

DESCRIPTION

WASTE WATER TREATMENT EQUIPMENT

5 TECHNICAL FIELD

[0001] The present invention relates to a waste water treatment technology using mainly an anaerobic bio-film (an anaerobic microbial film) having liquidity, and more particularly to a waste water treatment technology that
10 suppresses outflow of microorganism agglomerates (granules of self-granulated sludge which are formed by microorganisms and/or a microbial film containing a substance that is a nucleus) from a reactor tank in a UASB (Upflow Anaerobic Sludge Blanket) method.

15 BACKGROUND ART

[0002] The UASB method is a method in which, water to be treated is introduced into the reactor tank from a reactor tank bottom that is filled with the microorganism agglomerates, and organic substance (organic matter) and
20 nitrogen compound (nitrogenous substance) contained in the water to be treated are brought into contact with the microorganism agglomerates in an upward water flow that occurs due to this introduction of water to be treated then are decomposed by metabolism reaction of the
25 microorganism (disclosed in Patent Documents 1 to 3 etc.).

[0003] A most remarkable feature of the UASB method is that extremely heavy load can be treated by using high-densely agglutinated microorganism agglomerates without requiring any filler that is a carrier of the
30 microorganism. The microorganism agglomerates

correspond to a form called the granule formed by self-granulation of the microorganism and the microbial film containing the substance that is the nucleus. Further, with regard to organic substance-containing waste water, methane gas obtained during a process of an organic substance-containing waste water treatment can be used for vapor-recovery by a boiler or electric power-recovery by gas power generation. As utilization of the organic substance-containing wastewater treatment, it is applied to a wastewater treatment system in a facility where a high concentration of industrial effluent is drained out, such as a food-processing plant, a brewery, an alcoholic distillation plant and a paper and pulp plant. [0004] With respect to ammonia-containing waste water, there are, as a pre-treatment, a nitrification process in which ammonia is oxidized to nitric acid by aerobic bacteria, and as a post-treatment, a denitrification process in which the nitric acid is deoxidized to nitrogen gas by anaerobic heterotrophic bacteria using the organic substance. However, in recent years, anaerobic ammonium oxidation (commonly called "anammox") bacteria that allows the denitrification from the ammonia and nitrous acid has been focused on, and the UASB method is applied also to the present method. In a case where the anammox bacteria is used, by nitrifying approximately half of the ammonia to the nitrous acid in the pre-treatment, the denitrification process by the anammox of the post-treatment is allowed, therefore an aeration power required for the aerobic process is greatly reduced. Since an anammox reaction of the pre-treatment occurs

by autotrophic bacteria, the organic substance required for the denitrification by the heterotrophic bacteria does not become necessary, then this process does not require supply of the organic substance that is needed
5 for a low-C/N (carbon-nitrogen) ratio waste water. This process is such excellent nitrogen treatment method.
[0005] Here, most of the microorganism agglomerates such as the granules and the nucleus-containing microbial film have excellent sedimentation. When the upward flow of
10 the water to be treated is introduced from the reactor tank bottom, under a proper upward flow speed condition, a state called a sludge bed (a bed), in which a few floating microorganism agglomerates are present at a reactor tank top and numerous microorganism agglomerates sediment or
15 deposit and stay at a lower portion in the reactor tank, is formed. Due to generation of air bubbles of the methane gas and the nitrogen gas generated by the microbial reaction in the reactor tank, because of buoyancy of the air bubbles attached to the microorganism agglomerates,
20 also because of a strong ascending water flow caused by the air bubbles and the upward water flow of treated water, there is a possibility that the microorganism agglomerates will flow out of the reactor tank together with the treated water. Thus, various measures to prevent the outflow of
25 the microorganism agglomerates are taken (Patent Documents 1 to 3 etc.).

[0006] In a reactor tank disclosed in Patent Document 1, by the fact that the microorganism agglomerates, to which the air bubbles generated in the bed formed by the
30 deposition and the stay of the microorganism agglomerates

around the tank bottom are attached, contact or collide with a sludge contact part in the middle of floating, the air bubbles are separated from the microorganism agglomerates. While the microorganism agglomerates
5 having no air bubbles by the separation of air bubbles from the microorganism agglomerates sink or sediment by their own weight, the air bubbles are released into the atmosphere through a gas collecting portion arranged at the top of the reactor tank.

10 [0007] In Patent Document 2, a treatment device has a conical gas-liquid separation member inside the reactor tank in which the bed stays around the bottom, and by the fact that the microorganism agglomerates, to which the air bubbles generated in the bed are attached, contact
15 or collide with the gas-liquid separation member, the air bubbles are separated from the microorganism agglomerates. The air bubbles separated from the microorganism agglomerates are released into the atmosphere through a gas introduction pipe that is
20 connected to a top of the gas-liquid separation member. Further, a tube having different diameter openings at its upper and lower ends; a diameter of the upper end opening is larger than that of the lower end opening, is coaxially aligned with the gas-liquid separation member
25 in the reactor tank, thereby defining a sludge separation chamber. A liquid phase containing the microorganism agglomerates is introduced into this sludge separation chamber. The microorganism agglomerates which have undergone solid-liquid separation in the sludge
30 separation chamber go down at an outer side of a tubular

member that is coaxially aligned with both of the different diameter tube and the gas-liquid separation member between the different diameter tube and the gas-liquid separation member, and sink or sediment on the bed.

5 .[0008] In a treatment device disclosed in Patent Document 3, gable roof gas-liquid separation members are set at a middle layer and an upper layer in the reactor tank at which the microorganism agglomerates stay, thereby forming beds having different concentration of the
10 microorganism agglomerates in the reactor tank. Then, by the fact that the microorganism agglomerates, to which the air bubbles generated in each bed are attached, contact or collide with each gas-liquid separation member, the air bubbles are separated from the microorganism
15 agglomerates. The air bubbles separated from the microorganism agglomerates are released into the atmosphere through a gas introduction pipe that is connected to the gas-liquid separation member.

[0009] In Patent Document 1, there may occur a case where
20 the microorganism agglomerates to which the air bubbles are attached, which have not contacted or collided with the gas-liquid separation member in the reactor tank, reach a liquid level in the reactor tank by a short-circuited flow then flow out of a treatment device
25 (out of the reactor tank) together with the treated water. Further, in the case of the treatment device of Patent Document 2, there may occur a case where a part of the microorganism agglomerates that stay in the sludge separation chamber goes up or ascends by remaining air
30 bubbles and flows out of the treatment device (out of

the reactor tank) together with the treated water from an overflow trough in the sludge separation chamber.

[0010] In the case of the treatment device of Patent Document 3, as a position in the reactor tank becomes
5 higher from a lower layer to the upper layer in the reactor tank, the concentration of the microorganism agglomerates decreases. Therefore, as compared with the treatment devices of Patent Documents 1 and 2, it is possible to reduce the outflow of the microorganism agglomerates from
10 the treatment device. However, also in the treatment device of Patent Document 3, since the treated water is discharged from an upper end of the reactor tank by an overflowing method, there may occur a case where the microorganism agglomerates to which the air bubbles are
15 attached, which have not contacted or collided with the gas-liquid separation member of the upper layer, reach a liquid level in the reactor tank by a short-circuited flow then flow out of the treatment device (out of the reactor tank) together with the treated water.

20 **CITATION LIST**

PATENT DOCUMENT

[0011]

Patent Document 1: Japanese Patent Application
Publication No. JP62-279891

25 Patent Document 2: Japanese Patent Application
Publication No. JP9-225491

Patent Document 3: Japanese Patent Application
Publication No. JP2009-178628

SUMMARY OF THE INVENTION

[0012] Accordingly, in the present invention, the air bubbles are separated, by an air bubble separation member, from the microorganism agglomerates that float by the air bubbles of the methane gas and the nitrogen gas generated by the microbial reaction at a layer around the bottom of a UASB-type reactor tank, and the microorganism agglomerates stay at the layer around the bottom. On the other hand, the air bubbles separated from the microorganism agglomerates are collected by an air bubble collection member, and are guided up to an area around the liquid level in the reactor tank, then is released into a gas phase. Further, a liquid phase containing the microorganism agglomerates of the upper layer in the reactor tank is solid-liquid-separated into the microorganism agglomerates and the treated water by a solid-liquid separation member.

[0013] As embodiments of the present invention, a waste water treatment device by which water to be treated is brought into contact with microorganism agglomerates in an ascending water flow and organic substance and nitrogen compound contained in the water to be treated are decomposed, the waste water treatment device comprises: a reactor tank that introduces thereinto the water to be treated from a bottom and discharges the water to be treated as treated water from an upper portion of the reactor tank after the water to be treated is brought into contact with the microorganism agglomerates contained in a layer around the bottom; an air bubble separation member that separates air bubbles from the microorganism agglomerates to which the air bubbles of

gas generated from the layer are attached, by a fact that the microorganism agglomerates to which the air bubbles are attached contact the air bubble separation member; an air bubble collection member that collects the air
5 bubbles of the gas and the air bubbles separated from the microorganism agglomerates by the air bubble separation member; and a solid-liquid separation member that separates a liquid phase containing the microorganism agglomerates of an upper layer of the reactor tank into
10 the microorganism agglomerates and the treated water.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014]

Fig. 1 is a schematic block diagram showing a waste water treatment device according to an embodiment 1 of the
15 present invention.

Fig. 2 is a sectional view for explaining an example of operation (flow of fluid) of the waste water treatment device according to the embodiment 1.

Fig. 3 is a schematic block diagram showing the waste
20 water treatment device according to an embodiment 2 of the present invention.

Fig. 4 is a schematic block diagram showing an example of setting of an air bubble separation member.

Fig. 5 is a schematic block diagram showing the waste
25 water treatment device according to an embodiment 3 of the present invention.

Fig. 6 is a schematic block diagram showing an example of a reactor tank according to an embodiment 4 of the present invention.

Fig. 7 is a perspective view showing an example of a unit formed by joining the air bubble separation member, an air bubble collection member and a solid-liquid separation member together, according to the embodiment 4.

- 5 Fig. 8 is a schematic block diagram showing an example of a supply passage of water to be treated, according to an embodiment 5 of the present invention.

Fig. 9 is a drawing for explaining a function of the air bubble collection member.

- 10 Fig. 10(a) is a perspective view for explaining a function of the air bubble separation member, according to the embodiment 2. Fig. 10(b) is a side view of the reactor tank provided with a sludge drawing pipe.

- Fig. 11 is a perspective view showing an example of a
15 treated water outflow system at an upper portion of the reactor tank.

Fig. 12 is a sectional view for explaining flow of fluid around a bottom in the reactor tank.

- Fig. 13 is a schematic block diagram showing the waste
20 water treatment device according to an embodiment 6 of the present invention.

Fig. 14(a) is a front view showing setting of a bubbling pipe according to the embodiment 6. Fig. 14(b) is a sectional view of the air bubble collection member.

25 **EMBODIMENTS FOR CARRYING OUT THE INVENTION**

[0015] In the following description, embodiments of the present invention will be explained with reference to the drawings.

[0016] [Embodiment 1]

A waste water treatment device (waste water treatment equipment) 1 of an embodiment 1 shown in Fig. 1 is a waste water treatment device of a UASB method in which water to be treated is brought into contact with microorganism agglomerates in an upward water flow (an ascending water flow) and organic substance (organic matter) and nitrogen compound (nitrogenous substance) contained in the water to be treated are decomposed. The waste water treatment device 1 suppresses outflow of the microorganism agglomerates from the waste water treatment device then achieves a stable UASB treatment.

[0017] (Configuration of Device)

The waste water treatment device 1 has a reactor tank 10, an air bubble separation screen 11, an air bubble collection pipe 12, a side surface screen 13 and a center screen 14.

[0018] The water to be treated is introduced into the reactor tank 10 from a bottom 100, and after the water to be treated is brought into contact with the microorganism agglomerates contained in a bed that stays around the bottom 100, the water to be treated is discharged as treated water from an upper portion of the reactor tank 10. The water to be treated is supplied, by a pump P1, to the reactor tank 10 through a supply pipe 101 that is connected to a lower end portion of the reactor tank 10. As shown in Fig. 1, the reactor tank 10 is formed into a cylindrical shape. An inner circumferential surface, around the bottom 100, of the reactor tank 10 has a lower-side-tapered shape so that the microorganism agglomerates gather and accumulate at the bottom and

efficiency of the contact between the water to be treated and the microorganism agglomerates is increased.

[0019] The air bubble separation screen 11 separates air bubbles from the microorganism agglomerates to which the
5 air bubbles of gas generated from the bed staying around the bottom 100 of the reactor tank 10 by microbial reaction are attached, by the fact that the microorganism agglomerates to which the air bubbles are attached contact or collide with the air bubble separation screen 11. The
10 air bubble separation screen 11 is formed from a slit or lattice (or grid) screen such as a conical-shaped wedge wire screen, and an opening 111 is formed at a top of the air bubble separation screen 11. The air bubble separation screen 11 is arranged coaxially with the
15 reactor tank 10 around the bottom 100 in the reactor tank 10. Here, a screen scale spacing of the air bubble separation screen 11 is set to be smaller than or substantially equal to an average particle size of the microorganism agglomerate, for instance, it is 0.5 mm
20 ~ 0.8 mm.

[0020] As shown in Fig. 2, the air bubble collection pipe 12 collects the air bubbles of the gas generated from the bed and the air bubbles separated from the microorganism agglomerates by the air bubble separation
25 screen 11, and guides them up to an area around a liquid level in the reactor tank 10. The gas released from the liquid level is exhausted into the atmosphere through an exhaust pipe 103 that is connected to a ceiling portion 102 of the reactor tank 10, or if the generated gas is
30 gas that contains methane gas, the gas is used as energy

gas. The air bubble collection pipe 12 is formed by a conical-shaped collecting cone 121 and a cylinder portion 122 that is vertically connected to an upper end opening of the collecting cone 121. The air bubble collection
5 pipe 12 is arranged coaxially with the reactor tank 10 in the reactor tank 10.

[0021] The side surface screen 13 separates a liquid phase containing the microorganism agglomerates of an upper layer of the reactor tank 10 into the microorganism
10 agglomerates and the treated water. The side surface screen 13 is formed from a slit or lattice (or grid) screen such as a cylindrical-shaped wedge wire screen. A screen scale spacing of this side surface screen 13 is set so as to be smaller than the average particle size of the
15 microorganism agglomerate to render the side surface screen 13 fit for solid-liquid separation of the microorganism agglomerates and the treated water. The side surface screen 13 is formed into a cylindrical shape having the same diameter as that of the reactor tank 10,
20 and is set at a circumferential side surface around an upper end of the reactor tank 10. Then, a treated water separation chamber 17 to introduce therein the treated water through the side surface screen 13 is provided at an outer circumference around this upper end.

[0022] As shown in Fig. 2, the center screen 14 separates
25 the air bubbles from the microorganism agglomerates to which the air bubbles are attached, which come up or ascend inside the air bubble collection pipe 12, by the fact that the microorganism agglomerates to which the air
30 bubbles are attached contact or collide with the center

screen 14. The center screen 14 is formed from a slit or lattice (or grid) screen such as a cylindrical-shaped wedge wire screen. A diameter of the center screen 14 is larger than that of the cylinder portion 122 of the air bubble collection pipe 12 and is smaller than that of the side surface screen 13, and also the center screen 14 has a longer cylindrical shape than the side surface screen 13. As seen in Fig. 1, the center screen 14 is arranged coaxially with the reactor tank 10 in the reactor tank 10 so that an upper end of the center screen 14 is positioned to be higher than upper ends of the air bubble collection pipe 12 and the side surface screen 13 and also higher than the liquid level inside the reactor tank 10. Since a main aim of the center screen 14 is to separate the air bubbles speedily or immediately from the microorganism agglomerates to which the air bubbles are attached and further there is no intention of completely preventing the outflow of the microorganism agglomerates, a screen scale spacing of the center screen 14 could be set to a wider size than that of the side surface screen 13. For instance, the screen scale spacing of the center screen 14 is set to 0.7 mm ~ 1.0 mm.

[0023] Further, in order to be able to guide the air bubbles of the gas generated from the bed and the air bubbles separated from the microorganism agglomerates by the air bubble separation screen 11 to a lower end opening of the air bubble collection pipe 12, a guide portion 15 is provided on the inner circumferential surface of the reactor tank 10. The guide portion 15 is formed from a protrusion body having an upper-side-tapered

surface 151 and a lower-side-tapered surface 152. As shown in Fig. 2, the upper-side-tapered surface 151 is formed so as to be able to guide the air bubbles flowing in an ascending flow to an lower end of the air bubble collection pipe 12. On the other hand, as seen in Fig. 2, the lower-side-tapered surface 152 is formed so that the microorganism agglomerates that come down or sink can be guided toward the bottom 100 of the reactor tank 10.

10 [0024] Furthermore, a bypassing member 16, by which the air bubbles that flow out from the opening 111 of the top of the air bubble separation screen 11 and a flow of the microorganism agglomerates to which the air bubbles are attached bypass in a radial direction of the reactor tank 10, is provided in the middle of the guide portion 15. The bypassing member 16 is formed from a slit or lattice (or grid) screen such as a disc-shaped wedge wire screen. A diameter of the bypassing member 16 is larger than that of the opening 111 of the air bubble separation screen 11 and is smaller than an inside diameter of the guide portion 15. The bypassing member 16 is horizontally set in the reactor tank 10. A screen scale spacing of the bypassing member 16 can be set to the same screen scale spacing as the air bubble separation screen 11.

25 [0025] (Explanation of Operation)

An example of operation (flow of fluid) of the waste water treatment device 1 will be explained with reference to Fig. 2.

[0026] The water to be treated is introduced into the reactor tank 10 from the bottom 100 through the supply

pipe 101 by the pump P1. When the water to be treated is introduced into the reactor tank 10, the organic substance and the nitrogen compound contained in the water to be treated are decomposed by the microorganism agglomerates that form a bed 19. In an organic substance treatment, the methane gas is generated during a process of the decomposition of the organic substance. In addition, in a nitrogen treatment, ammonia component contained in the water to be treated is converted into nitrogen gas by a denitrification reaction by anaerobic ammonia-oxidizing bacteria that is one of bacteria forming the microorganism agglomerates. The air bubbles of the methane gas and the nitrogen gas etc. generated from the microorganism agglomerates go up or ascend toward the liquid level in the reactor tank 10 by the ascending water flow. The microorganism agglomerates existing around the bottom 100 where activity of the treatment is highest could lose sedimentation by the attachment of the gas due to strong gas generation, and these microorganism agglomerates go up or ascend by the ascending water flow (by riding the ascending water flow).

[0027] When the microorganism agglomerates to which the air bubbles are attached contact or collide with the air bubble separation screen 11, the air bubble are released from the microorganism agglomerates. The microorganism agglomerates having no air bubbles by the release of the air bubbles sink or sediment by their own weight, and stay around the bottom 100. Further, the treated water treated by the bed 19 is solid-liquid-separated by the air bubble separation screen 11, and thereafter passes

between the guide portion 15 and the bypassing member 16 and moves or flows toward the upper layer of the reactor tank 10 by the ascending water flow (by riding the ascending water flow). The released air bubbles and the

5 microorganism agglomerates to which the air bubbles are attached which have not contacted or collided with the air bubble separation screen 11 come out from the opening 111 of the air bubble separation screen 11. The above released air bubbles and the above microorganism

10 agglomerates to which the air bubbles are attached, coming out from the opening 111, bypass the bypassing member 16 and are guided by the upper-side-tapered surface 151 of the guide portion 15, then are introduced into the air bubble collection pipe 12.

15 [0028] In the air bubble collection pipe 12, the air bubbles and the microorganism agglomerates to which the air bubbles are attached, collected by the collecting cone 121, ride the ascending water flow of the treated water and go up or ascend in the cylinder portion 122,

20 then are guided up to the area around the liquid level. When the air bubbles coming out from the cylinder portion 122 reach the liquid level, the air bubbles are released, as the gas, into a gas phase in the reactor tank 10 and exhausted out of the waste water treatment device from

25 the exhaust pipe 103. Further, when a part of the microorganism agglomerates to which the air bubbles are attached, which come up or ascend inside the collecting cone 121, contacts or collides with an inner surface of the collecting cone 121, the air bubbles are separated

30 from the microorganism agglomerates, and only the air

bubbles are introduced into the cylinder portion 122. The microorganism agglomerates separated from the air bubbles go down by their own weight and sink toward the bed 19.

5 [0029] In addition, when the microorganism agglomerates to which the air bubbles are attached contact or collide with the center screen 14 by riding a flow of the treated water flowing out of the waste water treatment device through the side surface screen 13, the air bubbles are
10 released from a part of the microorganism agglomerates and the gas is released into the gas phase, then the microorganism agglomerates sink in an area between the center screen 14 and the air bubble collection pipe 12. Further, with respect to the microorganism agglomerates
15 that remain in the liquid phase in the center screen 14, by the fact that the air bubbles that come up or ascend from the lower-side-positioned air bubble collection pipe 12 continue colliding with the microorganism agglomerates, an effect of separating the air bubbles from the
20 microorganism agglomerates is produced, thereby helping the microorganism agglomerates to sink. In this manner, the microorganism agglomerates having no air bubbles by the release of the air bubbles sink by their own weight. This sinking microorganism agglomerates also go down or
25 sink toward the bed 19.

[0030] The treated water coming up to the upper layer around the liquid level in the reactor tank 10 is discharged out of the waste water treatment device from an outflow pipe 171 of the treated water separation chamber 17 after
30 being solid-liquid-separated by the side surface screen

13. Further, because the microorganism agglomerates that remain in the liquid phase between the side surface screen 13 and the center screen 14 may stay at an inner surface of the reactor tank 10 at upper sides of these screens 5 13 and 14 by riding the flow of the treated water, there is a need to draw them regularly. Here, if the inner surface part of the reactor tank 10 at upper side of the side surface screen 13, which is soaked in the liquid phase, is formed by the slit or the lattice (or the grid) 10 screen such as the wedge wire, the floating microorganism agglomerates are pushed out to an outflow side by the flow of the treated water and the side surface screen 13 tends to be clogged with the microorganism agglomerates. Thus, it is desirable that the inner surface part of the 15 reactor tank 10 of the upper portion of the side surface screen 13 have no permeability of the water. Further, for dilution of substrate concentration of the water to be treated, a part of the treated water is supplied to a pH control system (a pH control tank 18 having pH control 20 liquid or solution and a stirring and mixing means (both not shown)) through a circulation pipe 172, and thereafter supplied to the supply pipe 101 for the circulation through a return pipe 181.

[0031] (Effect)

25 According to the waste water treatment device 1, it is possible to separate the air bubbles from the floating microorganism agglomerates and to collect these separated air bubbles and guide them up to the area around the liquid level in the reactor tank 10 then to release the air bubbles 30 into the gas phase, also the liquid phase containing the

microorganism agglomerates of the upper layer in the reactor tank 10 can be separated into the microorganism agglomerates and the treated water. In this way, since the outflow of the microorganism agglomerates from the waste water treatment device is suppressed, a stable UASB treatment can be realized.

[0032] In particular, by providing the center screen 14, it is possible to separate the air bubbles speedily or immediately from the microorganism agglomerates to which the air bubbles are attached, which remain outside the air bubble collection pipe 12.

[0033] Further, by providing the guide portion 15 on the inner circumferential surface of the reactor tank 10, the air bubbles of the gas generated from the bed 19 and the flow of the air bubbles separated from the microorganism agglomerates by the air bubble separation screen 11 can be guided to the lower end opening of the air bubble collection pipe 12. It is therefore possible to lead the air bubbles to the air bubble collection pipe 12 efficiently without an occurrence of a short-circuited flow.

[0034] In addition, since the bypassing member 16 is located in the middle of the guide portion 15, the air bubbles flowing out from the opening 111 of the top of the air bubble separation screen 11 and the flow of the microorganism agglomerates to which the air bubbles are attached are made to bypass in the radial direction, and the separation of the air bubbles from the microorganism agglomerates flowing out and floating from the opening 111 can be promoted.

[0035] Furthermore, by diluting the water to be treated that is supplied to the reactor tank 10 by the return of pH-controlled treated water, such high concentration of the substrate that inhibits biological activity of the microorganism agglomerates is changed to a concentration level that does not inhibit the biological activity of the microorganism agglomerates, anaerobic biological activity of the bed 19 can therefore be maintained.

10 [0036] [Embodiment 2]

In a waste water treatment device (waste water treatment equipment) 2A of the present embodiment shown in Fig. 3, a reactor tank 20 is formed into a substantially rectangularparallelepiped shape. Airbubble separation screens 21 and 26, an air bubble collection member 22, a side surface screen 23, a center screen 24, a guide portion 25 and a treated water separation chamber 27 are provided to fit the shape of this reactor tank 20. Except for a configuration of this reactor tank 20, a configuration of the waste water treatment device 2A is the same as that of the waste water treatment device 1.

[0037] The water to be treated is introduced into the reactor tank 20 from a bottom 200, and after the water to be treated is brought into contact with the

25 microorganism agglomerates, the water to be treated is discharged as the treated water from an upper portion of the reactor tank 20. As same as the reactor tank 10 according to the embodiment 1, the water to be treated is supplied, by the pump P1, to the reactor tank 20 through the supply pipe 101 that is connected to a lower end portion

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of the reactor tank 20. Side surfaces, around the bottom 200, of the reactor tank 20 have a lower-side-tapered shape so that the microorganism agglomerates gather and accumulate at the bottom 200 and efficiency of the contact
5 between the water to be treated and the microorganism agglomerates is increased, same as the reactor tank 10.
[0038] The air bubble separation screen 21 separates the air bubbles from the microorganism agglomerates to which the air bubbles of the gas generated from the bed staying
10 in the bottom 200 of the reactor tank 20 are attached, by the fact that the microorganism agglomerates to which the air bubbles are attached contact or collide with the air bubble separation screen 21. The air bubble separation screen 21 is formed from a plate-shaped wedge
15 wire screen that extends longitudinally. Here, as same as the air bubble separation screen 11 according to the embodiment 1, a screen scale spacing of the air bubble separation screen 21 is set to be smaller than or substantially equal to the average particle size of the
20 microorganism agglomerate, for instance, it is 0.5 mm ~ 0.8 mm.

[0039] The air bubble separation screen 21 is set at a non-perpendicular angle to the liquid level around the bottom 200 in the reactor tank 20. In the drawing, two
25 air bubble separation screens 21 are set so that vertically-cut cross section of both the air bubble separation screens 21 is a shape of Japanese katakana letter "ハ" in a width direction of the reactor tank 20. That is, the two air bubble separation screens 21 are
30 set with these two air bubble separation screens 21

symmetrically inclined so that a distance or a space between opposing surfaces becomes smaller toward an upper side.

[0040] The air bubble collection member 22 collects the
5 air bubbles of the gas generated from the bed and the
air bubbles separated from the microorganism agglomerates
by the air bubble separation screen 21, and guides them
up to an area around the liquid level in the reactor tank
20. The gas released from the liquid level is exhausted
10 into the atmosphere through the exhaust pipe 103 that
is connected to a ceiling portion 202 of the reactor tank
20, or the gas is used as the energy gas. As shown in
the drawing, the air bubble collection member 22 is formed
by a pair of plate-shaped collecting members 221 whose
15 opposing surfaces are set with these opposing surfaces
symmetrically inclined so that a distance or a space
between the opposing surfaces becomes smaller toward the
upper side and a pair of plate-shaped guiding members
222 that are joined to upper ends of these collecting
20 members 221 at a perpendicular angle to the liquid level.

[0041] Further, as shown in Fig. 9, it is preferable to
provide plate-shaped rectification members 223a, 223b
and 223c by which the ascending flow of the fluid meanders
on either one of the opposing surfaces of the guiding
25 member 222. The rectification members 223a, 223b and 223c
are set with each rectification member inclined at a
predetermined angle with respect to a vertical direction
so that the ascending flow of the fluid can meander. By
such setting of the rectification members 223a ~ 223c,
30 a path of the ascending flow of the fluid between the

guiding members 222 becomes longer, it is thus possible to release the air bubbles from the microorganism agglomerates to which the air bubbles are attached by the contact between the microorganism agglomerates to which the air bubbles are attached and the rectification members 223a ~ 223c (also the contact between the microorganism agglomerates to which the air bubbles are attached and the guiding members 222).

[0042] The side surface screen 23 separates the liquid phase containing the microorganism agglomerates of an upper layer of the reactor tank 20 into the microorganism agglomerates and the treated water. The side surface screen 23 is formed from a slit or lattice (or grid) screen such as a plate-shaped wedge wire screen. As same as the embodiment 1, a screen scale spacing of this side surface screen 23 is set so as to be smaller than the average particle size of the microorganism agglomerate to render the side surface screen 23 fit for solid-liquid separation of the microorganism agglomerates and the treated water. The center screens 24 are arranged at both side surface sides around an upper end of the reactor tank 20 which face the guiding members 222 of the air bubble collection member 22. The treated water separation chambers 27 to introduce therein the treated water through the side surface screens 23 are provided outside the both side surfaces. The outflow pipe 171 to discharge the treated water out of the wastewater treatment device is connected to one treated water separation chamber 27. The circulation pipe 172, which communicates with the pH control tank 18 (the pH control liquid or solution and

the stirring and mixing means (both not shown)) to which the return pipe 181 for returning a part of the treated water is connected, is connected to the other treated water separation chamber 27.

5 [0043] The center screen 24 separates the air bubbles from the microorganism agglomerates to which the air bubbles are attached, which come up or ascend inside the air bubble collection member 22, by the fact that the microorganism agglomerates to which the air bubbles are
10 attached contact or collide with the center screen 24. Further, as seen in Fig. 10(a), in the present embodiment, the microorganism agglomerates to which the air bubbles are attached, which come up upwardly or float between the air bubble collection members 22, continue receiving
15 impact or shock by a strong gas flow from a lower side, then the attached gas is separated. The separated gas is released into the atmosphere from the liquid level. On the other hand, the microorganism agglomerates having no air bubbles by the release of the air bubbles go down
20 outside the air bubble collection member 22 by their own weight, and sink on the bed staying around the around the bottom 200 of the reactor tank 20.

[0044] Furthermore, as shown in Fig. 10(a), an aggregation (or a group) C of the microorganism
25 agglomerates that remains around the liquid level close to the center screen 24 without sinking, among the floating microorganism agglomerates, is regularly removed through a sludge drawing pipe 28 by a valve operation. The sludge drawing pipe 28 is connected to a side surface of the
30 reactor tank 20 which does not face the center screen

24. It is preferable that the sludge drawing pipe 28 be set at such setting height that the liquid phase around the liquid level can be drawn. As shown in Fig. 10(b), the sludge drawing pipe 28 might be connected to both side surfaces of the reactor tank 20. Here, instead of the sludge drawing pipe 28, a scraping device could be employed. As the scraping device, a well-known scraping device applied in a water treatment facility can be used.

[0045] The center screen 24 is formed from a slit or lattice (or grid) screen such as a plate-shaped wedge wire screen. A size of the center screen 24 is nearly same as that of the side surface screen 23. As seen in Fig. 3, the center screen 24 is secured to an inner surface of the reactor tank 20 so that an upper end of the center screen 24 is positioned to be higher than upper ends of the air bubble collection member 22 and the side surface screen 23 and also higher than the liquid level inside the reactor tank 20 and further the center screen 24 is arranged substantially parallel to these air bubble collection member 22 and side surface screen 23.

[0046] Since a main aim of the center screen 24 is to separate the air bubbles speedily or immediately from the microorganism agglomerates to which the air bubbles are attached and further there is no intention of completely preventing the outflow of the microorganism agglomerates, as same as the embodiment 1, a screen scale spacing of the center screen 24 is set to a wider size than that of the side surface screen 23. For instance, the screen scale spacing of the center screen 24 is set to 0.7 mm ~ 1.0 mm. Here, the microorganism agglomerates

that pass through the screen scale spacing of the center screen 24 can be prevented from flowing out by the side surface screen 23 having the narrower screen scale spacing.

5 [0047] As same as the embodiment 1, in order to be able to guide the air bubbles of the gas generated from the bed and the air bubbles separated from the microorganism agglomerates by the air bubble separation screen 21 to a lower end of the air bubble collection member 22, the
10 guide portion 25 is provided on the inner surface of the reactor tank 20. The guide portion 25 is formed from a protrusion body having a triangular-shape in cross section in a width direction of the reactor tank 20. This protrusion body is shaped so that a lower surface 251
15 can guide the air bubbles riding the ascending flow to the lower end of the air bubble collection member 22 and also an upper surface 252 can guide the sinking microorganism agglomerates to the bottom 200 of the reactor tank 20.

20 [0048] Additionally, as same as the embodiment 1, the air bubble separation screen 26 as the bypassing member, by which the air bubbles that flow out from the air bubble separation screen 21 (from an area between the air bubble separation screens 21) and a flow of the microorganism
25 agglomerates to which the air bubbles are attached bypass in a radial direction of the reactor tank 20, is provided in the middle of the guide portion 25. The air bubble separation screen 26 is formed from a slit or lattice (or grid) screen such as a plate-shaped wedge wire screen.
30 Although an overall length of the air bubble separation

screen 26 is substantially same as that of the air bubble separation screen 21, a width of the air bubble separation screen 26 is set to be larger than a minimum distance between the two air bubble separation screens 21. The
5 air bubble separation screen 26 is set horizontally with respect to the liquid level. A screen scale spacing of the air bubble separation screen 26 can be set to the same screen scale spacing as the air bubble separation screen 11 of the embodiment 1.

10 [0049] In addition, as shown in a waste water treatment device (waste water treatment equipment) 2B in Fig. 4, instead of the air bubble separation screen 26, it is preferable to provide air bubble separation screens 21a and 21b in the reactor tank 20.

15 [0050] The air bubble separation screens 21a and 21b are formed from a slit or lattice (or grid) screen such as a wedge wire screen that has a substantially same size and a substantially same shape as those of the air bubble separation screen 21. The air bubble separation screen
20 21a is set with the air bubble separation screen 21a inclined at a predetermined angle with respect to a horizontal direction at a predetermined distance from the bottom 200 of the reactor tank 20. The air bubble separation screen 21b is set between the air bubble separation screen 21 and the air bubble separation screen
25 21a with the air bubble separation screen 21b inclined at a predetermined angle in an inclination direction opposite to an inclination direction of the air bubble separation screen 21a. Since the ascending flow of the
30 fluid meanders by such setting of the air bubble separation

5 screens 21a and 21b, the air bubbles are easily separated from the microorganism agglomerates to which the air bubbles are attached by the contact between the microorganism agglomerates and the air bubble separation screens 21a, 21b and 21. It is therefore possible to suppress a movement of flow of the microorganism agglomerates that have high activity around the bottom 200 of the reactor tank 20.

[0051] According to the waste water treatment device 2A, 10 in addition to the effect of the waste water treatment device 1, the path of the ascending flow of the fluid between the guiding members 222 becomes longer, thereby promoting the separation of the air bubbles from the floating microorganism agglomerates. Further, 15 according to the waste water treatment device 2B, in addition to the effect of the waste water treatment device 2A, it is possible to lengthen a staying time of the microorganism agglomerates having the high activity around the bottom 200 of the reactor tank 20. Hence, the 20 microorganism agglomerates having the high activity can be kept at a high concentration around the bottom 200.

[0052] [Embodiment 3]

In a waste water treatment device (waste water treatment equipment) 3 of the present embodiment shown in Fig. 5, 25 instead of the side surface screen 23 and the center screen 24 of the embodiment 2, a solid-liquid separation screen 31 is provided, then a treated water separation chamber 32 is formed in the reactor tank 20. Except for these solid-liquid separation screen 31 and treated water 30 separation chamber 32, a configuration of the waste water

treatment device 3 is the same as that of the waste water treatment device 2B. Here, an air bubble separation screen 21c is added around the bottom 200 of the reactor tank 20.

5 [0053] The treated water separation chamber 32 is defined by dividing an upper end (an area around an upper end) of the reactor tank 20 by the solid-liquid separation screen 31. The solid-liquid separation screen 31 has a center screen part 311 and a side surface screen part
10 312. The center screen part 311 is formed from a slit or lattice (or grid) screen such as a plate-shaped wedge wire screen, and is arranged parallel to the guiding member 222 of the air bubble collection member 22. The side surface screen part 312 is formed from a slit or lattice
15 (or grid) screen such as a plate-shaped wedge wire screen. The side surface screen part 312 is secured to a lower end of the center screen part 311 and an inner surface of the reactor tank 20 which faces the guiding member 222 of the air bubble collection member 22 so that the
20 side surface screen part 312 inclines upwardly from the inner surface of the reactor tank 20 to the lower end of the center screen part 311. As same as the side surface screen 13 according to the embodiment 1, a screen scale spacing of the solid-liquid separation screen 31 is set
25 so as to be smaller than the average particle size of the microorganism agglomerate to render the solid-liquid separation screen 31 fit for solid-liquid separation of the microorganism agglomerates and the treated water. Further, a discharge trough 33 as shown in Fig. 11 could
30 be provided, instead of the outflow pipe 171, at an outside

of one of the treated water separation chambers 32 which discharges the treated water out of the waste water treatment device. The discharge trough 33 receives the treated water that overflows the reactor tank 20 from an upper end edge 201 of the reactor tank 20, and flows or delivers it to the outside of the waste water treatment device or a following facility by gravity flow (spontaneous or free flow). By employing the discharge trough 33, an outflow pipe system can be prevented from being clogged.

[0054] The air bubble separation screens 21a ~ 21c are set with the air bubble separation screens 21a ~ 21c inclined at different angles from each other from the bottom 200 of the reactor tank 20 so that the ascending flow of the introduced water to be treated meanders.

[0055] According to the above waste water treatment device 3, in addition to the effect of the waste water treatment devices 2A and 2B, since the waste water treatment device 3 has the configuration in which the treated water separation chamber is not arranged at an outer periphery around the upper end of the reactor tank, a compact waste water treatment device can be achieved. Further, since the air bubble separation screen is added around the bottom 200 of the reactor tank 20, the staying time of the activated microorganism agglomerates can be lengthened more than the waste water treatment devices 2A and 2B of the embodiment 2. As a consequence, the microorganism agglomerates having the high activity can be kept at a higher concentration around the bottom 200.

[0056] [Embodiment 4]

In a waste water treatment device (waste water treatment equipment) 4 of the present embodiment shown in Fig. 6, a width, positioned below the lower end of the air bubble collection member 22, of the reactor tank 40 is set to be smaller (narrower) than a width, positioned above the lower end of the air bubble collection member 22, of the reactor tank 40. A boundary side surface 403 between an upper side surface 401 and a lower side surface 402 of this reactor tank 40 is an inclined surface. With this structure, the guide portion 25 of the embodiment 3 can be removed in the reactor tank 40. Except for the structure of this reactor tank 40, a configuration of the waste water treatment device 4 is the same as that of the waste water treatment device 3 of the embodiment 3.

[0057] Widths of the air bubble separation screens 21 and 21a ~ 21c are set according to a shape of the reactor tank 40. The air bubble separation screens 21 are arranged between the boundary side surfaces 403 that face the air bubble separation screens 21 in the reactor tank 40. The air bubble separation screens 21a ~ 21c are arranged between the lower side surfaces 402 that face the air bubble separation screens 21a ~ 21c.

[0058] According to the above waste water treatment device 4, in addition to the effect of the waste water treatment devices 2A and 2B of the embodiment 2, the configuration of the waste water treatment device 4 can be simplified as compared with that of the waste water treatment device 3 of the embodiment 3. Further, as shown in Fig. 12, since the width, positioned below the lower end of the air bubble collection member 22, of the reactor

tank 40 is set to be smaller (narrower) than the width, positioned above the lower end of the air bubble collection member 22, of the reactor tank 40, the air bubbles riding the ascending water flow from a bottom 400 can be directly
5 guided to a lower end of the collecting member 221 of the air bubble collection member 22. Moreover, the sinking microorganism agglomerates can be guided to the bed 19 staying around the bottom 400 by going down along the boundary side surface 403.

10 [0059] In addition, in the present embodiment, as shown in Fig. 7 indicating a unit 41, it is preferable that the air bubble separation screens 21 and 21a ~ 21c, the air bubble collection member 22 and the solid-liquid separation screen 31 be joined together as one unit then
15 be set freely in the reactor tank 40 as a detachable unit.

[0060] The unit 41 has a supporting frame 42, a supporting fixation portion 43 and a hanging attachment 44. The supporting frame 42 is a pair of frame members that support the air bubble separation screens 21 and 21a ~ 21c, the
20 air bubble collection member 22 and the solid-liquid separation screen 31. The supporting fixation portion 43 is a pair of fixing members that support the supporting frame 42 and fix it to an upper end edge of the reactor tank 40 as the detachable unit. The hanging attachment
25 44 is a pair of hanging members that hang or lift the supporting fixation portion 43.

[0061] By providing the detachable unit 41 in the reactor tank 40, it is possible to lift out the unit 41 from an upper side of the reactor tank 40 by hitching a chain
30 hook of a hoisting machine to the hanging attachment 44

upon carrying out of maintenance. This facilitates carrying out of maintenance of the air bubble separation screens 21 and 21a ~ 21c, the air bubble collection member 22 and the solid-liquid separation screen 31.

5 [0062] [Embodiment 5]

In a waste water treatment device (waste water treatment equipment) 5 of the present embodiment shown in Fig. 8, a plurality of supply pipes, each of which branches off from the supply pipe 101 of the water to be treated, are
10 connected to side surfaces of the reactor tanks 10, 20 and 40 of the embodiments 1 ~ 4 so as to fit a setting state of the air bubble separation screen in the reactor tanks 10, 20 and 40.

[0063] In the embodiment shown in the drawing, supply
15 pipes 101a ~ 101c branch off from the supply pipe 101. The supply pipe 101a is connected to the bottom of the reactor tanks 10, 20 and 40. The supply pipe 101b is connected so as to be able to supply the water to be treated to an area between the lowest air bubble separation screen
20 21a and the air bubble separation screens 21b existing above the air bubble separation screen 21a in the reactor tanks 10, 20 and 40. The supply pipe 101c is connected so as to be able to supply the water to be treated to an area between the air bubble separation screens 21b
25 and the air bubble separation screens 21c existing above the air bubble separation screen 21b.

[0064] According to the above waste water treatment device 5, it is possible to form flows of the fluid along the air bubble separation screens 21a ~ 21c around the
30 bottom in the reactor tanks 10, 20 and 40. Adhesion or

aggregation of the bacteria of a microorganism agglomerate
origin in the air bubble separation screens 21a ~ 21c
is thus suppressed, and also the air bubble separation
screens 21a ~ 21c are prevented from being clogged with
5 the microorganism agglomerates. On the other hand, since
the microorganism agglomerates to which the air bubbles
of the gas generated from the microorganism agglomerates
are attached go up or ascend in the vertical direction
and collide with the air bubble separation screens 21a
10 ~ 21c, the air bubbles can be separated from the
microorganism agglomerates.

[0065] [Embodiment 6]

(Summary)

In a waste water treatment device (waste water treatment
15 equipment) 7 of the present embodiment shown in Fig. 13,
the gas collected by an air bubble collection member 72
is fed to the side surface screen 23 in a reactor tank
70 all the time, thereby maintaining a solid-liquid
separation function of the side surface screen 23.

20 [0066] (Configuration of Device)

The reactor tank 70 is formed into a substantially
rectangular parallelepiped shape having different widths.
The water to be treated is introduced into the reactor
tank 70 from a bottom 700, and after the water to be treated
25 is brought into contact with the microorganism
agglomerates, the water to be treated is discharged as
the treated water from an upper portion of the reactor
tank 70. As same as the reactor tank 20 according to the
embodiment 2, the water to be treated is supplied, by
30 the pump P1, to the reactor tank 70 through the supply

pipe 101 that is connected to a lower end portion of the reactor tank 70.

[0067] Longitudinal side surfaces, around the bottom 700, of the reactor tank 70 have a lower-side-tapered shape so that the microorganism agglomerates gather and accumulate at the bottom 700 and efficiency of the contact between the water to be treated and the microorganism agglomerates is increased, same as the reactor tank 10 of the embodiment 1. Further, a width of lower half, where the bed 19 stays, of the reactor tank 70 is set to be smaller (narrower) than that of upper half of the reactor tank 70. An inner surface of a boundary side surface section 703 between an upper side surface section 701 and a lower side surface section 702, of one of the longitudinal side surfaces of this reactor tank 70, is an inclined surface. The reactor tank 70 is configured to efficiently collect the sinking microorganism agglomerates into the bed 19 by employing this inclined surface.

[0068] Air bubble separation screens 21a ~ 21e, a guiding member 71, an air bubble collection member 72 and a guiding member 73 are provided in the reactor tank 70 to fit a shape of the reactor tank 70.

[0069] As same as the embodiments 3 ~ 5, the air bubble separation screens 21a ~ 21e are set with the air bubble separation screens 21a ~ 21e inclined at different angles from each other from the bottom 700 of the reactor tank 70 so that the ascending flow of the water to be treated introduced in the reactor tank 70 meanders. As seen in the drawing, the air bubble separation screens 21a ~ 21c

are arranged in the lower half of the reactor tank 70 with the air bubble separation screens 21a ~ 21c inclined at different angles. The air bubble separation screens 21d and 21e are arranged at substantially same height
5 positions as the boundary side surface section 703 of the reactor tank 70 with the air bubble separation screens 21d and 21e inclined at different angles.

[0070] The guiding member 71 guides the ascending flow in the reactor tank 70 to the air bubble collection member
10 72 that is located above the guiding member 71. The guiding member 71 is formed into a plate-shape. The guiding member 71 is set in the reactor tank 70 so that upper and lower end portions of the guiding member 71 are separate from both inner surfaces of the reactor tank 70 and further
15 both surfaces of the guiding member 71 are arranged at a substantially perpendicular angle to the inner surface of the boundary side surface section 703.

[0071] The air bubble collection member 72 collects the air bubbles separated by the air bubble separation screens
20 21a ~ 21e. The air bubble collection member 72 is formed from a plate-shaped member that has an inverted V-shape in cross section. As can be seen in Fig. 14(a), a length, in a depth direction, of the air bubble collection member 72 is set so as to fit a length of a lateral width of
25 the side surface screen 23. As shown in Fig. 13, a lower end of a narrow width plate portion 721 of the air bubble collection member 72 is firmly stuck onto an inner surface of a side surface section 704 which faces the upper side surface section 701 of the reactor tank 70. On the other
30 hand, a lower surface of a wide width plate portion 722

of the air bubble collection member 72 is arranged substantially parallel to the upper surface of the guiding member 71. Also, a lower end of the wide width plate portion 722 is positioned at least at a lower position than the upper end portion of the guiding member 71. Further, an angular obstruction member 74 is formed on the lower surface around the lower end of the wide width plate portion 722 along a longitudinal direction of the lower surface of the wide width plate portion 722. By providing this obstruction member 74, the flow of the microorganism agglomerates collides with the obstruction member 74, and a gas separation efficiency from the microorganism agglomerates is increased.

[0072] In addition, a gas pipe 75 for feeding the separation gas to a bubbling pipe 76 is connected to a top portion of the air bubble collection member 72. The bubbling pipe 76 is an air diffusing member to rinse or clean the side surface screen 23 by feeding the separation gas collected inside the air bubble collection member 72 to the side surface screen 23 that is set around an upper end of the side surface section 704 of the reactor tank 70.

[0073] As shown in Fig. 14(b), the bubbling pipe 76 is set in a space between the side surface section 704 located at a lower position than a lower end portion of the side surface screen 23 and the air bubble collection member 72. As seen in Fig. 14(a), the bubbling pipe 76 is set horizontally along a lower edge of the side surface screen 23. Further, as can be seen in Fig. 14(a), the bubbling pipe 76 is formed from a tubular body 760 whose both ends

are closed, and a plurality of diffusion holes 761 for diffusing the separation gas are formed along a longitudinal direction of the tubular body 760. An angle of the diffusion hole 761 formed in the bubbling pipe
5 76 could be set so as to be able to feed the separation gas to the side surface screen 23 side uniformly or evenly from the diffusion hole 761. For instance, as shown in Fig. 14(b), a plurality of the diffusion holes 761 are formed at the tubular body 760 at the same angle positions
10 of substantially 45 degree in a slanting direction to the side surface screen 23 side.

[0074] If an overall length of the bubbling pipe 76 is substantially same as the length of the lateral width of the side surface screen 23, the side surface screen
15 23 can be rinsed or cleaned evenly. As shown in Fig. 14(a), also in a case where a plurality of short pipes are arranged in series, the same effect can be obtained. Here, if setting of a height position of the bubbling pipe 76 can be changed, a liquid level in the air bubble collection
20 member 72 (a volume of a gas phase area 80) can be arbitrarily controlled.

[0075] Further, a gas feed pipe 77 for gas supply to the air bubble collection member 72 and the bubbling pipe 76 upon carrying out of maintenance of the side surface
25 screen 23 is connected to the gas pipe 75 through a valve V6. For instance, in a case where the air bubble collection member 72 is clogged with the sludge, a pressurized gas is fed to the air bubble collection member 72 from the gas feed pipe 77 by an operation of the valve V6, then
30 the liquid level in the air bubble collection member 72

falls by its gas pressure and a clogging matter is removed. Additionally, in a case where the sludge adheres to the slit or lattice (or grid) screen such as the wedge wire screen of the side surface screen 23, the pressurized gas is fed to the bubbling pipe 76 from the gas feed pipe 77 by the by the operation of the valve V6, then a strong gas cleaning can be possible. A cleaning effect of the screen can therefore be increased. Here, if air is used as the pressurized gas, a dissolved oxygen concentration in the reactor tank 70 rises. Therefore, it is preferable to collect the gas generated from and in the reactor tank 70 without releasing it into the atmosphere then to store or accumulate the generation gas in a pressure tank by a compressor and reuse it.

[0076] The guiding member 73 shown in Fig. 13 is a member to guide the ascending water flow in the reactor tank 70 to the side surface screen 23. The guiding member 73 is formed by an inclined plate section 731 and a vertical plate section 732. The inclined plate section 731 is arranged substantially parallel to an upper surface of the wide width plate portion 722 of the air bubble collection member 72. The vertical plate section 732 is arranged substantially parallel to the surface of the side surface screen 23.

[0077] Further, a guide member 705 having a triangular-shape in cross section is disposed along an upper edge of the side surface screen 23 at the side surface section 704 of the reactor tank 70 at an upper side of the side surface screen 23. By this guide member 705, the ascending flow between the side surface screen 23

and the vertical plate section 732 can be guided toward the upper side surface section 701. On the other hand, a returning gutter 79 to hold the microorganism agglomerates that overflow the reactor tank 70 from the upper side surface section 701 is added around an upper end of the upper side surface section 701 of the reactor tank 70. In the returning gutter 79, a pump P3 to return the microorganism agglomerates held in the returning gutter 79 to the reactor tank 70 is provided. A return pipe 173 is connected to the pump P3. The return pipe 173 is connected to the reactor tank 70 so as to be able to supply the microorganism agglomerates (also the treated water) to an area between the air bubble separation screen 21a and the air bubble separation screens 21b existing above the air bubble separation screen 21a in the reactor tank 70. With this connection, the microorganism agglomerates overflowing the reactor tank 70 from the upper side surface section 701 can be returned to the reactor tank 70, and also a flow of the fluid along the air bubble separation screen 21b can be formed. This brings about functions of suppressing adhesion or aggregation of the bacteria of the microorganism agglomerate origin in the air bubble separation screen 21b and of preventing the air bubble separation screen 21b from being clogged with the microorganism agglomerates. Also when forming the flow of the fluid along each of the air bubble separation screens 21a, 21c and 21d by selecting the connection of this return pipe 173 to the reactor tank 70, the same effect can be obtained. The return pipe 173 is provided with a valve V4 for regulating

a retuning amount. However, if a metering pump (a proportioning pump) is used as the pump P3 to return the microorganism agglomerates to the reactor tank 70, there is no need to provide the valve V4. Further, a drawing
5 pipe 174 is connected to the reactor tank 70 to draw the sludge from an area around an upper portion of the bed 19. The drawing pipe 174 is provided with a valve V5 for regulating a drawing amount of the sludge.

[0078] The supply pipes 101a ~ 101c of the water to be
10 treated are connected to the reactor tank 70 in the same manner as the waste water treatment device 5. It is preferable that a plurality of the supply pipes be connected to a plurality of positions at the reactor tank 70 then the water to be treated be supplied in order for
15 the bed 19 to readily flow. The supply pipes 101, 101b and 101c are provided with valves V1 ~ V3 respectively for regulating a supplying amount of the water to be treated. Here, in a case where the metering pump (the proportioning pump) is used as the pump P1 and there is no need to change
20 each rate of the supplying amount of the water to be treated from the supply pipes 101a ~ 101c, the valves V1 ~ V3 are not required.

[0079] (Explanation of Operation)

An example of operation (flow of fluid) of the waste water
25 treatment device 7 will be explained with reference to Fig. 13.

[0080] The water to be treated is introduced into the reactor tank 70 from the bottom 700 through the supply pipe 101 by the pump P1. When the water to be treated
30 is introduced into the reactor tank 70, the organic

substance and the nitrogen compound contained in the water to be treated are decomposed by the microorganism agglomerates that form the bed 19. In the organic substance treatment, the methane gas is generated during the process of the decomposition of the organic substance. In addition, in the nitrogen treatment, the ammonia component contained in the water to be treated is converted into nitrogen gas by the denitrification reaction by anaerobic ammonia-oxidizing bacteria that is one of bacteria forming the microorganism agglomerates. The air bubbles of the methane gas and the nitrogen gas etc. generated from the microorganism agglomerates go up or ascend toward the liquid level in the reactor tank 70 by the ascending water flow. The microorganism agglomerates existing around the bottom 700 where activity of the treatment is highest could lose sedimentation by the attachment of the gas due to strong gas generation, and these microorganism agglomerates go up or ascend by the ascending water flow (by riding the ascending water flow).

[0081] When the microorganism agglomerates to which the air bubbles are attached contact or collide with any of the air bubble separation screens 21a ~ 21e, the air bubble are released from the microorganism agglomerates. The microorganism agglomerates having no air bubbles by the release of the air bubbles sink or sediment by their own weight, and stay around the bottom 700. Further, the treated water treated by the bed 19 is solid-liquid-separated by the air bubble separation screens 21a ~ 21e and rides the ascending water flow,

and thereafter moves toward the air bubble collection member 72 by being guided by the guiding member 71. The released air bubbles and the microorganism agglomerates to which the air bubbles are attached which have not
5 contacted or collided with the air bubble separation screens 21a ~ 21e also ride the ascending water flow, and move toward the air bubble collection member 72 by being guided by the guiding member 71.

[0082] In the air bubble collection member 72, the
10 collected air bubbles are separated and stored in the gas phase area 80. A part of the gas in the gas phase area 80 is fed to the gas pipe 75. On the other hand, the treated water and a part of the microorganism agglomerates to which the air bubbles are attached, which
15 rides the ascending treated water flow, bypass the wide width plate portion 722 of the air bubble collection member 72 and move or flow toward the side surface screen 23 by being guided by the inclined plate section 731 of the guiding member 73. Further, when a part of the
20 microorganism agglomerates to which the air bubbles are attached contacts or collides with the obstruction member 74, the air bubbles are separated from the microorganism agglomerates, and only the air bubbles are introduced into the gas phase area 80 of the air bubble collection
25 member 72. The microorganism agglomerates having no air bubbles by the separation of the air bubbles go down along guiding member 71 by their own weight, and further sink toward the bed 19 by being guided by the inner surface of the boundary side surface section 703.

[0083] In addition, when the microorganism agglomerates to which the air bubbles are attached are guided by the guiding member 73 and contact or collide with the side surface screen 23 by riding the flow of the treated water flowing out of the waste water treatment device, the air bubbles are released from a part of the microorganism agglomerates and the gas is released into the gas phase at an upper side of the reactor tank 70. The microorganism agglomerates having no air bubbles by the release of the air bubbles come up or ascend by a gas flow that is produced by the bubbling pipe 76. The microorganism agglomerates coming up around the liquid level of the reactor tank 70 and a part of the treated water are guided to an area between the guiding member 73 and the upper side surface section 701 by the guide member 705, and sink shortly by their own weight. The microorganism agglomerates overflowing the reactor tank 70 from the upper side surface section 701, meanwhile, accumulate in the returning gutter 79. The accumulated microorganism agglomerates are regularly returned to the reactor tank 70 through the return pipe 173 by the pump P3.

[0084] The treated water coming up to an upper layer around the liquid level in the reactor tank 70 is discharged out of the waste water treatment device from the outflow pipe 171 of the treated water separation chamber 27 after being solid-liquid-separated by the side surface screen 23. Since the surface of the side surface screen 23 is rinsed or cleaned all the time by being fed with the air bubbles from the bubbling pipe 76, the solid-liquid separation function of the side surface screen 23 can

be maintained. Further, with regard to the microorganism agglomerates remaining or staying around the side surface screen 23, since the air bubbles fed by the bubbling pipe 76 continue colliding with the microorganism agglomerates, the effect of the separation of the air bubbles from the microorganism agglomerates is also promoted. Here, a part of the treated water is supplied to the pH control system (the pH control tank having pH control liquid or solution and the stirring and mixing means (both not shown)) through the circulation pipe 172, and thereafter supplied to the supply pipe 101 for the circulation.

[0085] (Effect)

According to the above waste water treatment device 7, in addition to the effect of the waste water treatment device 1 of the embodiment 1, since the air bubbles collected by the air bubble collection member 72 are fed to the side surface screen 23 all the time, the solid-liquid separation function of the side surface screen 23 can be maintained.

[0086] Further, since the guiding member 71 to guide the ascending flow in the reactor tank 70 to the air bubble collection member 72 is provided, an efficient forming of the gas phase area 80 in the air bubble collection member 72 can be achieved.

[0087] In addition, since the guiding member 73 to guide the ascending water flow in the reactor tank 70 to the side surface screen 23 is provided, an efficient solid-gas separation and solid-liquid separation by the side surface screen 23 can be performed. This allows reduction of a residence time of the water to be treated.

[0088] Furthermore, since the air bubble collection member 72 is provided with the obstruction member 74 on the lower surface around the lower end of the wide width plate portion 722, the flow of the microorganism

5 agglomerates around the lower end collides with the obstruction member 74 and the gas separation efficiency from the microorganism agglomerates is increased.

[0089] Moreover, since the bubbling pipe 76 is set at the lower position than the lower edge of the side surface
10 screen 23 with the bubbling pipe 76 arranged parallel to the lower edge of the side surface screen 23, it is possible to clean the side surface screen 23 side uniformly or evenly.

[0090] Additionally, since the guide member 705 is
15 disposed at the upper side of the side surface screen 23, the microorganism agglomerates coming up around the liquid level of the reactor tank 70 and a part of the treated water are fed to the area between the guiding member 73 and the upper side surface section 701. It is
20 therefore possible to efficiently gather the microorganism agglomerates in the bed 19.

EXPLANATION OF REFERENCE

[0091]

1, 2A, 2B, 3, 4, 5, 7 ... wastewater treatment device (waste
25 water treatment equipment)

10, 20, 40, 70 ... reactor tank

11, 21, 21a ~ 21e ... air bubble separation screen (air
bubble separation member)

- 12 ... air bubble collection pipe (air bubble collection member)
- 121 ... collecting cone
- 122 ... cylinder portion
- 5 22 ... air bubble collection member
- 221 ... collecting member
- 222 ... guiding member
- 13, 23 ... side surface screen
- 14, 24 ... center screen
- 10 15, 25 ... guide portion
- 16 ... bypassing member
- 18 ... pH control tank 18
- 19 ... bed (layer)
- 102, 181 ... return pipe
- 15 41 ... unit
- 71 ... guiding member (first guide member)
- 72 ... air bubble collection member
- 721 ... narrow width plate portion
- 722 ... wide width plate portion
- 20 73 ... guiding member (second guide member)
- 731 ... inclined plate section
- 732 ... vertical plate section
- 76 ... bubbling pipe
- C ... aggregation (or group) of microorganism agglomerates
- 25 that do not sink

CLAIMS

1. A waste water treatment device by which water to be treated is brought into contact with microorganism agglomerates in an ascending water flow and organic substance and nitrogen compound contained in the water to be treated are decomposed, the waste water treatment device comprising:
 - a reactor tank that introduces thereinto the water to be treated from a bottom and discharges the water to be treated as treated water from an upper portion of the reactor tank after the water to be treated is brought into contact with the microorganism agglomerates contained in a layer around the bottom;
 - an air bubble separation member that separates air bubbles from the microorganism agglomerates to which the air bubbles of gas generated from the layer are attached, by a fact that the microorganism agglomerates to which the air bubbles are attached contact the air bubble separation member;
 - an air bubble collection member that collects the air bubbles of the gas and the air bubbles separated from the microorganism agglomerates by the air bubble separation member; and
 - a solid-liquid separation member that separates a liquid phase containing the microorganism agglomerates of an upper layer of the reactor tank into the microorganism agglomerates and the treated water.

2. The waste water treatment device as claimed in claim 1, further comprising:

5 an air bubble separation member that separates the air bubbles from the microorganism agglomerates to which the air bubbles are attached, which remain outside the air bubble collection member, by a fact that the microorganism agglomerates to which the air bubbles are attached contact the air bubble
10 separation member.

3. The waste water treatment device as claimed in claim 1 or 2, wherein:

15 the reactor tank is formed into a cylindrical shape, the air bubble separation member is formed into a conical-shape having an opening at a top thereof, and is arranged coaxially with the reactor tank around the bottom of the reactor tank,

20 the air bubble collection member is formed by a conical-shaped collecting portion and a cylinder portion that is connected, vertically with respect to a liquid level, to an upper end opening of the collecting portion, and the air bubble collection member is arranged coaxially with the reactor tank, and
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the solid-liquid separation member is formed into a cylindrical shape having same diameter as that of the reactor tank, and is set at a circumferential side surface around an upper end of the reactor
30 tank.

4. The waste water treatment device as claimed in claim 1 or 2, wherein:

5 the reactor tank is formed into a substantially rectangular parallelepiped shape,
the air bubble separation member is formed into a plate-shape, and a plurality of the air bubble separation members are set at non-perpendicular angles to the liquid level,
10 the air bubble collection member is formed by a pair of plate-shaped collecting members whose opposing surfaces are set with the opposing surfaces symmetrically inclined so that a distance between the opposing surfaces becomes smaller toward an
15 upper side and a pair of plate-shaped guiding members that are joined to upper ends of the collecting members at a perpendicular angle to the liquid level, and
the solid-liquid separation member is formed into
20 a plate-shape, and is arranged at a side surface side around an upper end of the reactor tank.

5. The waste water treatment device as claimed in claim 3 or 4, further comprising:

25 a guide portion that is provided at an inner surface of the reactor tank and guides flows of the air bubbles of gas generated from the layer and the separated air bubbles to a lower end opening of the air bubble collection member.

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6. The waste water treatment device as claimed in claim 5, wherein:
a bypassing member, by which the air bubbles that flow out from the opening of the top of the air bubble separation member and a flow of the microorganism agglomerates to which the air bubbles are attached bypass in a radial direction of the reactor tank, is provided in a middle of the guide portion.
- 10 7. The waste water treatment device as claimed in any one of the preceding claims 4 to 6, wherein:
a rectification member by which an ascending flow of fluid meanders is provided on either one of the opposing surfaces of the air bubble collection member.
- 15 8. The waste water treatment device as claimed in any one of the preceding claims 3 to 6, wherein:
a width, positioned below a lower end of the air bubble collection member, of the reactor tank is set to be narrower than a width, positioned above the lower end of the air bubble collection member, of the reactor tank.
- 20 9. The waste water treatment device as claimed in claim 8, wherein:
the air bubble separation member, the air bubble collection member and the solid-liquid separation member are joined together as one unit, and the unit
- 25

is freely set in the reactor tank as a detachable unit.

10. The waste water treatment device as claimed in claim
5 1, wherein:

the reactor tank is formed into a substantially
rectangular parallelepiped shape,
the solid-liquid separation member is set around
an upper portion of a longitudinal-side side
10 surface section of the reactor tank, and
the air bubble collection member is provided with
an air diffusing member that feeds the collected
gas to the solid-liquid separation member.

- 15 11. The waste water treatment device as claimed in claim
10, further comprising:

a first guide member that guides the ascending flow
in the reactor tank to the air bubble collection
member.

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12. The waste water treatment device as claimed in claim
10 or 11, further comprising:

a second guide member that guides the ascending flow
in the reactor tank to the solid-liquid separation
25 member.

13. The waste water treatment device as claimed in claim
12, wherein:

the first guide member is formed from a plate-shaped
30 member,

the air bubble collection member is formed from a plate-shaped member that has an inverted V-shape in cross section, and a lower end of a narrow width plate portion of the air bubble collection member is firmly stuck onto an inner surface of the longitudinal-side side surface section of the reactor tank, and a lower surface of a wide width plate portion of the air bubble collection member is arranged substantially parallel to an upper surface of the first guide member, and further a lower end of the wide width plate portion is positioned at least at a lower position than an upper end portion of the first guide member, and the second guide member is formed by an inclined plate section that is arranged substantially parallel to an upper surface of the wide width plate portion of the air bubble collection member and a vertical plate section that is arranged substantially parallel to a surface of the solid-liquid separation member.

14. The waste water treatment device as claimed in claim 13, wherein:
an obstruction member is formed on the lower surface around the lower end of the wide width plate portion along a longitudinal direction of the lower surface of the wide width plate portion.

15. The waste water treatment device as claimed in any one of the preceding claims 10 to 14, wherein:

the air diffusing member is formed from a tubular body, and is arranged substantially parallel to a lower edge of the solid-liquid separation member at a lower position than the lower edge of the

5 solid-liquid separation member.