once every three months. The slurry in the storage tank is regularly transported by the tanker truck to the decentralized organic waste recycling system in the form of a container for subsequent treatment.

Environmentally friendly feed production unit

Ultrasonic treatment machine

The tanker truck will put the slurry into the slurry storage device. After that, the slurry will be sent to the ultrasonic treatment machine. The purpose of this step is to cavitate the slurry using low frequency ultrasonic waves, such as those having a frequency range of 20-60 KHz, for a retention time for 30 minutes. This step allows not only uniform mixing of the reactants within the slurry to accelerate the diffusion of the reactants, but also increases the solubility of the organic matter, thereby accelerating the decomposition of the organic matter. In addition, the ultrasonic treatment machine can be provided with a pH adjustment device that can automatically adjust the pH value. Under normal conditions, the pH value should be maintained within 3-7.

Integrated bioreactor

The integrated bioreactor is a conventional equipment, which is mainly divided into two parts: the upper part and the lower part. The slurry is continuously fed from the bottom of the reactor, and the mechanical stirring device equipped allows the organic matter and

microbial bacteria in the slurry to undergo an intensive mixing process, so as to increase the rate of hydrolysis, acidification and fermentation. In addition, during the operation, the reactor temperature should be maintained in the range of 28-40°C, for a retention time of 3-5 days. Three pipe outlets are provided in the upper layer of the reactor, and the organic slurry will continuously overflow on the upper inner layer. Using physical precipitation, a certain amount of mixed slurry stored in the upper inner layer is divided into three layers of product with different densities. From top to bottom, they are waste grease, an organic acid-rich nutrient solution and a protein-rich solid sludge. Since the waste grease is the one with lowest density among the three products, it can float to the top layer in a short time, and can be recycled as a raw material for biodiesel production. The middle layer is the organic acid-rich nutrient solution, which will enter the methane production bioreactor to produce methane. The lower layer is the protein-rich solid sludge, which would be turned into environmentally friendly feed through the sludge heating cylinder, the sludge dryer and the pelletizer.

Sludge heating cylinder

As above, after the precipitated sludge is extracted from the integrated bioreactor, it is subjected to heating at a high temperature and drying to remove part of the moisture. The first heating step is performed in the sludge heating cylinder where the solid sludge is first heated to 70°C using residual heat from the process in sludge dryer. This sludge heating cylinder can be equipped with a mechanical stirring device inside and a heat exchange coil outside the cylinder.

Sludge dryer

After passing through the sludge heating cylinder, the solid sludge enters the sludge dryer, where the moisture in the solid sludge is removed by evaporation at a high temperature of 200°C. The dried sludge is then pelletized by a pelletizer to become a high protein environmentally friendly animal feed. The electricity for the sludge heating cylinder and the sludge dryer is supplied by methane produced by the methane generation and utilization unit. Specifically, the methane is used as a raw material to generate electricity using the biogas generator, and the resulting electricity is supplied to the sludge heating cylinder and the sludge dryer, thereby forming a self-sustaining system.

Methane generation and utilization unit

Methane production bioreactor

Considering the compactness of the whole recycling system, the methane production bioreactor used in the utility model can be an up-flow anaerobic sludge bed (UASB) reactor. The organic acid-rich nutrient solution enters from the bottom of this reactor, while the generated biogas is collected at the top thereof. On the other hand, a small settling tank can be equipped at the back end of the UASB reactor to prevent a large loss of anaerobic sludge (granular sludge) with methane producing bacteria. The anaerobic sludge in the settling tank is drawn back to the reactor periodically depending on the system operation. Sludge cultivation and domestication can be completed in this reactor, and the microorganisms in the methane production bioreactor will slowly turn into granular sludge, making the reaction more efficient in this stage. In practice, the temperature in the methane production bioreactor is controlled in the range of 28-40°C to provide the most suitable environment for the growth of methane producing bacteria in the reactor. Most of the organic matter in the organic acid-rich nutrient solution is converted to a methane-rich biogas within a retention time of 7-10 days, with a methane content of about 50-85%. The methane content can be further increased by passing the gas through gas purification devices for water vapor separation and sulfur removal. The organic matter content in the effluent of this methane production bioreactor is in the range of 4000-15000 mg/L in terms of soluble chemical oxygen demand (SCOD).

Bag filter

The bag filter in the methane generation and utilization unit mainly functions to treat the nutrient solution remaining after passing through the methane production bioreactor. The nutrient solution flows into the bag filter by pressure in a side-entry manner and is filtered to remove impurity particles so that particles with fineness greater than 200 μm cannot enter the next unit. The filtered nutrient solution will enter the integrated bioreactor for recycling.

Central odor treatment device

The decentralized organic waste recycling system in the form of a container provided by the utility model is equipped with a central odor treatment device. The exhaust gas from

all units will enter this device at the bottom of the tower via a duct for centralized processing. By means of the ventilator, the exhaust gas quickly fills the space of the inlet section and then evenly rises through the uniform flow section to a layer of filler-absorbing section. On the surface of the fillers, the acid in the gas phase reacts chemically with the alkaline in the liquid phase to remove the odor, and then clean air is discharged to the atmosphere.

In conclusion, by using the decentralized organic waste recycling system in the form of a container provided in the utility model, a high protein sludge can be extracted from the organic waste, which can be subsequently treated to obtain environmentally friendly feed. The by-products of the refining process include waste grease which can be converted into biodiesel and an organic acid-rich nutrient solution which can be used to obtain biogas through the methane production bioreactor. The biogas can be used to generate electricity for the system through a biogas generator, thus making the system self-sufficient in electricity.

The decentralized organic waste recycling system in the form of a container provided by the utility model may have advantages including:

(1) In conventional kitchen waste disposal processes, the kitchen waste usually needs to be stored to a certain amount before it is transported away, which can lead to a series of problems, such as the accumulation of odors during collection and delivery, which can have adverse effects on human health. In contrast, the system developed by the utility model can pre-treat kitchen waste at the sites where they are produced, thereby shortening the exposure time and reducing the chance of odor generation.

(2) Conventional kitchen waste disposal processes usually require a large space to store the treatment system. In contrast, the system provided by the utility model houses most of the equipment (except large equipment) in only two containers, which reduces the occupied area of the treatment system by arranging the containers in an upward direction.

(3) Conventional kitchen waste disposal processes generally require more than 20 days of retention time for materials in the stage of methane production. In contrast, this system has a retention time of 7-10 days, which reduces the occupied area and increases the treatment capacity.

(4) In conventional kitchen waste disposal processes, the methane content produced by anaerobic digestion systems is typically 40-60%. In contrast, this system increases the methane content to 70-80%, which greatly increases the calorific value of biogas and makes the system self-sufficient in energy utilization.

(5) The system provided by the utility model can reuse the effluent discharged from the methane production bioreactor to the integrated bioreactor, thereby reducing the discharge of effluent.

Brief Description of the Drawings

FIG.1 is a layout of the site of the decentralized organic waste recycling system in the form of a container provided in Example 1 of the utility model.

FIG.2 is a top view of the site of the decentralized organic waste recycling system in the form of a container provided in Example 1 of the utility model.

FIG.3 is a structural representation of the upper layer of the container in Example 1 of the utility model.

FIG.4 is a structural representation of the lower layer of the container in Example 1 of the utility model.

FIG.5 is a brief structural representation of the decentralized organic waste recycling system in the form of a container provided in Example 1 of the utility model.

FIG.6 is a structural representation of the decentralized organic waste recycling system in the form of a container provided in Example 1 of the utility model.

Numerical references in accompanying figures

100: pre-treatment unit;

200: environmentally friendly feed production unit;

300: methane generation and utilization unit;

1: hot oil cylinder;

2: sludge dryer;

3: hot oil pump;

4: generator;

5: hot water tank;

- 6: gas boiler;
- 7: sludge heating cylinder;
- 8: bag filter;
- 9: biogas tank;
- 10: gas purifier;
- 11: first buffer tank;
- 12: second buffer tank;
- 13: base tank;
- 14: acid tank;
- 15: automatic control device;
- 16: ultrasonic treatment machine;
- 17: pH adjustment device;
- 18: hydraulic sealing device;
- 19: integrated bioreactor;
- 20: methane production bioreactor;
- 21: slurry storage device;
- 22: central odor treatment device;
- 23: automatic organic waste sorting machine;
- 24: pelletizer;
- 25: biogas generator;
- 26: oil storage cylinder.

Detailed Description of Preferred Embodiments

It is noted that the term “comprises” or “includes” in the specification and claims of the utility model and the accompanying drawings above, and any variations thereof, are intended to cover non-exclusive inclusion. For example, processes, methods, systems, products, or apparatus comprising a series of steps or units are not be limited to those steps or units clearly listed, but may include other steps or units not clearly listed but inherent to those processes, methods, products, or apparatus.

In the utility model, the orientation or positional relationship indicated by the terms

“on/above”, “under/below”, “inside”, “outside”, “middle/inter-”, or the like, is based on the orientation or positional relationship shown in the accompanying drawings. These terms are used primarily to better describe the utility model and its embodiments, and are not intended to define that the indicated device, element, or component must have a particular orientation or be constructed and operated in a particular orientation as shown.

Moreover, some of the above terms may be used to denote other meanings in addition to orientation or location relationships. For example, the term “on/above” may also be used in some instances to indicate a dependency or connection relationship. For those of ordinary skill in the art, the specific meaning of these terms can be understood in the context of the utility model .

In addition, the terms “disposed”, “connected/connecting/connection” should be understood in a broad sense. For example, a “connection” may refer to a fixed connection, a detachable connection, or an integral construction, or a mechanical connection or an electrical connection. It may be a direct connection or an indirect connection through an intervening medium. Alternatively, it may be an internal connection between two devices, components or parts. To a person of ordinary skill in the art, the specific meaning of the above terms can be understood in the context of the utility model.

In the utility model, unless otherwise specified, all the embodiments mentioned herein as well as the preferred embodiments can be combined with each other to form new technical solutions.

In the utility model, unless otherwise specified, all the technical features mentioned herein as well as the preferred features can be combined with each other to form new technical solutions.

In order to more clearly understand the purposes, technical solutions and advantages of the utility model, the utility model will be further described in detail below with the accompanying drawings and examples. The examples described below are part of the examples of the utility model, not all of them. They are only used to illustrate the utility model and should not be regarded as limiting the scope of the utility model. Based on the examples in the utility model, all other examples obtained by a person of ordinary skill in the field without making creative labor belong to the protection scope of the utility model.

The experimental methods in the examples that do not indicate specific conditions are conventional methods and conventional conditions known to the art to which they belong, or are carried out according to the conditions suggested by the instrument manufacturer or conventional conditions. The reagents or equipment used without specifying the manufacturer are conventional reagents or equipment that can be obtained through commercially available purchases.

Example 1

This examples provides a decentralized organic waste recycling system in the form of a container, of which a brief structural representation is shown in FIG.5, a specific structural representation is shown in FIG.6, and a layout and a top view of the site are shown in FIGs.1 and 2 respectively. From FIGs.1-2 and 5-6, it can be seen that the system comprises a pre-treatment unit 100, an environmentally friendly feed production unit 200 and a methane generation and utilization unit 300, which are connected in sequence.

The pre-treatment unit 100 comprises an automatic organic waste sorting machine 23.

The structural representation of the upper layer of the container is shown in FIG. 3. From FIGs. 2 and 3, it can be seen that the environmentally friendly feed production unit 200 comprises a slurry storage device 21, a ultrasonic treatment machine 16, an integrated bioreactor 19, a hot oil cylinder 1, a sludge dryer 2, a hot oil pump 3, a gas boiler 6, a sludge heating cylinder 7, a pelletizer 24 and an oil storage cylinder 26; wherein each of the hot oil cylinder 1, the sludge dryer 2, the hot oil pump 3, the gas boiler 6 and the sludge heating cylinder 7 in the environmentally friendly feed production unit 200 and the generator 4 and the hot water tank 5 in the methane generation and utilization unit 300 are disposed at the upper layer of the container.

The structural representation of the lower layer of the container is shown in FIG. 4. From FIGs. 2 and 4, the methane generation and utilization unit 300 comprises a methane production bioreactor 20, a generator 4, a hot water tank 5, a bag filter 8, a gas purifier 10, a biogas tank 9, a first buffer tank 11, a second buffer tank 12, a base tank 13, an acid tank 14, an automatic control device 15, a pH adjustment device 17, a hydraulic sealing device 18 and a biogas generator 25; each of the bag filter 8, the biogas tank 9, the gas purifier 10, the

first buffer tank 11, the second buffer tank 12, the base tank 13, the acid tank 14, the pH adjustment device 17 and the hydraulic sealing device 18 in the methane generation and utilization unit 300 and the ultrasonic treatment machine 16 in the environmentally friendly feed production unit 200 are disposed at the lower layer of the container.

In the system, the material outlet of the slurry storage device 21 is connected to the material inlet of the ultrasonic treatment machine 16; the material outlet of the ultrasonic treatment machine 16 is connected to the material inlet of the integrated bioreactor 19; the sludge outlet of the integrated bioreactor 19 is connected to the material inlet of the sludge heating cylinder 7; the material outlet of the sludge heating cylinder 7 is connected to the material inlet of the sludge dryer 2; the material outlet of the sludge dryer 2 is connected to the material inlet of the pelletizer 24; the material inlet and the material outlet of the hot oil pump 3 are connected to the material inlet and the material outlet of the hot oil cylinder 1 respectively, for supplying the required hot oil to the sludge dryer 2; the nutrient solution outlet of the integrated bioreactor 19 is connected to the material inlet of the methane production bioreactor 20; the liquid outlet (corresponding to the nutrient solution outlet) of the methane production bioreactor 20 is connected to the nutrient solution inlet of the first buffer tank 11; the nutrient solution outlet of the first buffer tank 11 is connected to the material inlet (corresponding to the nutrient solution inlet) of the bag filter 8; the material outlet (corresponding to the water outlet) of the bag filter 8 is connected to the water inlet of the second buffer tank 12; the water outlet of the second buffer tank 12 is connected to the material inlet of the integrated bioreactor 19; and the waste grease outlet of the integrated bioreactor 19 is connected to the inlet of the oil storage cylinder 26.

The nutrient solution outlet of the integrated bioreactor 19 is also connected to the inlet of the pH adjustment device 17, while outlet of the pH adjustment device 17 is connected to the material inlet of the methane production bioreactor 20. Each of the outlets of the base tank 13 and the acid tank 14 is connected to the inlet of the pH adjustment device 17.

The gas outlet of the methane production bioreactor 20 is connected to the material inlet of the hydraulic sealing device 18, while the material outlet of the hydraulic sealing device 18 is connected to the material inlet of the gas purifier 10. The material outlet of the

gas purifier 10 is connected to the biogas tank 9, while the material outlet of the biogas tank 9 is connected to the biogas generator 25, which is used to power the decentralized organic waste recycling system in the form of a container.

The generator 4 is used to power the hot water tank 5, while the material outlet of the hot water tank 5 is connected to the material inlet of the methane production bioreactor 20.

In this example, the system further comprises a central odor treatment device 22 and an automatic control device that can automate the entire system (not shown in the figures), wherein the central odor treatment device 22 is disposed outside the container for centralized processing of exhaust gases generated by the pre-treatment unit 100, the environmentally friendly feed production unit 200 and the methane generation and utilization unit 300.

In this example, the pre-treatment unit 100 can be installed distributedly in sites such as shopping malls, schools, restaurants or residences, to satisfy the need for kitchen waste treatment in different places. Taking restaurant kitchen waste as an example, it is first emptied into a waste collection bin to facilitate waste collection, and then processed by the automatic organic waste sorting machine to obtain an organic slurry. The obtained organic slurry is transferred to the slurry storage unit via a pipe for subsequent processing. The environmentally friendly feed production unit 200 and the methane generation and utilization unit 300 in the form of a container are installed distributedly in various urban areas.

To further illustrate the decentralized organic waste recycling system in the form of a container provided in this example, a method for recycling the restaurant waste using said system is described in detail below by using restaurant waste as an example, wherein said method comprises:

(1) Pre-treatment stage: Restaurant waste of about 500 kg was fed daily in batches into an automatic organic waste sorting machine. After treatment in the automatic organic waste sorting machine, the organic matter in the restaurant waste was turned into a homogeneous slurry with a total solids (TS) content of 5% to 15 % and a solids particle diameter of about 1-2 mm. Large pieces of hard-to-degrade or non-degradable waste, such as bones, wooden chopsticks, disposable plastic tableware, and the like., were temporarily retained in the

automatic organic waste sorting machine, and then discharged periodically through other discharge ports. The homogenized slurry was then transferred to a storage tank via a pipe for storage. The slurry in the storage tank was regularly transported by the tanker truck to the decentralized organic waste recycling system in the form of a container for subsequent treatment.

(2) Environmentally friendly feed production stage: The tanker truck put the slurry into the slurry storage unit. The homogenized slurry then entered the ultrasonic treatment machine from the slurry storage device where the homogenized slurry was subjected to an ultrasonic treatment with a frequency range of 20-40 KHz for a retention time of about 30 minutes. The homogenized slurry after ultrasonic treatment was fed into the integrated bioreactor, where the homogenized slurry was continuously fed from the bottom of the reactor with a slow speed stirrer in a processing capacity of about 1 ton/day. The temperature of the integrated bioreactor was kept in the range of 28-40°C for a retention time of 3-5 days. A storage space for physical precipitation was disposed in the upper layer of the reactor to achieve solid-liquid separation. Finally, the product was divided into 3 layers in the storage space, wherein the bottom layer was protein-rich solid sludge, which was heated and dried for animal/ pet feed; the middle layer was organic acid-rich nutrient solution, which was pumped to the methane production bioreactor for conversion into a methane-rich biogas, which was used to generate electricity for heating and drying of the solid sludge to achieve self-sufficiency; the top layer was waste oil and grease, which was used as biodiesel feedstock after measurement. After extraction from the integrated bioreactor, the TS of solid sludge was 5-10%. The sludge would undergo two heating processes, the first of which was carried out using a sludge heating cylinder. The heat exchange coils provided in the outer layer of the sludge heating cylinder maintained the cylinder temperature at approximately 70°C with the residual heat from the sludge dryer. During this process, the TS of the solid slag was increased to 15-20%. It was then heated to a TS of 65-80% at 200°C in the sludge dryer and subsequently pelletized to produce an environmentally friendly feed.

(3) Methane production and use stage: By measurement, the organic acid-rich nutrient solution had a pH value of about 4-5.5 and a soluble chemical oxygen demand (SCOD) of

about 30000-80000 mg/L. After adjusting the pH of the nutrient solution to about 6-6.5, it was pumped regularly and quantitatively from the bottom to the methane production bioreactor (UASB reactor) using a pump. The anaerobic sludge (granular sludge) with methanogenic bacteria (the activated sludge may come from the anaerobic tanks of wastewater stations that use anaerobic processes to treat wastewater from the food industry or domestic wastewater) was already present in the reactor, and the sludge bed height was about 20-40% of the entire reactor. The temperature inside the reactor was maintained at about 28-40°C by temperature control equipment inside the reactor, and the retention time in the reactor is about 7-10 days. The organic matter in the water was transformed into methane-rich biogas in the reactor, which was collected and released from the top of the UASB reactor and then stored for use, after passing through a water-gas separation unit and a desulfurization unit in which water and hydrogen sulfide are removed. By measurement, the volume content of methane in this biogas was about 70%-80% and the volume content of carbon dioxide was about 15%-25%. The soluble chemical oxygen demand (SCOD) in the effluent of the UASB reactor is about 5,000-15,000 mg/L. After retreatment by the bag filter, the soluble chemical oxygen demand in the effluent is further reduced to 1,500-4,000 mg/L. The entire effluent from the bag filter can be recycled to the integrated bioreactor to reduce the effluent discharge.

The above is only a specific example of the utility model and cannot be used to limit the scope of the implementation of the utility model. Therefore, the replacement of equivalent components or equivalent changes and modifications according to the protection scope of the utility model should still fall under the scope of the utility model.

CLAIMS

1. A decentralized organic waste recycling system in the form of a container, comprising a pre-treatment unit, an environmentally friendly feed production unit and a methane generation and utilization unit, which are connected in sequence,

wherein the pre-treatment unit comprises an automatic organic waste sorting machine;

the environmentally friendly feed production unit comprises a slurry storage device, an ultrasonic treatment machine, an integrated bioreactor, a sludge heating cylinder, a sludge dryer and a pelletizer;

the methane generation and utilization unit comprises a methane production bioreactor, a bag filter, a hydraulic sealing device, a gas purifier, a biogas tank and a biogas generator;

wherein the automatic organic waste sorting machine is installed at the sites where kitchen waste is produced for pre-treatment of kitchen waste, and the slurry storage device has a material outlet connected to the material inlet of the ultrasonic treatment machine; the ultrasonic treatment machine has a material outlet connected to the material inlet of the integrated bioreactor; the integrated bioreactor has a sludge outlet connected to the material inlet of the sludge heating cylinder; the sludge heating cylinder has a material outlet connected to the material inlet of the sludge dryer; the sludge dryer has a material outlet connected to the material inlet of the pelletizer; the integrated bioreactor has a nutrient solution outlet connected to the material inlet of the methane production bioreactor; the methane production bioreactor has a liquid outlet connected to the material inlet of the bag filter; the bag filter has a material outlet connected to the material inlet of the integrated bioreactor; the methane production bioreactor has a gas outlet connected to the material inlet of the hydraulic sealing device; the hydraulic sealing device has a material outlet connected to the material inlet of the gas purifier; the gas purifier has a material outlet connected to the material inlet of the biogas tank; the biogas tank has a material outlet connected to the material inlet of the biogas generator; and the biogas generator is used to power the decentralized organic waste recycling system in the form of a container.

2. The decentralized organic waste recycling system in the form of a container according to claim 1, wherein the environmentally friendly feed production unit further

comprises an oil storage cylinder, which has an inlet connected to the waste grease outlet of the integrated bioreactor.

3. The decentralized organic waste recycling system in the form of a container according to claim 1, wherein the environmentally friendly feed production unit further comprises a hot oil cylinder and a hot oil pump, and the material inlet and material outlet of the hot oil pump are connected to the material outlet and material inlet of the hot oil cylinder respectively, for supplying the required hot oil to the sludge dryer.

4. The decentralized organic waste recycling system in the form of a container according to claim 1, wherein the methane generation and utilization unit further comprises a hot water tank having a material outlet connected to the material inlet of the methane production bioreactor, and a generator used to power the hot water tank.

5. The decentralized organic waste recycling system in the form of a container according to claim 1, wherein the methane generation and utilization unit further comprises several buffer tanks having inlets connected to the liquid outlet of the methane production bioreactor and/or the material outlet of the bag filter respectively.

6. The decentralized organic waste recycling system in the form of a container according to claim 1, wherein the system further comprises a base tank, an acid tank, and a pH adjustment device having inlets connected to the nutrient solution outlet of the integrated bioreactor and also to the outlets of the base tank and acid tank respectively, and the pH adjustment device has an outlet connected to the material inlet of the methane production bioreactor.

7. The decentralized organic waste recycling system in the form of a container according to any one of claims 1 to 6, wherein the sludge dryer, the hot oil cylinder, the hot oil pump, the generator, the sludge heating cylinder and the hot water tank are disposed at the upper layer of the container.

8. The decentralized organic waste recycling system in the form of a container according to any one of claims 1 to 6, wherein the bag filter, the biogas tank, the gas purifier, the buffer tanks, the base tank, the acid tank, the ultrasonic treatment machine, the pH adjustment device and the hydraulic sealing device are disposed at the lower layer of the container.

9. The decentralized organic waste recycling system in the form of a container according to claim 1, wherein the system further comprises a central odor treatment device disposed outside the container, for centralized processing of exhaust gases generated by the pre-treatment unit, the environmentally friendly feed production unit and the methane generation and utilization unit.

10. The decentralized organic waste recycling system in the form of a container according to claim 1, wherein the system further comprises an automatic control device that can automate the entire system.