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(71) **Applicant** (for all designated States except US): **SUMITOMO CHEMICAL COMPANY, LIMITED** [JP/JP]; 27-1, Shinkawa 2-chome, Chuo-ku, Tokyo 104-8260 (JP).

(72) Inventors: and

(75) Inventors/Applicants (for US only): SAIKI, Rina [JP/JP]; c/o SUMITOMO CHEMICAL COMPANY, LIMITED, 1-98, Kasugadenaka 3-chome, Konohana-ku, Osaka-shi, Osaka 554-8558 (JP). **MATSUI, Shuhei** [JP/JP]; c/o SUMITOMO CHEMICAL COMPANY, LIMITED, 5-1, Sobiraki-cho, Niihama-shi, Ehime 792-8521 (JP). **SHIMADA, Naoki** [JP/JP]; c/o SUMITOMO CHEMICAL COMPANY, LIMITED, 5-1, Sobiraki-cho, Niihama-shi, Ehime 792-8521 (JP).

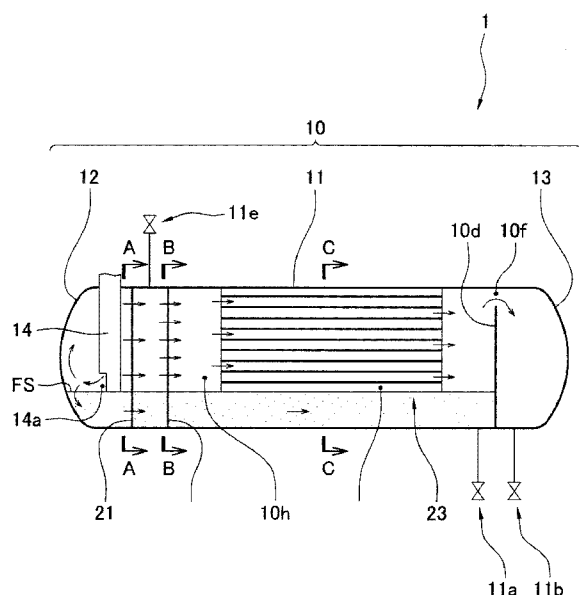
(74) **Agents:** TANAI, Sumio et al.; 1-9-2, Marunouchi, Chiyo-da-ku, Tokyo 100-6620 (JP).

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(54) Title: SEDIMENTATION TYPE LIQUID-LIQUID SEPARATOR

FIG. 1



(57) Abstract: To provide a sedimentation type liquid-liquid separator capable of exhibiting a liquid separating effect in the entire cross-section of a passageway of a liquid mixture in a device. Provided is a sedimentation type liquid-liquid separator that separates a liquid mixture, in which liquids with different specific gravities are mixed with each other while forming an interface therebetween, into respective liquids, the sedimentation type liquid-liquid separator including: a main body portion 10 that includes a hollow cylindrical body portion 11 including a liquid path 10h formed therein, an inflow path 14 supplying the liquid mixture to the liquid path 10h of the body portion 11, and discharge paths 11a and 11b discharging a separated liquid from the body portion; a sedimentation member 23 that settles a liquid with a high specific gravity contained in the liquid mixture; and rectification members 21 and 22 that are installed between the sedimentation member 23 and the inflow path, wherein the main body portion 10 is equipped with a reflection member that has a reflection surface intersecting with the axial direction of the liquid path 10h of the body portion 11, wherein the inflow path 14 is disposed between the reflection member and the rectification members 21 and 22, and wherein a supply port 14a is formed so that the liquid mixture is supplied toward the reflection member.



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DESCRIPTION

SEDIMENTATION TYPE LIQUID-LIQUID SEPARATOR

5 TECHNICAL FIELD

[0001]

The present invention relates to a sedimentation type liquid-liquid separator. More specifically, the invention relates to a sedimentation type liquid-liquid separator that separates a liquid mixture, in which liquids, such as oil and water, with different specific gravities are mixed with each other while forming an interface therebetween,
10 into respective liquids.

BACKGROUND ART

[0002]

15 Hitherto, as a device that separates a liquid mixture in which liquids, such as water and oil, with different specific gravities are mixed with each other while forming an interface therebetween into respective liquids, a device which performs a settling treatment using a difference in the specific gravity has been developed (for example, see Patent Document 1).

20 [0003]

The technique of Patent Document 1 discloses a sedimentation type liquid-liquid separator including: a main body portion which includes a hollow cylindrical body portion, wherein the inside of the main body portion is equipped with a rectification member and a sedimentation member used to settle a sedimentation liquid with a high
25 specific gravity in the liquid mixture passing through the rectification member.

Then, in the sedimentation type liquid-liquid separator of Patent Document 1, the liquid mixture enters similar to a laminar state by the rectification member, and the liquid mixture which enters similar to a laminar state is supplied to a region provided with the sedimentation member, so that the separation of the liquid mixture is promoted
5 in the sedimentation member. Furthermore, since the sedimentation surface of the sedimentation member is not inclined upward from the upstream side to the downstream side, the separated sedimentation liquid may be prevented from being mixed with the main liquid with a low specific gravity.

[0004]

10 However, in the sedimentation type liquid-liquid separator of Patent Document 1, the liquid mixture is supplied from the tubular inflow path to the liquid path inside the body portion, and the liquid mixture which flows from the tubular inflow path collides with the rectification member. For this reason, the flow rate of the liquid mixture which flows therinto may be decreased, and the liquid mixture may be dispersed inside the
15 body portion.

[0005]

However, in the sedimentation type liquid-liquid separator of Patent Document 1, the direction where the liquid mixture flows from the inflow path into the body portion substantially matches the direction where the liquid mixture flows to the liquid path
20 inside the body portion. For this reason, the period in which the liquid mixture collides with the rectification member and passes through the rectification member is shortened, and the liquid mixture may not be sufficiently dispersed inside the cross-section of the body portion. Then, there is a possibility that the sedimentation liquid with a high specific gravity compared to the specific gravity of the main liquid may not be supplied
25 to the upper portion of the body portion and the sedimentation liquid may be excessively

supplied to the lower portion of the body portion. In such a state, in a portion to which a liquid mixture containing a small ratio of sedimentation liquid is supplied, a liquid separating function may be excessively exhibited. In a portion to which a liquid mixture containing a large ratio of sedimentation liquid is supplied, a liquid separating function may not be sufficiently exhibited. That is, the separation treatment is not uniformly performed within the same cross-section of the liquid path, which may degrade the entire separating efficiency.

[0006]

Thus, in order to improve the efficiency of separating the liquid mixture in the sedimentation type liquid-liquid separator, it is desirable to use a sedimentation type liquid-liquid separator with a structure capable of making the state of the liquid mixture so that the liquid separating effect is exhibited in the entire cross-section inside the body portion.

CITATION LIST

PATENT DOCUMENTS

[0007]

Patent Document 1: Japanese Patent Application Laid-Open No. 2009-178654

DISCLOSURE OF INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0008]

The invention is made in view of the above-described circumstances, and it is an object of the invention to provide a sedimentation type liquid-liquid separator capable of exhibiting a liquid separating effect in the entire cross-section of a passageway of a liquid

mixture in a device.

MEANS TO SOLVE THE PROBLEMS

[0009]

5 According to a first invention, there is provided a sedimentation type liquid-liquid separator that separates a liquid mixture, in which liquids with different specific gravities are mixed with each other while forming an interface therebetween, into respective liquids, the sedimentation type liquid-liquid separator including: a main body portion that includes a hollow cylindrical body portion including a liquid path
10 formed therein, an inflow path installed at the front end of the body portion and supplying the liquid mixture to the liquid path of the body portion, and a discharge path installed at the rear end of the body portion and discharging a separated liquid from the body portion; a sedimentation member that settles a liquid with a high specific gravity contained in the liquid mixture inside the main body portion; and a rectification member
15 that is installed between the sedimentation member and the inflow path inside the main body portion, wherein the main body portion is equipped with a reflection member that has a reflection surface intersecting with the axial direction of the liquid path of the body portion so that the rectification member is interposed between the sedimentation member and the reflection member, wherein the inflow path is disposed between the reflection
20 member and the rectification member, and wherein a supply port which supplies the liquid mixture into the liquid path of the body portion is formed so that the liquid mixture is supplied toward the reflection member.

 According to a second invention, in the sedimentation type liquid-liquid separator of the first invention, the reflection member is a barrelhead that is installed at
25 the axial end portion of the body portion.

According to a third invention, in the sedimentation type liquid-liquid separator of the first and second inventions, a supply port of the inflow path is disposed at a position where a free surface of a liquid with a high specific gravity settling inside the liquid path is formed inside the liquid path of the body portion.

5

EFFECT OF THE INVENTION

[0010]

According to the first invention, when the liquid mixture is supplied from the supply port of the inflow path toward the reflection member, the liquid mixture which is supplied from the supply port of the inflow path flows in the direction opposite to the direction (hereinafter, referred to as a main direction) where the liquid mixture flows inside the liquid path of the body portion, and collides with the reflection member. Then, the liquid mixture which is supplied from the supply port of the inflow path first stays in the vicinity of the reflection member when colliding with the reflection surface of the reflection member and flows toward the main direction. Accordingly, the flow of the liquid mixture becomes a flow which is slower than the liquid mixture supplied from the supply port of the inflow path, and flows in the liquid path. Furthermore, when the liquid mixture collides with the reflection surface of the reflection member, a substantially radial flow is formed along the reflection surface so as to have substantially the same flow speed in any direction, and the liquid mixture may flow toward the main direction. For this reason, a flow of a slow liquid mixture may be formed inside the liquid path of the body portion so that the flow speed is substantially the same within the cross-section of the body portion by the liquid mixture. Furthermore, the liquid mixture may be supplied to substantially the entire cross-section of the body portion. Then, since the state of the liquid mixture may be made to be substantially the same within the

25

same cross-section of the body portion, the state in which the liquid mixture is separated into respective liquids may be made to be almost uniform in any portion within the same cross-section of the body portion. Thus, since the entire cross-section of the liquid path of the body portion may be effectively used to separate the liquid, the liquid separating efficiency may be improved.

According to the second invention, since the barrelhead is used as the reflection member, there is no need to install a particular reflection member inside the body portion, and the structure of the body portion may be made to be simple.

According to the third invention, when the liquid mixture is supplied from the supply port of the inflow path, it is possible to suppress the separated liquids from being mixed with each other again inside the body portion due to the influence of the flow of the liquid mixture. Then, it is possible to suppress the degradation of the liquid separating efficiency which is caused when the separated liquids are mixed with each other again.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

FIG. 1 is a schematic cross-sectional view illustrating a sedimentation type liquid-liquid separator of the embodiment.

FIG. 2(A) is a cross-sectional view taken along the line A-A of FIG. 1, FIG. 2(B) is a cross-sectional view taken along the line B-B of FIG. 1, and FIG. 2(C) is a cross-sectional view taken along the line C-C of FIG. 1.

FIG. 3 is a schematic diagram illustrating a sedimentation type liquid-liquid separator of Comparative example, where FIG. 3(A) is a cross-sectional view, FIG. 3(B) is a cross-sectional view taken along the line B-B of FIG. 3(A), and FIG. 3(C) is a

cross-sectional view taken along the line C-C of FIG. 3(A).

FIG. 4 is a diagram illustrating a calculation result of a status inside a separator of Comparative example, where FIG. 4(A) illustrates a flow speed distribution and FIG. 4(B) illustrates a calculation result of a water volume ratio distribution.

5 FIG. 5 is a diagram illustrating a calculation result of a status inside a separator of Example, where FIG. 5(A) illustrates a flow speed distribution and FIG. 5(B) illustrates a calculation result of a water volume ratio distribution.

MODE FOR CARRYING OUT THE INVENTION

10 [0012]

Next, an embodiment of the invention will be described by referring to the drawings.

A sedimentation type liquid-liquid separator of the embodiment is a device that separates a liquid mixture in which liquids with different specific gravities are mixed
15 with each other while forming an interface therebetween into respective liquids, and is a device which is appropriate for a facility such as a chemical plant or a treatment device where a liquid mixture needs to be continuously treated.

In particular, even in the case of a liquid mixture in which a difference in the mixture ratio between respective liquids is comparatively small, the liquid mixture may
20 be efficiently separated into respective liquids.

[0013]

Furthermore, the liquid mixture in which liquids with different specific gravities are mixed with each other while forming an interface therebetween indicates, for example, a liquid mixture which is formed by mixing oil and water or oil and alcohol.
25 Specifically, a liquid with a low mixture ratio is dispersed in the form of liquid droplets

in a liquid with a high mixture ratio contained in the liquid mixture. Then, the liquid mixture which is separated into respective liquids by the sedimentation type liquid-liquid separator of the embodiment may be a liquid mixture in which liquids with different specific gravities are mixed with each other while forming an interface therebetween, although the type of liquid which is mixed in the liquid mixture is not particularly limited.

[0014]

Hereinafter, a liquid with a low specific gravity in a liquid mixture is referred to as a low-specific-gravity liquid, and a liquid with a higher specific gravity than that of the low-specific-gravity liquid is referred to as a sedimentation liquid.

Further, in the liquid mixture which is separated by the sedimentation type liquid-liquid separator of the embodiment, the mixture ratio between the low-specific-gravity liquid and the sedimentation liquid is not particularly limited, but hereinafter, a case will be representatively described in which the sedimentation liquid is mixed in the low-specific-gravity liquid. That is, a case will be representatively described in which the liquid mixture formed by dispersing the sedimentation liquid in the low-specific-gravity liquid in the form of liquid droplets is separated into the low-specific-gravity liquid and the sedimentation liquid.

[0015]

(Description of entire structure of sedimentation type liquid-liquid separator 1 of embodiment)

In FIG. 1, the reference sign 10 indicates a sedimentation type liquid-liquid separator 1 of the embodiment (hereinafter, simply referred to as a separator 1) of a main body portion. A main body portion 10 is a hollow container that includes a hollow cylindrical body portion 11 and barrelheads 12 and 13 provided at both ends of the body

portion 11 in the axial direction. For example, in a case where the separator 1 of the embodiment is used in a chemical plant, the main body portion 10 in which the inner diameter of the body portion 11 is about several m and the axial length is several times the inner diameter of the body portion 11 is used, but the main body portion 10 is not particularly limited to the above-described size, and may be freely determined depending on the amount, the property, or the like of a liquid to be treated.

[0016]

The left end (the front end) of the body portion 11 is equipped with an inflow path 14 which is used to supply a liquid mixture into the main body portion 10. The inflow path 14 is a tubular member which is disposed at the side surface of the body portion 11. With regard to the inflow path 14, the upper end thereof protrudes to the outside of the main body portion 10 and the lower end thereof is disposed inside the main body portion 10.

Furthermore, the lower end of the inflow path 14 is disposed so as to be positioned at a height of the interface (the free interface FS) between the sedimentation liquid accumulated in the lower portion of the main body portion 10 and the liquid mixture. Then, a supply port 14a which supplies the liquid mixture into the body portion 11 of the main body portion 10 is provided at the side surface of the inflow path 14 near the front-end barrelhead 12 (the front-end barrelhead 12), the reason for which will be described later.

[0017]

As shown in FIG. 1, the right end side (the rear end side) of the inflow path 14 is provided with two rectification members 21 and 22 and a sedimentation member 23 which are arranged in this order. The two rectification members 21 and 22 and the sedimentation member 23 are provided so as to separate the liquid mixture into the

low-specific-gravity liquid and the sedimentation liquid, the details of which will be described later.

[0018]

In the vicinity of the rear end of the main body portion 10, a separation plate 10d
5 which divides the inside of the body portion 11 of the main body portion 10 is provided
between the sedimentation member 23 and the barrelhead 13 (the rear-end barrelhead 12).
Specifically, the separation plate 10d is installed so as to divide the inside of the body
portion 11 into a liquid separation space and a low-specific-gravity liquid discharge space.
Furthermore, the liquid separation space is a space where the sedimentation member 23
10 is accommodated.

The separation plate 10d is formed so that a communication path 10f is formed
between the upper end thereof and the inner surface of the body portion 11 for the
purpose of communication between both spaces. For this reason, the liquid positioned
at the upper portion of the liquid separation space, that is, the low-specific-gravity liquid
15 may be made to flow into the low-specific-gravity liquid discharge space through the
communication path 10f.

[0019]

Then, the rear end of the main body portion 10 is equipped with discharge paths
11a and 11b which discharge a liquid from the inside of the main body portion 10 to the
20 outside thereof.

[0020]

In the vicinity of the rear end of the body portion 11, a sedimentation liquid
discharge path 11a is installed at the lower portion of the liquid separation space near the
separation plate 10d. The sedimentation liquid discharge path 11a is a path which is
25 used to discharge the sedimentation liquid separated from the low-specific-gravity liquid

to the outside. The sedimentation liquid discharge path 11a is equipped with a mechanism (for example, a valve or the like) capable of interrupting the communication between the inside and the outside of the main body portion 10, and is configured to discharge the sedimentation liquid from the sedimentation liquid discharge path 11a at a
5 predetermined period. Specifically, the discharge amount of the sedimentation liquid is adjusted so that the amount of the sedimentation liquid accumulated in the lower portion of the body portion 11 becomes a predetermined amount (that is, a predetermined depth).

[0021]

On the other hand, in the rear end of the body portion 11, a low-specific-gravity
10 liquid discharge path 11b is installed at the lower portion of the low-specific-gravity liquid discharge space near the separation plate 10d. The low-specific-gravity liquid discharge path 11b is a path which is used to discharge the low-specific-gravity liquid, flowing into the low-specific-gravity liquid discharge space through the communication path 10f after the sedimentation liquid is separated, to the outside therethrough. The
15 low-specific-gravity liquid discharge path 11b is equipped with a mechanism (for example, a valve or the like) capable of interrupting communication between the inside and the outside of the main body portion 10, and adjusts the flow rate of the low-specific-gravity liquid discharged from the low-specific-gravity liquid discharge path 11b. Specifically, the liquid level of the low-specific-gravity liquid is adjusted to be
20 constant.

[0022]

With the above-described configuration, when the liquid mixture is supplied from the inflow path 14 installed at the front end of the main body portion 10, the liquid mixture may be supplied into the body portion 11 of the main body portion 10.

25 Since the rear end of the main body portion 10 is equipped with the discharge

paths 11a and 11b, the liquid mixture flows inside the body portion 11 from the inflow path 14 toward the discharge paths 11a and 11b (that is, from the front end of the main body portion 10 toward the rear end thereof).

Then, in the inside of the body portion 11, two rectification member 21 and 22
5 and the sedimentation member 23 are installed between the inflow path 14 and the discharge paths 11a and 11b. Accordingly, the sedimentation liquid is separated from the low-specific-gravity liquid during a time when the liquid mixture flows from the inflow path 14 to the discharge paths 11a and 11b.

Then, since the sedimentation liquid is accumulated in the lower portion of the
10 liquid separation space, only the low-specific-gravity liquid positioned at the upper portion of the liquid separation space flows from the communication path 10f into the low-specific-gravity liquid discharge space. For this reason, the respective liquids which are separated inside the liquid separation space may be respectively discharged from the discharge paths 11a and 11b without being mixed with each other again.

15 That is, in the separator 1 of the embodiment, when the liquid mixture is supplied from the inflow path 14 into the body portion 11, the liquid mixture may be separated into the low-specific-gravity liquid and the sedimentation liquid, and the respective separated liquids may be collected.

[0023]

20 Furthermore, it is needless to mention that the low-specific-gravity liquid which is discharged from the low-specific-gravity liquid discharge path 11b does not mean only the state where almost no sedimentation liquid is contained, but the state where the ratio of the sedimentation liquid decreases compared to the liquid mixture supplied from the inflow path 14. In the same way, it is needless to mention that the sedimentation liquid
25 which is discharged from the sedimentation liquid discharge path 11a does not mean only

a state where almost no low-specific-gravity liquid is contained, but also a state where the low-specific-gravity liquid is somewhat contained.

[0024]

Further, a gas discharge portion 11e is installed above the front end of the body portion 11. The gas discharge portion 11e is equipped with a mechanism (for example, a valve or the like) capable of interrupting communication between the inside and the outside of the main body portion 10, and is configured to appropriately discharge a gas accumulated inside the main body portion 10.

[0025]

(Detailed description of respective constituents)

Next, the respective constituents of the sedimentation type liquid-liquid separator of the embodiment 1 will be described in detail.

[0026]

(Description of inflow path 14)

Further, as shown in FIG. 1, the inflow path 14 is a tubular member which is disposed at the side surface of the body portion 11, and is disposed at the side of the front-end barrelhead 12 in relation to the two rectification members 21 and 22 in the front end of the body portion 11.

The front end of the inflow path 14 is closed, and the side surface of the front end thereof is provided with the supply port 14a. That is, the liquid mixture which is supplied from the base end of the inflow path 14 is supplied from the supply port 14a provided in the side surface of the front end into the body portion 11.

Furthermore, the supply port 14a is provided at the side surface near the front-end barrelhead 12, and the flowing direction of the liquid mixture supplied from the supply port 14a into the liquid path 10h is substantially parallel to the axial direction of

the body portion 11.

[0027]

Since the inflow path 14 has the above-described structure, the liquid mixture which is supplied from the supply port 14a of the inflow path 14 in the direction opposite to the direction where the liquid mixture flows inside the body portion 11 (in FIG. 1, the direction from the left to the right, and hereinafter, referred to as a main direction), and collides with the inner surface of the front-end barrelhead 12. Then, since the liquid mixture which collides with the inner surface of the front-end barrelhead 12 first stays in the vicinity of the inner surface of the front-end barrelhead 12 and flows toward the main direction, the liquid mixture becomes a low-speed flow compared to the state where the liquid mixture is supplied from the supply port 14a of the inflow path 14 and flows inside the body portion 11 toward the rectification members 21 and 22.

Furthermore, since the front-end barrelhead 12 with which the liquid mixture collides is formed so that the inner surface has a substantially spherical shape, a flow of a liquid mixture is formed along the inner surface of the front-end barrelhead 12 in a manner such that the liquid mixture is made to collide with the inner surface of the front-end barrelhead 12. That is, the liquid mixture becomes a substantially radial flow which is formed along the inner surface of the front-end barrelhead 12 and has a small difference in speed at respective positions, and then the liquid mixture flows toward the main direction. Then, the flow of the liquid mixture becomes a flow which has a small difference in flow speed at respective positions within the cross-section of the body portion 11 until it reaches the rectification members 21 and 22.

That is, the flow speed of the liquid mixture may be made to have a small difference in flow speed at respective positions within the cross-section of the body portion until the liquid mixture reaches the rectification members 21 and 22.

[0028]

Furthermore, the position where the supply port 14a is formed in the side surface of the inflow path 14 is not particularly limited, but it is desirable that the supply port 14a be formed at the height of the free surface FS of the sedimentation liquid accumulated in the body portion 11. When the supply port 14a of the inflow path 14 is disposed at such a position, it is possible to prevent the sedimentation liquid accumulated in the body portion 11 from being stirred by the supplied liquid mixture when the liquid mixture is supplied from the supply port 14a of the inflow path 14 into the body portion 11.

Then, since the sedimentation liquid accumulated in the body portion 11 may be prevented from being changed into liquid droplets and mixed with the low-specific-gravity liquid again (dispersed into the low-specific-gravity liquid again), the degradation of the liquid separating efficiency of the device may be suppressed when the sedimentation liquid accumulated in the body portion 11 and the low-specific-gravity liquid are mixed with each other again.

[0029]

Furthermore, even when the supply port 14a is formed at the height of the free surface FS, a part of the liquid mixture which is supplied from the supply port 14a into the body portion 11 collides with the inner surface of the front-end barrelhead 12, so that a phenomenon occurs in which the liquid mixture flows into the sedimentation liquid accumulated in the body portion 11. However, since the amount of the fluid mixture which flows into the sedimentation liquid accumulated in the body portion 11 is small and the speed is small, the sedimentation liquid is hardly mixed with the flowing liquid mixture.

Further, since the sedimentation liquid is accumulated in the bottom portion of the body portion 11, most of the liquid mixture flows inside a space above the free

interface FS of the sedimentation liquid. Accordingly, hereinafter, the “space above the free interface FS of the sedimentation liquid inside the body portion 11” is referred to as a “liquid path 10h”, and the “cross-section of the space above the free interface FS of the sedimentation liquid inside the body portion 11” is referred to as a “cross-section of the liquid path 10h”.
5

[0030]

(Description of two rectification members 21 and 22)

In the separator 1 of the embodiment, in order to improve the separation effect, the two rectification members 21 and 22 and the sedimentation member 23 are provided inside the body portion 11 of the main body portion 10.
10

[0031]

As shown in FIG. 1, the two rectification members 21 and 22 which divide the inside of the body portion 11 of the main body portion 10 are provided between the inflow path 14 and the sedimentation member 23. Specifically, the two rectification members 21 and 22 are installed so as to divide the front end of the body portion 11 into the liquid supply space and the liquid separation space. Furthermore, as described above, the liquid separation space is a space where the sedimentation member 23 is accommodated and the liquid supply space is a space where the inflow path 14 is accommodated.
15

20 [0032]

The two rectification members 21 and 22 are both a plate-like member, and have plural penetration holes which penetrate the front and rear surfaces thereof (FIGS. 2(A) and 2(B)).

[0033]

25 First, in the two rectification members 21 and 22, the rectification member 21

positioned near the inflow path 14 (hereinafter, referred to as the upstream rectification member 21) is a plate-like member with plural penetration holes. The upstream rectification member 21 is provided with plural penetration holes 21a and 21b which have different hole diameters. For example, as shown in FIG. 2(A), in the upstream rectification member 21, a region provided with the penetration hole 21a having a large hole diameter (the upper region 21A) is provided at the upper portion, and a region provided with the penetration hole 21b having a small hole diameter (the lower region 21B) is provided at the lower portion. Then, the upper region 21A is formed so that the area thereof becomes smaller than that of the lower region 21B.

10 [0034]

Further, the rectification member 22 (hereinafter, referred to as the downstream rectification member 22) is also a plate-like member provided with plural penetration holes. The downstream rectification member 22 is formed so that the penetration holes 22h having the same hole diameter are provided, different to the upstream rectification member 21. The hole diameter of the penetration hole 22h is not particularly limited, but it is desirable that the hole diameter be approximately equal to the penetration hole 21a of the upstream rectification member 21 in order to effectively exhibit the rectification effect.

[0035]

20 When the two rectification members 21 and 22 with the above-described structure are provided, the following effect may be obtained.

[0036]

First, in the liquid mixture which flows toward the upstream rectification member 21, since the specific gravity of the sedimentation liquid is larger than the specific gravity of the low-specific-gravity liquid, the flow of the sedimentation liquid

25

which is directed toward the lower portion of the upstream rectification member 21 is generated. For this reason, in the flow of the liquid mixture which is directed toward the upstream rectification member 21, the flow speed of the lower portion may easily become faster than that of the upper portion.

5 [0037]

On the other hand, in the upstream rectification member 21, the penetration hole 21b formed in the lower region 21B is smaller than the penetration hole 21a formed in the upper region 21A. Accordingly, the liquid mixture may not easily pass through the lower portion of the upstream rectification member 21 (the portion of the lower region
10 21B) compared to the upper portion (the portion of the upper region 21A). That is, the resistance acting on the passage of the liquid mixture becomes larger at the lower portion of the upstream rectification member 21 compared to the upper portion thereof.

[0038]

Then, at the time when the liquid mixture passes through the upstream
15 rectification member 21, since the flow of the liquid mixture passing through the lower region 21B is suppressed more than the flow of the liquid mixture passing through the upper region 21A, it is possible to decrease a difference in flow speed of the liquid mixture between the upper and lower portions at the position where the liquid mixture passes through the upstream rectification member 21. That is, it is possible to decrease
20 a difference in flow speed of the fluid mixture at respective positions within the cross-section of the liquid path 10h and make the flow rate of the liquid mixture uniform within the cross-section of the liquid path 10h.

[0039]

Then, since the liquid mixture which passes through the upstream rectification
25 member 21 passes through the downstream rectification member 22 provided with the

uniform penetration holes 22h, it is possible to further decrease a difference in flow speed of the liquid mixture at respective positions within the cross-section of the liquid path 10h.

Then, since it is possible to prevent a circulating flow from occurring at the position where the liquid mixture passes through the downstream rectification member 22 due to a difference in flow speed of the liquid mixture, it is possible to prevent a difference in distance which is necessary for separating the low-specific-gravity liquid and the sedimentation liquid formed when the circulating flow is generated (a distance necessary for settling the sedimentation liquid).

10 [0040]

Further, if the flow of the liquid mixture passing through the lower region 21B is more suppressed than the flow of the liquid mixture passing through the upper region 21A when the liquid mixture passes through the upstream rectification member 21, a part of the liquid mixture which flows toward the lower region 21B may flow toward the upper region 21A. That is, a comparatively large amount of sedimentation liquid may pass through the upper region 21A of the upper region 21 of the upstream rectification member 21 compared to the case where the upstream rectification member 21 is provided with the penetration holes having the same hole diameter. Then, the mixing of the low-specific-gravity liquid and the sedimentation liquid contained in the liquid mixture between the rectification members 21 and 22 is performed depending on how much the sedimentation liquid passing through the upper region 21A settles between the upstream rectification member 21 and the downstream rectification member 22, and a difference in the mixture ratio of both liquids in the liquid mixture within the cross-section of the liquid path 10h may be decreased.

25 [0041]

That is, since the two rectification members 21 and 22 are provided, it is possible to decrease a difference in the state (a flow rate, a mixture ratio, or the like) of the liquid mixture supplied to the sedimentation member 23 within the cross-section of the liquid path 10h.

5 [0042]

(Description of two rectification members 21 and 22 in a case of sedimentation liquid>low-specific-gravity liquid)

Furthermore, in the above-described example, a case has been described in which the amount of the low-specific-gravity liquid is larger than the amount of the sedimentation liquid in the liquid mixture. However, when the amount of the sedimentation liquid is larger than the amount of the low-specific-gravity liquid in the liquid mixture different to the above-described example, the rectification member is used as below.

[0043]

15 When the amount of the sedimentation liquid is larger than the amount of the low-specific-gravity liquid in the liquid mixture, the upstream rectification member 21 shown in FIG. 2(A) and rotated by 180° is used as the upstream rectification member. That is, the member, in which the hole diameter of the penetration hole formed in the lower portion is larger than that the penetration hole formed in the upper portion and the area of the portion (the lower region) provided with the penetration hole having a large hole diameter is narrower than that of the portion (the upper region) provided with the penetration hole having a small hole diameter, is used as the upstream rectification member.

25 Then, since the flow speed of the liquid mixture passing through the upper region may be suppressed, a difference in flow rate of the liquid mixture within the

cross-section of the liquid path 10h (that is, a difference in flow rate of the liquid mixture within the cross-section of the liquid path 10h) at a position where the liquid mixture passes through the upstream rectification member may be decreased.

Furthermore, since the ratio of the low-specific-gravity liquid which passes
5 through the lower portion of the upstream rectification member may be increased compared to the case where the upstream rectification member is provided with the penetration holes having the same diameter, the mixture of the low-specific-gravity liquid and the sedimentation liquid in the liquid mixture between both rectification members is performed in a manner such that the low-specific-gravity liquid rises to a certain extent
10 between the upstream rectification member and the downstream rectification member, and a difference in the mixture ratio between both liquids in the liquid mixture within the cross-section of the liquid path 10h may be decreased.

Accordingly, even when the amount of sedimentation liquid is larger than the amount of the low-specific-gravity liquid, a difference in the state (a flow rate, a mixture
15 ratio, or the like) of the liquid mixture which passed through the downstream rectification member within the cross-section of the liquid path 10h may be decreased.

[0044]

(Description of sedimentation member 23)

Further, as shown in FIG. 1, the sedimentation member 23 is provided between
20 the downstream rectification member 22 and the separation plate 10d. The sedimentation member 23 is provided with plural penetration holes 23h which are formed along the direction of the body portion 11 of the main body portion 10. The plural penetration holes 23h are arranged so that the center axes are horizontal and the center axes are parallel to each other.

25 Further, each of the plural penetration holes 23h has a substantially square

cross-sectional shape, and almost all penetration holes 23h are formed so as to have the same shape and the same cross-sectional area. Furthermore, as shown in FIG. 2(C), the penetration hole 23h which is formed at a position where the sedimentation member 23 contacts the inner surface of the body portion 11 is formed so as to match the shape of the inner surface of the body portion 11.

[0045]

Since the sedimentation member 23 has the above-described configuration, the liquid mixture may be made to flow into the plural penetration holes 23h of the sedimentation member 23 in a region where the sedimentation member 23 is provided in the liquid path 10h.

The liquid mixture which flows into the penetration hole 23h is separated into the sedimentation liquid and the low-specific-gravity liquid when passing through the penetration hole 23h. Specifically, the sedimentation liquid settles inside the penetration hole 23h of the sedimentation member 23, and the settling sedimentation liquid contacts and adheres to the inner surface of the penetration hole 23h, so that it is separated from the liquid mixture (that is, the low-specific-gravity liquid). At this time, since the cross-sectional area of the penetration hole 23h is small (the vertical length is short), the settling distance until the sedimentation liquid contacts the inner surface of the penetration hole 23h becomes shortened, and the time until the sedimentation liquid contacts the inner surface of the penetration hole 23h also becomes shortened.

Accordingly, when the above-described sedimentation member 23 is provided, the sedimentation liquid and the low-specific-gravity liquid may be rapidly and efficiently separated from each other.

[0046]

Then, the sedimentation liquid which adheres to the inner surface of the plural

penetration holes 23h flows toward to the rear end of the sedimentation member 23 while being pressed by the liquid mixture flowing into the penetration hole 23h, and is discharged from the rear end of the sedimentation member 23. Then, the sedimentation liquid which is separated from the liquid mixture inside the penetration hole 23h of the sedimentation member 23 is discharged from the rear end of the sedimentation member 23, so that the sedimentation liquid settles to the lower portion of the liquid path 10h.

On the other hand, the liquid mixture from which the sedimentation liquid is separated flows out of the plural penetration holes 23h and flows upward in a pressed state in the direction opposite to that of the sedimentation liquid, so that the liquid mixture flows into the low-specific-gravity liquid discharge space through the communication path 10f.

Accordingly, the sedimentation liquid which is discharged from the rear end of the sedimentation member 23 and settles toward the bottom portion of the liquid path 10h may be prevented from being mixed with the liquid mixture having a large content of low-specific-gravity liquid again.

[0047]

Further, since the plural penetration holes 23h are formed so as to have the same cross-sectional shape and the same cross-sectional area, it is possible to decrease a difference in flow resistance between the penetration holes 23h when the liquid mixture flows therethrough. Then, the liquid mixture may be made to almost uniformly flow into the plural penetration holes 23h of the sedimentation member 23. That is, since the flow rates of the liquid mixtures passing through the respective penetration holes 23h of the sedimentation member 23 may be made to be almost uniform, all the penetration holes 23h may be effectively used for the liquid separation, and the liquid separating efficiency of the device may be improved.

In particular, since the two rectification members 21 and 22 are provided, when the state of the liquid mixture supplied to the sedimentation member 23 is almost uniform within the cross-section of the liquid path 10h, the liquid separating efficiency of each penetration hole 23h may be made to be almost uniform in any penetration hole 23h, thereby further improving the liquid separating efficiency of the device.

[0048]

Furthermore, since the sedimentation member 23 is disposed so that the center axes of the plural penetration holes 23h are horizontal, the resistance in which the sedimentation liquid inside the penetration hole 23h is made to flow while being pressed by the liquid mixture decreases. Accordingly, the sedimentation liquid may be efficiently discharged from the inside of the plural penetration holes 23h, and both liquids separated once may be prevented from being mixed again.

[0049]

Furthermore, with regard to the sedimentation member 23, the center axes of the plural penetration holes 23h may not be horizontal, and may not be inclined upward from the upstream side toward the downstream side when the sedimentation liquid is mixed in the low-specific-gravity liquid. For example, when the surface is inclined downward from the upstream side to the downstream side, the resistance in which the sedimentation liquid present on the inner surface of the penetration hole is made to flow by the liquid mixture may further decrease, thereby efficiently discharging the sedimentation liquid from the inside of the penetration hole 23h. Then, the liquid separating efficiency inside the penetration hole 23h of the sedimentation member 23 may be improved, and both liquids separated once may be prevented from being mixed with each other.

[0050]

(Method of forming sedimentation member 23)

The above-described sedimentation member 23 may be formed by any method, and the method is not particularly limited. For example, the sedimentation member 23 may be easily formed by arranging plural tubular members. In a case of forming the sedimentation member by arranging the plural tubular members, the tubular members
5 having the same diameter are used. Accordingly, the sedimentation member 23 with the penetration holes 23h all having the same cross-sectional shape and the same cross-sectional area may be simply and reliably formed.

[0051]

(Cross-sectional shape of penetration hole)

10 Furthermore, the cross-sectional shape of the penetration hole 23h formed in the sedimentation member 23 is not limited to the above-described rectangular shape, and may be a circular shape, a triangular shape, or the like. That is, the cross-sectional shape is not particularly limited.

For example, in a case of a liquid mixture in which water (a sedimentation
15 liquid) with high purity is mixed in a low-specific-gravity liquid such as oil, even when the water contacts the side surface of the penetration hole 23h, the water may be separated from the liquid mixture. In a case of treating such a liquid mixture, when the cross-section of the penetration hole 23h is formed in a rectangular shape which is elongated in the vertical direction so that the cross-sectional area increases, the water
20 may adhere to the cross-sectional area thereof so as to be separated from the low-specific-gravity liquid, thereby separating the water from the low-specific-gravity liquid with higher efficiency.

[0052]

(Process of separating liquid mixture using separator 1)

25 Next, the process of separating the liquid mixture using the separator 1 of the

embodiment will be described.

First, a liquid mixture to be treated is supplied from the inflow path 14 into the body portion 11 of the main body portion 10. Then, the liquid mixture flows in the direction opposite to the main direction and collides with the inner surface of the front-end barrelhead 12. Then, the liquid mixture becomes a substantially radial flow along the inner surface of the front-end barrelhead 12 and flows toward the main direction. That is, the liquid mixture first flows toward the front-end barrelhead 12, and is reversed so as to flow from the front-end barrelhead 12 toward the rectification members 21 and 22. Then, during a time when the liquid mixture flows from the front-end barrelhead 12 to the upstream rectification member 21, the liquid mixture becomes a flow which has a substantially uniform flow speed within the cross-section of the liquid path 10h.

[0053]

When the liquid mixture reaches the upstream rectification member 21, the liquid mixture passes through the penetration hole of the upstream rectification member 21. Since the liquid mixture is formed by dispersing the sedimentation liquid in the low-specific-gravity fluid, the flow speed of the liquid mixture which flows to the lower region 21B of the upstream rectification member 21 becomes faster.

On the other hand, since the penetration hole 21a formed in the upper region 21A is larger than the penetration hole 21b formed in the lower region 21B, the resistance acting on the passage of the liquid mixture becomes larger at the lower portion of the upstream rectification member 21 than the upper portion thereof.

Accordingly, since the flow speed of the liquid mixture passing through the lower region 21B may be suppressed, a difference in flow speed within the cross-section of the liquid path 10h becomes smaller in the fluid mixture which has passed through the

upstream rectification member 21.

[0054]

Furthermore, since the flow speed of the liquid mixture passing through the lower region 21B is suppressed, a comparatively large amount of sedimentation liquid which may easily pass through the lower region 21B of the upstream rectification member 21 may pass through the upper region 21A. Then, since the sedimentation liquid which has passed through the upper region 21A settles to a certain extent during a time when the liquid mixture which has passed through the upstream rectification member 21 flows to the downstream rectification member 22, the mixture of the low-specific-gravity liquid and the sedimentation liquid in the liquid mixture between the upstream rectification member 21 and the downstream rectification member 22 is promoted, and a difference in mixture ratio of the liquid mixture within the cross-section of the liquid path 10h may be decreased.

[0055]

Then, since the fluid mixture which has passed through the upstream rectification member 21 passes through the downstream rectification member 22 provided with the uniform penetration holes 22h, the flow speed within the cross-section of the liquid path 10h becomes further uniform.

[0056]

The liquid mixture which has passed through the downstream rectification member 22, that is, the fluid mixture of which a difference in flow speed and a difference in the mixture ratio within the cross-section of the liquid path 10h decrease, passes through an area provided with the sedimentation member 23. At this time, since the sedimentation liquid contained in the liquid mixture settles and contacts the inner bottom surface of the penetration hole 23h so as to adhere thereto during a time when the liquid

mixture flows inside the penetration hole 23h of the sedimentation member 23 from the front end toward the rear end, the sedimentation liquid is separated from the liquid mixture. That is, the sedimentation liquid and the low-specific-gravity liquid are separated from each other in the penetration hole 23h.

5 [0057]

The separation of the sedimentation liquid and the low-specific-gravity liquid is performed while the liquid mixture passes through the penetration hole 23h, and the ratio of the sedimentation liquid dispersed in the low-specific-gravity liquid gradually decreases as the liquid mixture flows toward the rear end of the penetration hole 23h.

10 Then, at the time when the liquid mixture is discharged from the rear end of the penetration hole 23h, the ratio of the sedimentation liquid dispersed in the low-specific-gravity liquid is low, and the liquid mixture is almost completely separated into the low-specific-gravity liquid and the sedimentation liquid.

[0058]

15 Then, when the low-specific-gravity liquid reaches the separation plate 10d, the low-specific-gravity liquid flows into the low-specific-gravity liquid discharge space through the communication path 10f, and is discharged from low-specific-gravity liquid discharge path 11b.

[0059]

20 On the other hand, the settling sedimentation liquid settles at the bottom portion of the liquid path 10h so as to be accumulated therein, and is discharged to the outside through the sedimentation liquid discharge path 11a. Then, if a predetermined amount or more of the sedimentation liquid is accumulated when the accumulated sedimentation liquid is discharged from the sedimentation liquid discharge path 11a, it is possible to
25 prevent the low-specific-gravity liquid from being mixed with the sedimentation liquid

again or prevent the low-specific-gravity liquid from flowing out of the sedimentation liquid discharge path 11a together with the sedimentation liquid.

[0060]

As described above, by using the separator 1 of the embodiment, it is possible to
5 separate and collect the low-specific-gravity liquid and the sedimentation liquid by effectively separating the low-specific-gravity liquid and the sedimentation liquid contained in the liquid mixture.

[0061]

(Another example of rectification member)

10 Furthermore, in the above-described example, a case has been described in which the two rectification members 21 and 22 are installed, but the downstream rectification member 22 may not be necessarily installed if the flow of the liquid mixture may be adjusted to an extent that the liquid separation of the sedimentation member 23 is sufficiently performed only by the upstream rectification member 21.

15 [0062]

(Another example of sedimentation member 23)

Furthermore, in the above-described example, a case has been described in which the sedimentation member 23 includes plural penetration holes 23h. However, the sedimentation member may have a structure in which the liquid mixture may be
20 separated into the low-specific-gravity liquid and the sedimentation liquid while the liquid mixture passes through the position of the sedimentation member, although the invention is not limited to the above-described structure. That is, a structure may be adopted in which the flow rate of the liquid mixture may be decreased somewhat and the sedimentation distance of the sedimentation liquid may be shortened when the liquid
25 mixture passes through the position of the sedimentation member.

For example, as the sedimentation member, a sedimentation member which is formed by arranging plural plate-like members with a gap therebetween in the vertical direction may be used.

[Example 1]

5 [0063]

Next, a numerical simulation of the flow of the liquid mixture inside the liquid path and the water volume ratio in the liquid mixture was performed when the liquid mixture in which two types or more liquids with different specific gravities were mixed with each other were separated by the sedimentation type liquid-liquid separator.

10 [0064]

The numerical simulation was performed on the sedimentation type liquid-liquid separator of the invention having the structure of FIG. 1 (Example) and the sedimentation type liquid-liquid separator having the structure of FIG. 3 (Comparative example).

[0065]

15 The calculation was performed according to ANSYS CFX. The calculation conditions are as below.

[0066]

(1) Liquid mixture

Liquid mixture: liquid mixture including oil (with density of 900 kg/m^3 and viscosity of 1.5 cP) and water (with density of 970 kg/m^3 and viscosity of 0.4 cP)

20 Flow rate of liquid mixture: $70 \text{ m}^3/\text{h}$

Flow rate ratio: water:oil=1:2

Particle diameter of water: $180 \text{ }\mu\text{m}$

[0067]

25 (2) Main body portion

Length of body portion (including barrelhead portion: 7600 mm

Length from inner surface of front-end barrelhead to separation plate: 6300 mm

Inner diameter: 1800 mm

Height of separation plate: 1550 mm

5 Diameter of inflow path: 300 mm

Furthermore, the side surface opening (only in Example) was formed by removing a portion with an axial length of 200 mm and a radial length of 100 mm (in the left-right direction of FIG. 1) in the side surface of the inflow path.

[0068]

10 (3) Rectification member

(i) Example

Upstream rectification member: upper region with opening rate of 30% and lower region with opening rate of 10%

Area ratio between upper region and lower region: upper region:lower

15 region=1:5

Downstream rectification member: opening rate of 30%

(ii) Comparative example

Rectification member: opening rate of 30%

20 Furthermore, in the calculation, as the rectification member, the calculation was performed by installing an object having a pressure loss corresponding to the opening rate instead of the porous plate shown in FIGS. 2 and 3.

[0069]

(4) Sedimentation member

(i) Example

25 Cross-sectional shape of penetration hole: 80 mm × 80 mm

Length: 3000 mm

(ii) Comparative example

Length: 3000 mm

Distance between sedimentation members: 400 mm

5 [0070]

The result of the numerical simulation is shown in FIGS. 4 and 5.

Furthermore, in FIGS. 4(B) and 5(B), the dark colored region indicates a region where the water volume ratio is large.

[0071]

10 As shown in FIG. 4(A), in Comparative example, since the size of penetration holes 121h of a rectification member 121 are all the same, it is found that the circulating flow directed from the vicinity of the inner surface of the body portion 111 toward the center of the body portion 111 is generated at the downstream side of the rectification member 121. Due to the influence of the circulating flow, there is a difference in flow
15 speed of the liquid which flows through the sedimentation member 123 between the portion positioned near the center of the body portion 111 and the periphery thereof.

[0072]

On the other hand, as shown in FIG. 5(A), in Example, the circulating flow is not generated at the downstream side of the downstream rectification member 22. Further,
20 since the water flows so as to settle downward, the flow speed of the lower portion becomes faster than that of the other portions at the downstream side of the downstream rectification member 22, but the flow speed is almost the same and slow at the portion other than the lower portion. Then, even when the liquid mixture passes through the sedimentation member 23, a difference in flow speed of the fluid mixture passing
25 through the penetration holes 23h is small.

[0073]

As described above, in the separator of Example, it is found that the flow speed of the liquid mixture flowing inside the sedimentation member 23 may be almost uniform.

5 [0074]

Further, as shown in FIG. 4(B), in the separator of Comparative example, it is found that the water volume ratio smoothly changes from 0.25 to 0.05 and the water volume ratio gradually changes from the lower portion of the body portion 111 to the upper portion at the downstream side of the rectification member 121. That is, a
10 difference in water volume ratio at respective positions within the body portion 111 becomes larger at the downstream side of the rectification member 121.

[0075]

On the other hand, as shown in FIG. 5(B), in the separator of Example, the water volume ratio changes within a narrow range of 0.25 to 0.05 at the downstream side of the
15 downstream rectification member 22. That is, with regard to the water volume ratio inside the body portion 11 at the downstream side of the downstream rectification member 22, a difference in water volume ratio at respective positions within the cross-section of the body portion 11 becomes smaller than that of the case of the separator of Comparative example except for the vicinity of the portion where water is
20 accumulated.

[0076]

As described above, in the separator of Example, it is found that there is a small difference in the mixture ratio of the liquid mixture supplied to the sedimentation member 23 within the cross-section of the body portion 11.

25 [0077]

Then, when the water collection rates of the separator of Example and the separator of Comparative example are compared with each other, the water collection rate of the separator of Comparative example is about 0.86, and the water collection rate of the separator of Example is about 0.96. That is, it was proved that the water collection rate was largely improved, that is, oil and water were efficiently separated from each other by adopting the separator of Example.

INDUSTRIAL APPLICABILITY

[0078]

The sedimentation type liquid-liquid separator of the invention is appropriate for separating a liquid mixture in a chemical plant, a treatment device, or the like, and is particularly appropriate as a separator in a facility that continuously performs a separation process.

REFERENCE SIGNS LIST

[0079]

1: SEDIMENTATION TYPE LIQUID-LIQUID SEPARATOR

10: MAIN BODY PORTION

10h: LIQUID PATH

11: BODY PORTION

11a: LOW-SPECIFIC-GRAVITY LIQUID DISCHARGE PATH

11b: SEDIMENTATION LIQUID DISCHARGE PATH

14: INFLOW PATH

21: UPSTREAM RECTIFICATION MEMBER

22: DOWNSTREAM RECTIFICATION MEMBER

23: SEDIMENTATION MEMBER

23h: PENETRATION HOLE

LF: COLLISION PORTION

CLAIMS

1. A sedimentation type liquid-liquid separator that separates a liquid mixture,
in which liquids with different specific gravities are mixed with each other while forming
5 an interface therebetween, into respective liquids, the sedimentation type liquid-liquid
separator comprising:

a main body portion that includes

a hollow cylindrical body portion including a liquid path formed
therein,

10 an inflow path installed at the front end of the body portion and
supplying the liquid mixture to the liquid path of the body portion, and

a discharge path installed at the rear end of the body portion and
discharging a separated liquid from the body portion;

a sedimentation member that settles a liquid with a high specific gravity
15 contained in the liquid mixture inside the main body portion; and

a rectification member that is installed between the sedimentation member and
the inflow path inside the main body portion,

wherein the main body portion is equipped with a reflection member that has a
reflection surface intersecting with the axial direction of the liquid path of the body
20 portion so that the rectification member is interposed between the sedimentation member
and the reflection member,

wherein the inflow path is disposed between the reflection member and the
rectification member, and

wherein a supply port which supplies the liquid mixture into the liquid path of
25 the body portion is formed so that the liquid mixture is supplied toward the reflection

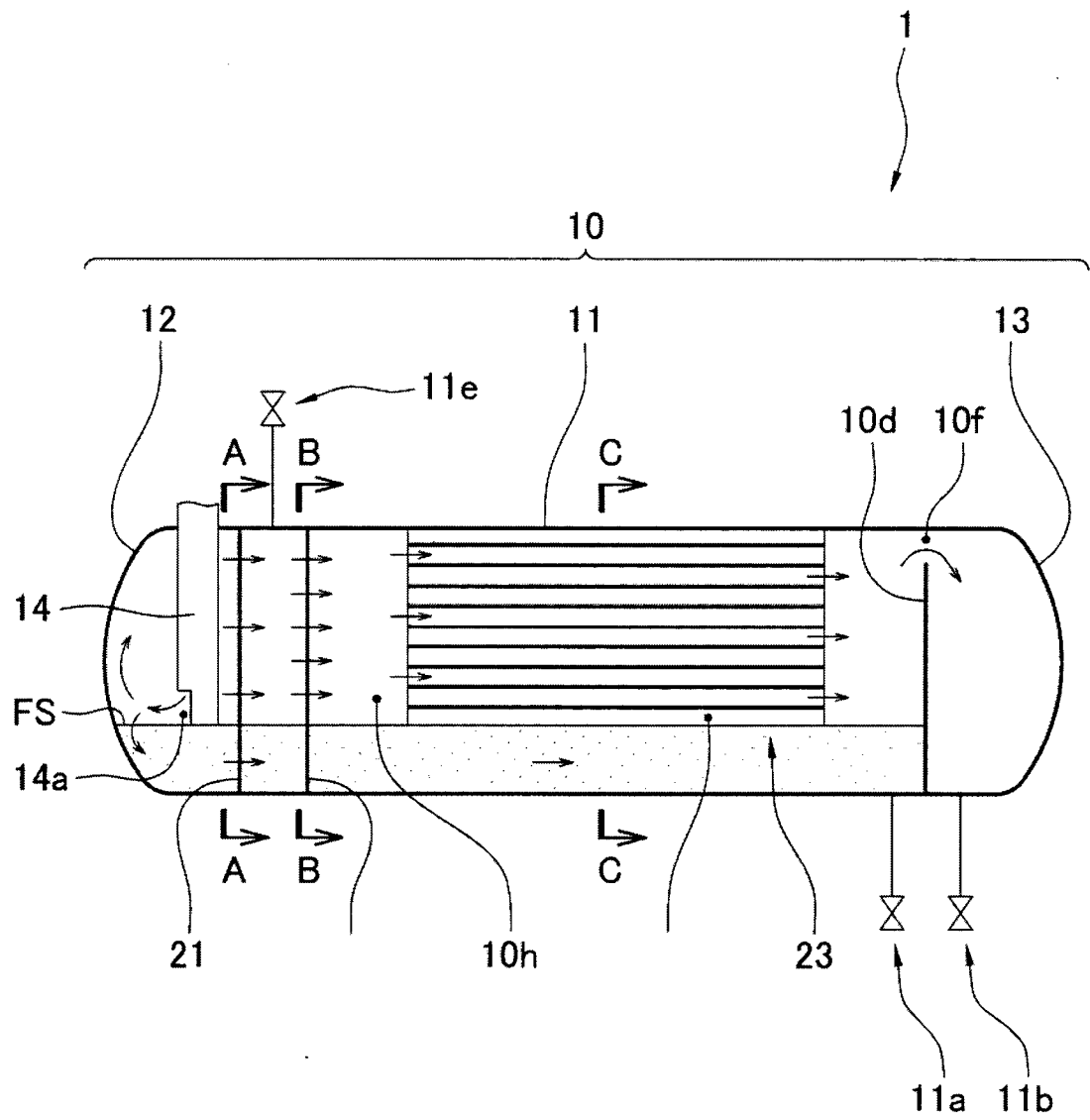
member.

2. The sedimentation type liquid-liquid separator according to Claim 1,
wherein the reflection member is a barrelhead that is installed at the axial end portion of
5 the body portion.

3. The sedimentation type liquid-liquid separator according to Claim 1 or 2,
wherein a supply port of the inflow path is disposed at a position where a free surface of
a liquid with a high specific gravity settling inside the liquid path is formed inside the
10 liquid path of the body portion.

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FIG. 1



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FIG. 2A

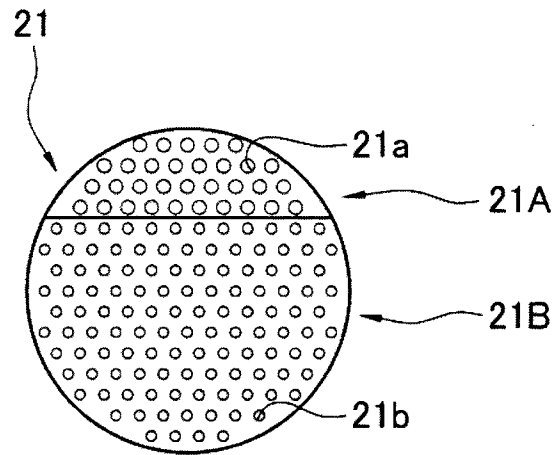


FIG. 2B

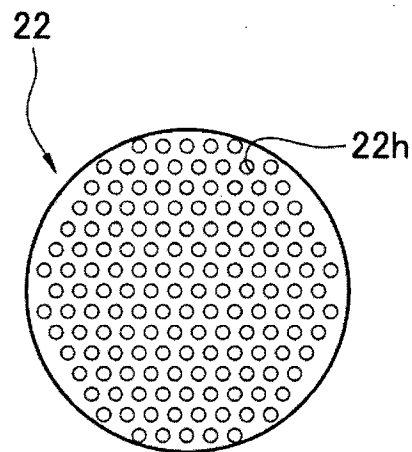


FIG. 2C

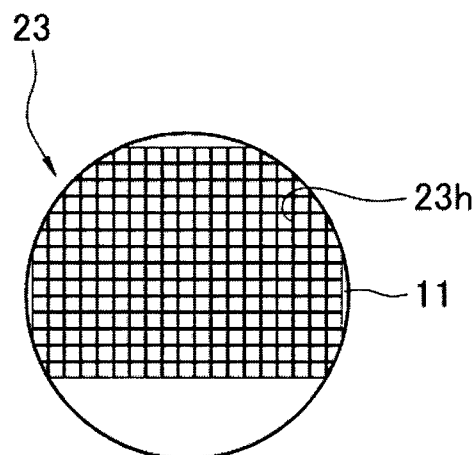


FIG. 3A

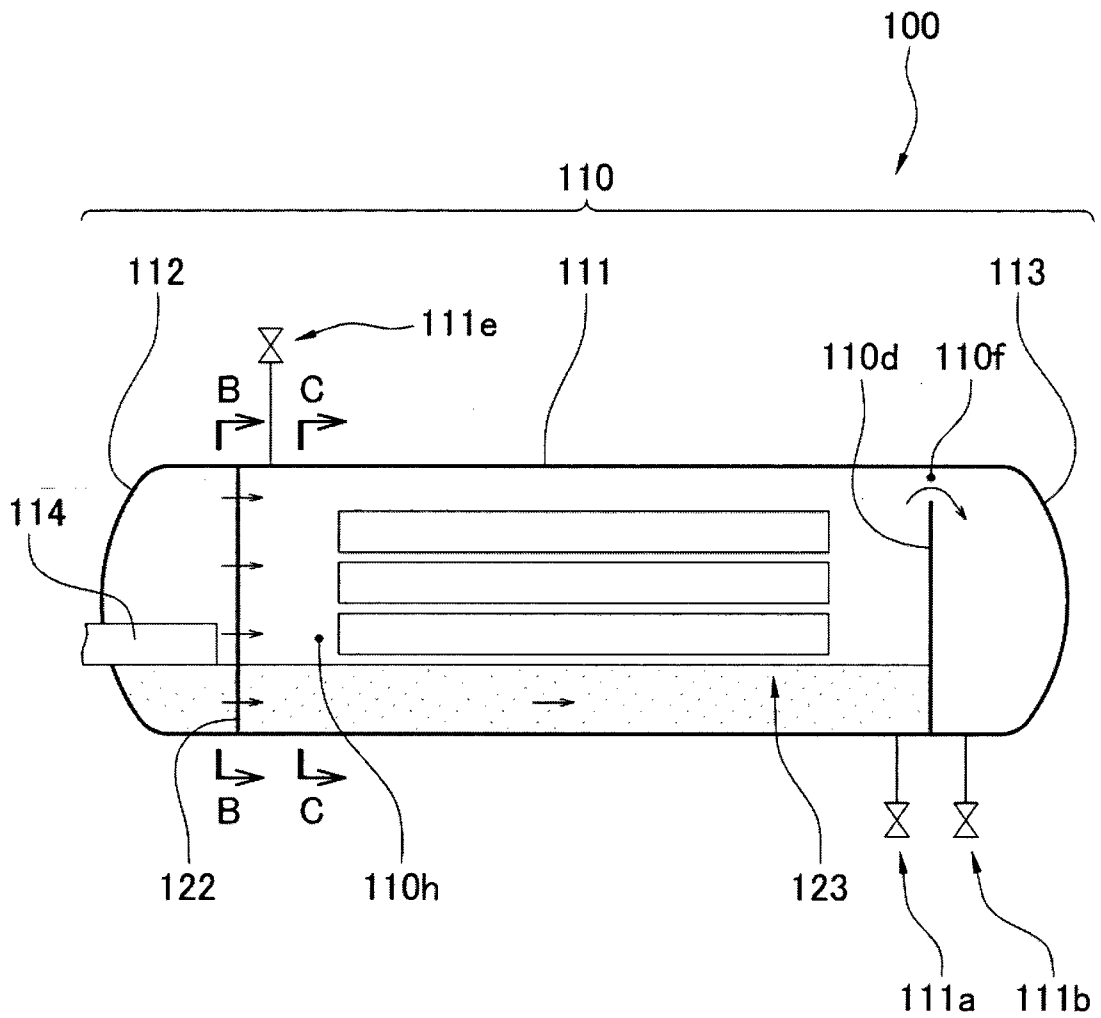


FIG. 3B

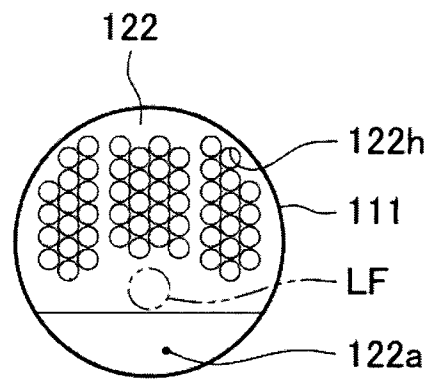
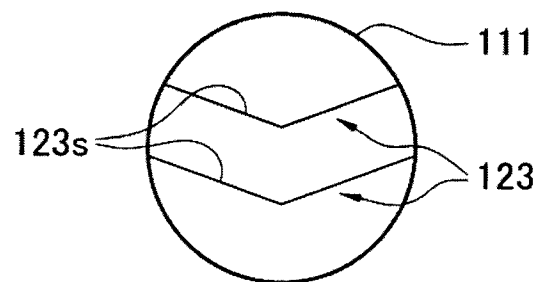


FIG. 3C



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FIG. 4A

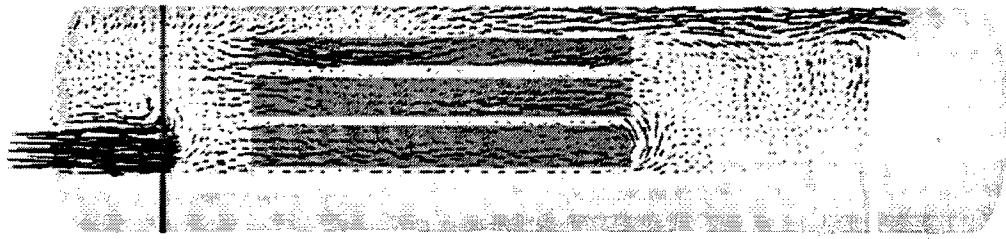


FIG. 4B

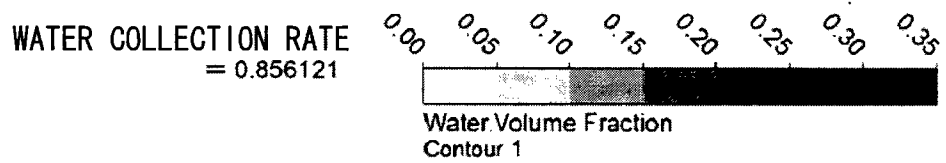
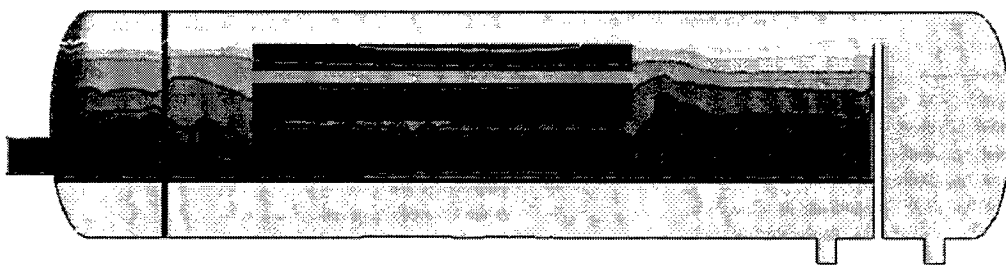


FIG. 5A

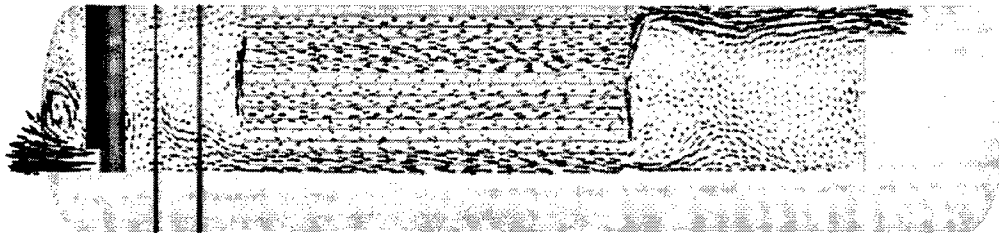
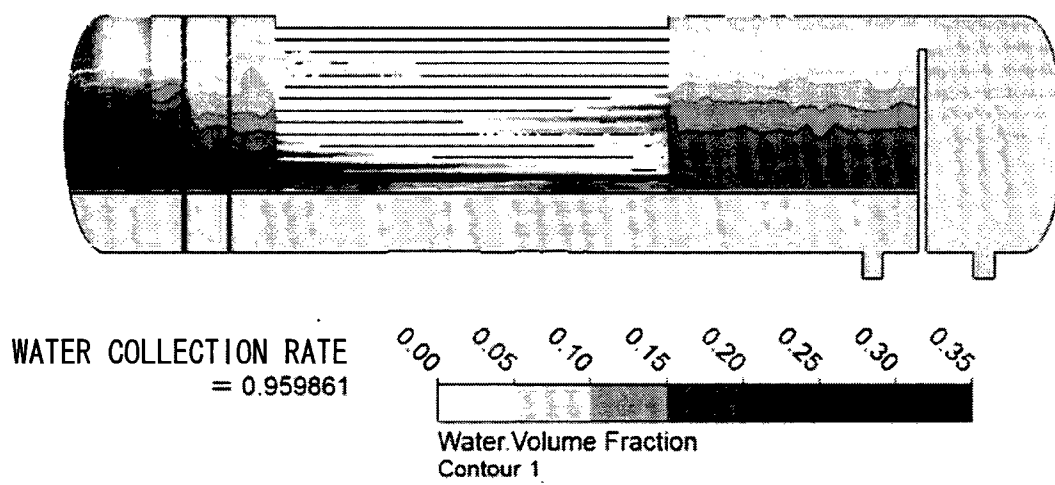


FIG. 5B



INTERNATIONAL SEARCH REPORT

International application No

PCT/JP2012/054689

A. CLASSIFICATION OF SUBJECT MATTER

INV. B01D17/02

ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	GB 1 234 610 A (MALCOLM HUVAL) 9 June 1971 (1971-06-09) page 2, line 17 - line 29 page 2, line 62 - line 76 -----	1-3
A	US 5 874 008 A (HIRS GENE [US]) 23 February 1999 (1999-02-23) abstract; figures column 1, line 41 - column 2, line 26 ----- -/-	1-3



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

8 June 2012

Date of mailing of the international search report

19/06/2012

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Lapeyrère, Jean

INTERNATIONAL SEARCH REPORT

International application No

PCT/JP2012/054689

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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