

DESCRIPTION

TITLE OF THE INVENTION:

SOLID-LIQUID SEPARATION APPARATUS AND SOLID-LIQUID
SEPARATION METHOD

5 FIELD OF THE INVENTION

[0001]

The present invention relates to a solid-liquid separation apparatus and a solid-liquid separation method, and more specifically to a solid-liquid separation apparatus that includes a solid-liquid separation tank that performs solid-liquid
10 separation of raw water containing sludge by gravity settling, and a solid-liquid separation method that performs solid-liquid separation of raw water by means of the solid-liquid separation apparatus.

RELATED ART

[0002]

15 Hitherto, the solid-liquid separation apparatus of the above type is used to produce purified water that is supernatant by performing solid-liquid separation of raw water in a solid-liquid separation area of a solid-liquid separation tank, thereby separating the raw water into a supernatant layer having supernatant, the content rate of sludge of which is smaller than the raw water, and a
20 concentrate layer having sludge concentrate, the content rate of sludge of which is greater than the raw water.

[0003]

The solid-liquid separation apparatus poses a problem in that, when raw water is newly supplied into the solid-liquid separation tank having the
25 supernatant layer and the concentrate layer formed therein, this newly supplied raw water causes disturbance of an interface between the supernatant layer and the concentrate layer, which makes it hard to achieve satisfactory solid-liquid

separation in a state where raw water is being supplied, and hence hard to produce supernatant at a high efficiency.

[0004]

In view of the above, as shown in FIG. 4, there is disclosed a solid-liquid
5 separation apparatus 100 equipped with a distributor 102 that is located below liquid level of a solid-liquid separation tank 101 to distribute and supply raw water A into a solid-liquid separation area 101a (e.g., Patent Documents 1 and 2).

[0005]

According to the thus configured solid-liquid separation apparatus 100,
10 even when raw water A is newly supplied into the solid-liquid separation area 101a having a supernatant layer 110 and a concentrate layer 111 formed therein, the raw water A is dispersed over the inside of the solid-liquid separation area 101a when it is being supplied. Thus, the interface between the supernatant layer 110 and the concentrate layer 111 is unlikely to be disturbed so that
15 solid-liquid separation can be satisfactorily achieved even in a state where the raw water A is being supplied. As a result, supernatant B can be relatively efficiently produced.

Prior Art Documents

Patent Documents

20 [0006]

Patent Document 1: Japanese Patent Application Laid-open No.
2002-361003

Patent Document 2: Japanese Patent Application Laid-open No.
Hei-7-80211

25 DISCLOSURE OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0007]

Meanwhile, the solid-liquid separation apparatus 100 includes a transfer tank 103 that is located on the upper side of the distributor 102 to transfer supplied raw water A to the distributor 102, as well as the solid-liquid separation tank 101 and the distributor 102. With this configuration, raw water A supplied into the transfer tank 103 is transferred while falling within the transfer tank 103.

[0008]

The thus configured solid-liquid separation apparatus 100 may cause raw water A to entrain air when the raw water A is supplied into the transfer tank 103, and hence the raw water A to be impeded from falling within the transfer tank 103 due to the buoyancy of the entrained air. This results in a problem in that the raw water A is hard to be transferred to the distributor 102 from the transfer tank 103, the raw water A is hard to be supplied into the solid-liquid separation area 101a from the distributor 102, and hence supernatant B cannot be satisfactorily and efficiently produced.

[0009]

In consideration of the above problem, it is an object of the present invention to provide a solid-liquid separation apparatus and a solid-liquid separation method that are capable of satisfactorily and efficiently producing supernatant.

MEANS FOR SOLVING PROBLEMS

[0010]

According to the present invention, there is provided a solid-liquid separation apparatus comprising a solid-liquid separation tank having a solid-liquid separation area, through which the solid-liquid separation tank generates supernatant and sludge concentrate from raw water containing sludge by gravity settling, in which the content rate of sludge of the supernatant is smaller than that of the raw water and the content rate of sludge of the sludge

concentrate is greater than that of the raw water; a distributor that is located below liquid level of the solid-liquid separation tank to distribute and supply the raw water into the solid-liquid separation area; and a transfer tank that is located on the upper side of the distributor to transfer the supplied raw water to the distributor so that the raw water supplied into the transfer tank is transferred while falling within the transfer tank, wherein

the transfer tank has a tapered shape toward the lower side,

the solid-liquid separation apparatus is configured so that the raw water falls within the transfer tank while being pressed against an inner peripheral surface of the transfer tank by centrifugal force and gravity to form an air release passage in a portion of the transfer tank, through which air entrained in the raw water is released.

[0011]

The solid-liquid separation apparatus is configured so that the raw water falls within the transfer tank while being swirled along the inner peripheral surface of the transfer tank.

[0012]

In the solid-liquid separation apparatus, the inner peripheral surface of the transfer tank includes an inclined surface inclined relative to a horizontal plane so that the raw water falls within the transfer tank while being pressed against the inclined surface by gravity.

[0013]

According to another aspect of the present invention, there is provided a solid-liquid separation method for subjecting raw water containing sludge to solid-liquid separation by using the solid-liquid separation apparatus.

[0014]

The solid-liquid separation apparatus and the solid-liquid separation method, which are configured so that raw water falls within the transfer tank while being pressed against the inner peripheral surface of the transfer tank by at

least one of centrifugal force and gravity, makes it hard for raw water to pass through a certain portion of the transfer tank (e.g., an area in the axial direction, such as a central axial area, or the like) when raw water falls within the transfer tank, so that an air release passage may be easily formed in that portion. Thus, even if air is entrained in raw water, it can be easily separated from the raw water through this air release passage. This enables reduction in buoyancy of air applied to raw water, facilitates falling of raw water within the transfer tank, facilitates transferring of raw water into the distributor from the transfer tank, facilitates supply of raw water from the distributor to the solid-liquid separation area, and makes it possible to produce supernatant satisfactorily and efficiently.

ADVANTAGES OF THE INVENTION

[0015]

As described above, according to the present invention, it is possible to satisfactorily and efficiently produce supernatant.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

FIG. 1 is a schematic view of a solid-liquid separation apparatus according to one embodiment.

FIG. 2 is a schematic view of a solid-liquid separation apparatus according to one embodiment.

FIG. 3 is a schematic view of a solid-liquid separation apparatus according to one embodiment.

FIG. 4 is a schematic view of a conventional solid-liquid separation apparatus.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0017]

Now, the description will be made for embodiments of the present

invention with reference to the drawings attached hereto.

[0018]

As shown in FIG. 1, a solid-liquid separation apparatus 1 of this embodiment includes: a solid-liquid separation tank 2 having a solid-liquid
5 separation area 2a, through which the solid-liquid separation tank 2 generates supernatant B and sludge concentrate C from raw water A containing sludge by gravity settling, in which the content rate of sludge of the supernatant B is smaller than that of the raw water A and the content rate of sludge of the sludge concentrate C is greater than that of the raw water A; a distributor 3 that is
10 located below liquid level of the solid-liquid separation tank 2 to distribute and supply raw water A into the solid-liquid separation area 2a; a transfer tank 4 that is located on the upper side of the distributor 3 to transfer the supplied raw water A to the distributor 3 so that the raw water A supplied into the transfer tank 4 is transferred while falling within the transfer tank 4.

15 [0019]

The solid-liquid separation tank 2 has a sludge concentrate discharge port 2c that discharges sludge concentrate C into a bottom portion 2b. The bottom portion 2b may be inclined toward the sludge concentrate discharge port 2c, thus having a tapered shape toward a lower side.

20 [0020]

The distributor 3 has a vertically downwardly oriented opening 3a, through which raw water A is supplied into the solid-liquid separation area 2a.

[0021]

The transfer tank 4 has a circular shape in horizontal cross section.
25 Specifically, the transfer tank 4 has a tapered shape toward the lower side.

The distributor 3 and the transfer tank 4 are configured to be rotated by a motor (not shown) disposed on the upper side of the solid-liquid separation tank 2.

A sludge rake device (not shown) that includes a rake arm (not shown) is provided within the bottom portion 2b of the solid-liquid separation tank 2 to rake sludge within the bottom portion 2b of the solid-liquid separation tank 2 by rotation of the rake arm (not shown). The rake arm (not shown) is configured to be rotated by the motor (not shown) along with the distributor 3 and the transfer tank 4.

[0022]

The solid-liquid separation apparatus 1 of this embodiment is configured so that raw water A is supplied into the transfer tank 4; supernatant B generated in the solid-liquid separation area 2a is transferred into a supernatant storage tank (not shown); and sludge concentrate C generated in the solid-liquid separation area 2a is transferred into a sludge concentrate storage tank (not shown) .

Specifically, the solid-liquid separation apparatus 1 of this embodiment includes: a raw water supply conduit 5a that supplies raw water A into the transfer tank 4; a supernatant transfer conduit 5b that transfers supernatant B generated in the solid-liquid separation area 2a to a supernatant storage tank (not shown); and a sludge concentrate transfer conduit 5c that transfers sludge concentrate C generated in the solid-liquid separation area 2a to a sludge concentrate storage tank (not shown).

[0023]

The solid-liquid separation apparatus 1 of this embodiment is configured so that raw water A falls within the transfer tank 4 while being pressed against the inner peripheral surface of the transfer tank 4 by centrifugal force.

Specifically, the solid-liquid separation apparatus 1 of this embodiment is configured so that raw water falls within the transfer tank 4 while being swirled along the inner peripheral surface of the transfer tank 4.

[0024]

The solid-liquid separation apparatus 1 of this embodiment is configured so that raw water A falls within the transfer tank 4 while being pressed against the inner peripheral surface of the transfer tank 4 by gravity.

Specifically, the solid-liquid separation apparatus 1 of this embodiment
5 has an inclined surface which is inclined relative to the horizontal plane, and is configured so that raw water A falls along the inclined surface, and thereby falls within the transfer tank 4 while being pressed against the inner peripheral surface of the transfer tank 4 by gravity.

[0025]

10 Examples of the raw water A include industrial wastewater (e.g., wastewater from a steel, food, electric power, electronic, pharmaceutical or automobile plant), domestic wastewater, wastewater such as garbage leachate, etc. Examples also include sludge containing water generated by biologically treating sewage or various industrial wastewater.

15 A specific example of the biological treatment includes activated sludge treatment or the like. The activated sludge treatment is a treatment to mix activated sludge, which contains biological species, such as bacteria, protozoa and metazoan, with wastewater containing organic matter under aeration conditions to decompose the organic matter by the biological species.

20 [0026]

While the solid-liquid separation apparatus of this embodiment has the above configuration, the description will be hereinafter made for a solid-liquid separation method of this embodiment.

[0027]

25 In the solid-liquid separation method of this embodiment, raw water containing sludge is subjected to solid-liquid separation by means of the solid-liquid separation apparatus of this embodiment.

Specifically, in the solid-liquid separation method of this embodiment, raw water A with flocculant added thereto is supplied via the raw water supply conduit 5a so as to fall within the transfer tank 4 while being swirled along the inner peripheral surface of the transfer tank 4, so that the raw water A falls within the transfer tank 4 while being pressed against the inner peripheral surface of the transfer tank 4 by at least one of centrifugal force and gravity, and is transferred to the distributor 3. Then, the transferred raw water A is distributed and supplied into the solid-liquid separation area 2a of the solid-liquid separation tank 2 through an opening 3a of the distributor 3 to generate supernatant B and sludge concentrate C from the distributed and supplied raw water A. The supernatant B generated is transferred to a supernatant storage tank (not shown) via the supernatant transfer conduit 5b, and the generated sludge concentrate C is transferred to a sludge concentrate storage tank (not shown) via the sludge concentrate transfer conduit 5c.

[0028]

Although the solid-liquid separation apparatus and the solid-liquid separation method of this embodiment have the above configurations, the solid-liquid separation apparatus and the solid-liquid separation method of the present invention may be modified according to needs and circumstances without limitation thereto.

[0029]

The solid-liquid separation apparatus 1 of this embodiment is configured so that raw water A falls within the transfer tank 4 while being pressed against the inner peripheral surface of the transfer tank 4 by centrifugal force and gravity, but may be configured so that raw water A falls within the transfer tank 4 while being pressed against the inner peripheral surface of the transfer tank 4 only by centrifugal force.

Specifically, the solid-liquid separation apparatus 1 of this embodiment has the transfer tank 4 having a tapered shape toward the lower side, but, as shown in FIG. 2, the transfer tank 4 may have a cylindrical inner peripheral surface, as long as the apparatus 1 is configured so that raw water A falls within the transfer tank 4 while being pressed against the inner peripheral surface of the transfer tank 4 by centrifugal force.

[0030]

The solid-liquid separation apparatus 1 of this embodiment may be configured so that raw water A falls within the transfer tank 4 while being pressed against the inner peripheral surface of the transfer tank 4 only by gravity.

Specifically, although the solid-liquid separation apparatus 1 of this embodiment is configured so that raw water A falls within the transfer tank 4 while being swirled along the inner peripheral surface of the transfer tank 4, the solid-liquid separation apparatus 1 may be configured so that raw water A falls within the transfer tank 4 while being not swirled but pressed against an inclined surface of the transfer tank 4 by gravity, as shown in FIG. 3.

DESCRIPTION OF THE REFERENCE NUMERALS

[0031]

1: solid-liquid separation apparatus, 2: solid-liquid separation tank, 2a: solid-liquid separation area, 2b: bottom portion, 2c: sludge concentrate discharge port, 3: distributor, 3a: opening, 4: transfer tank, 5a: raw water supply conduit, 5b: supernatant transfer conduit, 5c: sludge concentrate transfer conduit, 100: solid-liquid separation apparatus, 101: solid-liquid separation tank, 101a: solid-liquid separation area, 102: distributor, 103: transfer tank, 110: supernatant layer, 111: concentrate layer, A: raw water, B: supernatant, C: sludge concentrate

CLAIMS

1. A solid-liquid separation apparatus comprising a solid-liquid separation tank having a solid-liquid separation area, through which the
5 solid-liquid separation tank generates supernatant and sludge concentrate from raw water containing sludge by gravity settling, in which the content rate of sludge of the supernatant is smaller than that of the raw water and the content rate of sludge of the sludge concentrate is greater than that of the raw water; a distributor that is located below liquid level of the solid-liquid separation tank to
10 distribute and supply the raw water into the solid-liquid separation area; and a transfer tank that is located on the upper side of the distributor to transfer the supplied raw water to the distributor so that the raw water supplied into the transfer tank is transferred while falling within the transfer tank, wherein
the transfer tank has a tapered shape toward the lower side,
15 the solid-liquid separation apparatus is configured so that the raw water falls within the transfer tank while being pressed against an inner peripheral surface of the transfer tank by centrifugal force and gravity to form an air release passage in a portion of the transfer tank, through which air entrained in the raw water is released,
20 the raw water falls within the transfer tank while being swirled along the inner peripheral surface of the transfer tank, and
the inner peripheral surface of the transfer tank comprises an inclined surface inclined relative to a horizontal plane so that the raw water falls within the transfer tank while being pressed against the inclined surface by gravity.

2. A solid-liquid separation method for subjecting raw water containing sludge to solid-liquid separation by using the solid-liquid separation apparatus according to claim 1.