

DESCRIPTION

HOLDER, FILTRATION SYSTEM, AND FILTRATION TREATMENT

APPARATUS

Technical Field

[0001]

The present invention relates to a holder holding a plurality of filtration membrane units, a filtration system including the plurality of filtration membrane units and the holder, and a filtration treatment apparatus including a plurality of filtration systems.

Background Art

[0002]

Conventionally, there has been known a holder including a first holding unit that holds each of ends on one side in a longitudinal direction of a plurality of filtration membrane units and a second holding unit that holds each of ends on the other side in the longitudinal direction of the plurality of filtration membrane units.

[0003]

For example, a membrane separation apparatus as filtration treatment apparatus described in Patent Literature 1 includes a plurality of membrane modules. A membrane module as a filtration system includes a holder including two water collection cases and two cover members.

The structure of the holder is a frame-like structure including a peripheral wall, each of the two water collection cases constitutes a pair of walls facing each other on the peripheral wall, and the two cover members also constitute a pair of walls facing each other on the peripheral wall. In a frame having a frame-like configuration, a plurality of membrane elements is arranged as a filtration membrane unit. One of the two water collection cases of the holder functions as a first holding unit that holds each of ends on one side in the longitudinal direction of the plurality of membrane elements disposed in the frame of the frame-like structure. The other water collection case functions as a second holding unit that holds each of the ends on the other side in the longitudinal direction of the plurality of membrane elements. Each of the plurality of membrane elements held by the holder in this manner is aligned along the thickness direction of the membrane.

Citation List

Patent Literature

[0004]

Patent Literature 1: JP 2012-148230 A

Summary of Invention

Technical Problem

[0005]

The membrane separation apparatus described in Patent Literature 1 holds a plurality of membrane modules stacked in multiple stages by a metal frame. In such a configuration, when each membrane module is removed from the frame for maintenance and inspection, pillars of the frame interfere with the removal work, and thus there is a problem that maintenance and inspection take time and effort.

[0006]

The present invention has been made in view of the above background, and an object of the present invention is to provide a holder, a filtration system, and a filtration treatment apparatus capable of reducing effort for maintenance and inspection of a filtration system such as a membrane module.

Solution to Problem

[0007]

In order to achieve the above object, one aspect of the present invention is a holder in which a first holding unit that holds each of ends on one side in a longitudinal direction of a plurality of filtration membrane units and a second holding unit that holds each of ends on another side

in the longitudinal direction of the plurality of filtration membrane units hold the plurality of filtration membrane units in a mode in which the plurality of filtration membrane units is aligned in a thickness direction of each of the filtration membranes, and constitute a pair of facing walls in a frame-like structure including a peripheral wall, the holder including a pillar penetration portion that allows a pillar to penetrate in a vertical direction in each of different walls in the frame-shaped structure.

Advantageous Effects of Invention

[0008]

According to the present invention, there is an excellent effect that the effort for maintenance and inspection of the filtration system can be reduced.

Brief Description of Drawings

[0009]

Fig. 1 is a diagram illustrating a schematic configuration of a water treatment facility including a filtration system according to an embodiment.

Fig. 2 is a perspective view illustrating a filtration membrane unit according to the embodiment.

Fig. 3 is a cross-sectional view illustrating a

longitudinal cross section of a suction side socket of the filtration membrane unit.

Fig. 4 is a side view illustrating the filtration membrane unit from a side.

Fig. 5 is a perspective view illustrating a filtration system according to the embodiment.

Fig. 6 is a perspective view illustrating two water collection cassettes stacked on each other in the filtration system.

Fig. 7 is a perspective view illustrating a holder of the filtration system.

Fig. 8 is a perspective view illustrating the holder together with four divided pillars.

Fig. 9 is a perspective view illustrating both ends in an axial direction of a divided pillar.

It is a perspective view illustrating a water collection cassette of a holder according to an embodiment.

Fig. 10 is a perspective view illustrating a holder of the filtration system arranged at a lowermost stage.

Fig. 11 is an exploded perspective view illustrating a hanger of the filtration system.

Fig. 12 is an exploded perspective view illustrating the hanger together with a lower end of the divided pillar.

Fig. 13 is a perspective view illustrating corner bottom portions of a first side cover and a blind cassette

in the filtration system arranged at the lowermost stage.

Fig. 14 is a perspective view illustrating respective holders of two filtration systems stacked in two layers.

Fig. 15 is an exploded perspective view illustrating a coupler of the filtration system.

Fig. 16 is an exploded perspective view illustrating the coupler together with the divided pillar.

Description of Embodiments

[0010]

Hereinafter, an embodiment of a filtration treatment apparatus to which the present invention is applied will be described with reference to the drawings. In the embodiment, for easy understanding, structures and elements other than a main part of the present invention will be described in a simplified or omitted manner. In each drawing, the same elements are denoted by the same reference numerals. Note that the shapes, dimensions, and the like of elements illustrated in the drawings are schematically illustrated, and do not indicate actual shapes, dimensions, and the like.

[0011]

Fig. 1 is a diagram illustrating a schematic configuration of a water treatment facility including a filtration treatment apparatus according to the embodiment.

The water treatment facility includes a raw water tank 1, a filtration treatment water tank 2, a treated water tank 3, a control device 4, a raw water pump 5, a first water level sensor 6, a raw water transfer pipe 7, a treated water transfer pipe 8, a suction pump 9, a second water level sensor 11, a third water level sensor 12, and the like. The water treatment facility includes a blower 13, an air supply pipe 14, a frame 15, a filtration treatment apparatus 20, a bubble generation device 90, and the like.

[0012]

In the raw water tank 1, raw water (water before treatment) W_1 as a liquid is stored. The first water level sensor including an ultrasonic sensor or the like installed in the raw water tank 1 detects the water level (water surface height) of the raw water W_1 in the raw water tank 1, and transmits the detection result to the control device 4 as a water level signal. The raw water pump 5 installed in the raw water tank 1 sucks and discharges the raw water W_1 in the raw water tank 1, and sends the raw water W_1 to the filtration treatment water tank 2 through the raw water transfer pipe 7. As the raw water pump 5, one including a submersible pump has been exemplified, but one including a land pump may be used.

[0013]

The filtration treatment water tank 2 is a water tank

made of reinforced concrete. In the filtration treatment water tank 2, a filtration treatment apparatus 20 and a bubble generation device 90 are installed. The filtration treatment apparatus 20 and the bubble generation device 90 are supported by a frame 15. The frame 15 supports the bubble generation device 90 so as to be positioned immediately below the filtration treatment apparatus 20. Each of the filtration treatment apparatus 20 and the bubble generation device 90 is immersed in the raw water W_1 in the filtration treatment water tank 2.

[0014]

The blower 13 discharges air as gas sucked from a suction port to the air supply pipe 14 through the discharge port. The air discharged to the air supply pipe 14 is supplied to the bubble generation device 90. The bubble generation device 90 discharges the air supplied from the air supply pipe 14 upward as bubbles. The discharged air bubbles rise in the raw water W_1 while being in contact with a plurality of filtration membranes mounted on the filtration treatment apparatus 20. At this time, the air bubbles separate solids attached to surfaces of the filtration membranes from the surfaces of the filtration membranes. This separation suppresses clogging of the filtration membrane.

[0015]

The third water level sensor 12 installed in the filtration treatment water tank 2 detects the water level of the raw water W_1 in the filtration treatment water tank 2, and transmits the detection result as a water level signal to the control device 4.

[0016]

The suction pump 9 sucks the raw water W_1 in the filtration treatment water tank 2 via the treated water transfer pipe 8 and a plurality of filtration membranes to be described later mounted in the filtration treatment apparatus 20. The sucked raw water W_1 is filtered by a filtration membrane to become treated water W_2 , and then sent to the treated water tank 3 through the treated water transfer pipe 8. The second water level sensor 11 set in the treated water tank 3 detects the water level of the treated water W_2 in the treated water tank 3, and transmits the detection result as a water level signal to the control device 4.

[0017]

Note that, instead of the suction pump 9, a pump that generates a suction force using hydraulic head pressure may be used. Means for suction is not particularly limited.

[0018]

When the water level of the treated water tank 3 does not reach an upper limit and a predetermined operation

execution condition is satisfied, the control device 4 operates the suction pump 9 and the blower 13 to execute a filtration treatment of the raw water W_1 . However, even if the operation execution condition is satisfied, when the water level of the raw water W_1 in the raw water tank 1 is equal to or lower than a lower limit and when the water level of the raw water W_1 in the filtration treatment water tank 2 is equal to or lower than a lower limit, the control device 4 stops the execution of the filtration treatment.

[0019]

The filtration treatment apparatus 20 includes a plurality of filtration systems (described in detail later) according to the embodiment. Each filtration system includes a plurality of filtration membrane units (described in detail later) according to the embodiment.

[0020]

Fig. 2 is a perspective view illustrating a filtration membrane unit 21 according to the embodiment. The filtration membrane unit 21 includes a flat filtration membrane 22. Examples of the material of the filtration membrane 22 include organic materials such as polyvinylidene fluoride (PVDF) and polyvinyl chloride (PVC). As a material of the filtration membrane 22, ceramic containing alumina, silicon carbide, or the like as a main component may be used. The filtration membrane 22

of the filtration membrane unit 21 according to the embodiment is made of a ceramic membrane.

[0021]

When the above-described suction pump (9 in Fig. 1) is operated, a suction force along a longitudinal direction of the filtration membrane 22 is applied to the filtration membrane 22. In the filtration system according to the embodiment, a suction force is applied to the filtration membrane 22 from one side in the longitudinal direction of the filtration membrane 22 (right side in the left-right direction in Fig. 4 described later). That is, one side in the longitudinal direction of the filtration membrane 22 is a suction side to which a suction force is applied. The other side in the longitudinal direction of the filtration membrane 22 (left side in the left-right direction in Fig. 4 described later) is a shielding side that shields against the suction force applied to the filtration membrane 22.

[0022]

The filtration membrane unit 21 includes a suction side socket 23 and a shielding side socket 24 in addition to the filtration membrane 22 described above. The suction side socket 23 as a socket in the present invention is fixed to an end on one side in the longitudinal direction of the filtration membrane 22 in order to hold the filtration membrane 22 on one side (suction side) in the longitudinal

direction. The shielding side socket 24 is fixed to an end on the other side in the longitudinal direction of the filtration membrane 22 in order to hold the filtration membrane 22 on the other side (shielding side) in the longitudinal direction. Each of the suction side socket 23 and the shielding side socket 24 extends in a lateral direction of the filtration membrane 22 (vertical direction along a gravity direction in the embodiment) in a state of being fixed to the filtration membrane 22.

[0023]

Fig. 3 is a cross-sectional view illustrating a longitudinal cross section of the suction side socket 23. The suction side socket 23 includes a socket body 23a. The socket body 23a includes a recess 23d into which an end on one side in the longitudinal direction of the filtration membrane (22 in Fig. 2) is inserted, and a flow path 23e that communicates with the recess 23d and extends in an extending direction of the socket body 23a.

[0024]

The socket body 23a covers the entire circumference of a circumferential surface constituted by a front surface, a back surface, and two side surfaces at an end on one side in the longitudinal direction of the filtration membrane (22 in Fig. 2) by the inner peripheral surface of the recess 23d. Since the inner peripheral surface of the

recess 23d covers the entire peripheral surface at the end on one side in the longitudinal direction of filtration membrane (22), rattling of the end in the recess 23d is prevented.

[0025]

The suction side socket 23 includes a first protrusion 23b and a second protrusion 23c in addition to the socket body 23a described above. The first protrusion 23b and the second protrusion 23c are positioned outside (right side in Fig. 3) the socket body 23a in the longitudinal direction (left and right direction in Fig. 3) of filtration membrane (22 in Fig. 2), and are arranged along the extending direction of the socket body 23a (vertical direction in Fig. 3).

[0026]

Each of the first protrusion 23b and the second protrusion 23c protrudes toward one side from an end surface on one side (right side in Fig. 3) of the socket body 23a in the longitudinal direction (left-right direction in Fig. 3) of filtration membrane (22).

[0027]

In such a configuration, when each of the first protrusion 23b and the second protrusion 23c is inserted into an insertion hole provided in a holder (not illustrated), one end in the longitudinal direction of the

filtration membrane unit (21) is positioned with respect to the holder and held by the holder. The area of the outer peripheral surface of first protrusion 23b is much smaller than the area of the outer peripheral surface of the socket body 23a. The area of the outer peripheral surface of second protrusion 23c is also much smaller than the area of the outer peripheral surface of the socket body 23a. Therefore, even if the clearance between the outer periphery of the first protrusion 23b and the inner periphery of the insertion hole and the clearance between the outer periphery of the second protrusion 23c and the inner periphery of the insertion hole are substantially eliminated, each of the protrusions (23b and 23c) can be easily inserted into the individual insertion hole. When the clearance is set as described above, rattling of the end on one side in the longitudinal direction of the filtration membrane unit (21) is prevented.

[0028]

The structure of each of the first protrusion 23b and the second protrusion 23c is a tubular structure having a hollow (23b-1 and 23c-1). The hollows (23b-1 and 23c-1) of the first protrusion 23b and the second protrusion 23c communicate with the flow path 23e of the socket body 23a. Further, the hollows (23b-1 and 23c-1) in the first protrusion 23b and the second protrusion 23c are opened at

both ends in an extending direction (left-right direction in Fig. 3) of the protrusions (23b and 23c). Of the two openings in the hollow 23b-1 of the first protrusion 23b, the opening on one side (right side in Fig. 3) in the extending direction (left-right direction in Fig. 3) of the first protrusion 23b is a first outlet 23b-2 as a discharge port for discharging the treated water (W_2 in Fig. 1) in the flow path 23e. Of the two openings in the hollow 23c-1 of the second protrusion 23c, the opening on one side (right side in Fig. 3) in the extending direction (left-right direction in Fig. 3) of the second protrusion 23c is a second outlet 23c-2 as a discharge port for discharging the treated water in the flow path 23e.

[0029]

The hollow 23b-1 of the first protrusion 23b communicates with the flow path 23e through an opening 23b-3 on the other side (left side in Fig. 3) in the extending direction (left-right direction in Fig. 3) of the first protrusion 23b, of the two openings thereof. In addition, the hollow 23c-1 of the second protrusion 23c communicates with the flow path 23e through an opening 23c-3 on the other side (left side in Fig. 3) in the extending direction (left-right direction in Fig. 3) of the second protrusion 23c, of the two openings thereof.

[0030]

When the suction pump (9 in Fig. 1) is operated, a suction force due to negative pressure is generated in each of the hollow 23b-1 of the first protrusion 23b and the hollow 23c-1 of the second protrusion 23c. By this suction force, the treated water in the flow path 23e of the socket body 23a is sucked toward the inside of the hollow 23b-1 of the first protrusion 23b and the hollow 23c-1 of the second protrusion 23c.

[0031]

Fig. 4 is a side view illustrating the filtration membrane unit 21 from the side. The shielding side socket 24 of the filtration membrane unit 21 includes a socket body 24a and two protrusions 24b. The socket body 24a includes a recess (not illustrated) into which an end on the other side (left side in Fig. 4) in the longitudinal direction (left-right direction in Fig. 4) of the filtration membrane 22 is inserted. Note that the socket body 24a does not include a flow path communicating with the recess. The suction force applied to the filtration membrane 22 is shielded by the shielding side socket 24 on the other side in the longitudinal direction of the filtration membrane 22.

[0032]

Each of the two protrusions 24b in the shielding side socket 24 is positioned outside (left side in Fig. 4) the

socket body 24a in the longitudinal direction (left-right direction in Fig. 4) of the filtration membrane 22 and is arranged along the extending direction of the socket body 24a (vertical direction in Fig. 4).

[0033]

Fig. 5 is a perspective view illustrating a filtration system 31 according to the embodiment. The filtration system 31 includes a plurality of filtration membrane units 21 and a holder 40 that holds the plurality of filtration membrane units 21. The holder 40 includes a water collection cassette 41, a blind cassette 60, a first side cover 65, and a second side cover 66. The structure of the holder 40 is a frame-like structure including a peripheral wall formed by connecting four walls. The water collection cassette 41 functions as a first holding unit that holds each of the ends on one side in the longitudinal direction of the plurality of filtration membrane units 21. In addition, the blind cassette 60 functions as a second holding unit that holds each of the ends on the other side in the longitudinal direction of the plurality of filtration membrane units 21.

[0034]

As illustrated in the drawing, the water collection cassette 41 and the blind cassette 60 form a pair of walls facing each other in the frame-like structure of the holder

40, and hold the plurality of filtration membrane units 21 in a mode of being arranged in the thickness direction of each filtration membrane 22. In addition, the first side cover 65 and the second side cover 66 form a pair of walls facing each other in the frame-like structure of the holder 40 separately from the above-described pair.

[0035]

As illustrated in Fig. 4, the treated water filtered by the plurality of filtration membrane units 21 moves from the other side to one side in the longitudinal direction in the filtration membrane 22, and is collected in the water collection cassette 41 illustrated in Fig. 5 via the first protrusion 23b or the second protrusion 23c.

[0036]

Fig. 5 is a perspective view illustrating the filtration treatment apparatus 20 according to the embodiment. The filtration treatment apparatus 20 includes three filtration systems 31. The three filtration systems 31 have a three-stage structure in which the three filtration systems 31 are stacked in the vertical direction. Note that the number of stages is not limited to three, and may be two or four or more. In addition, a multiple multistage structure in which a plurality of filtration systems 31 is connected in the same stage may be employed.

[0037]

Fig. 6 is a perspective view illustrating two water collection cassettes 41 stacked on each other in the filtration system (31). The connecting pipes 70 illustrated in the drawing serve to connect the two water collection cassettes 41. On the top plate 42 of each of the two water collection cassettes 41, three top plate openings 42a are arranged at predetermined intervals along the longitudinal direction of the top plate 42. The top plate openings 42a face upward in the vertical direction. Three tubular first connection sockets 50 are disposed inside the water collection cassette 41. These first connection sockets 50 are fixed to a back surface of the top plate 42 and communicate with the top plate opening 42a.

[0038]

On the bottom plate 45 of each of the three water collection cassettes 41, three bottom plate openings 45a are arranged in a mode of being aligned at predetermined intervals along the longitudinal direction of the bottom plate 45. The bottom plate openings 45a faces downward in the vertical direction. One of the three top plate openings 42a and one of the three bottom plate openings 45a face each other along the vertical direction. The other one of the three top plate openings 42a and the other one

of the three bottom plate openings 45a face each other along the vertical direction. Furthermore, the last one of the three top plate openings 42a and the last one of the three bottom plate openings 45a face each other along the vertical direction.

[0039]

Three tubular second connection sockets 51 are disposed inside the water collection cassette 41. These second connection sockets 51 are fixed to the back surface of the bottom plate 45 and communicate with the bottom plate openings 45a. The water collection cassette 41 arranged on the lower side of the drawing and the water collection cassette 41 arranged on the upper side of the drawing are connected by three connecting pipes 70. The connecting pipes 70 are disposed so that the pipe length direction is along the vertical direction. At each of one end and the other end in the longitudinal direction of the connecting pipe 70, a ring-shaped recess (not illustrated) extending over the entire circumference of the pipe circumferential surface is disposed, and an O-ring 71 is fitted into each of the ring-shaped recesses.

[0040]

The one end in the longitudinal direction of the connecting pipe 70 is inserted into the second connection socket 51 of the water collection cassette 41 on the upper

side in the drawing. Further, the other end in the longitudinal direction of the connecting pipe 70 is inserted into the first connection socket 50 of the water collection cassette 41 on the upper side in the drawing. The internal space of the water collection cassette 41 on the upper side in the drawing and the internal space of the water collection cassette 41 on the lower side in the drawing communicate with each other through the three connecting pipes 70.

[0041]

Note that, in the lowermost water collection cassette 41 among the three water collection cassettes 41 stacked in three stages, the connecting pipe 70 is not inserted into each of the three second connection sockets 51, but a sealing plug (not illustrated) is inserted into each of the second connection sockets 51. Accordingly, it is possible to prevent the suction force generated in the internal space of the lowermost water collection cassette 41 from leaking to the outside through the second connection socket 51.

[0042]

Further, among the three water collection cassettes 41 stacked in three stages, in the uppermost water collection cassette 41, the water collection branch pipe is inserted instead of the connecting pipes 70 being inserted into the

three first connection sockets 50. These water collection branch pipes are connected to one treated water transfer pipe (8 in Fig. 1).

[0043]

Treated water having passed through the filtration membranes (22) of the plurality of filtration membrane units (21) held by the water collection cassette 41 flows into the internal space of the water collection cassette 41 on the lower side of the drawing. Treated water having passed through the filtration membranes (22) of the plurality of filtration membrane units (21) held by the water collection cassette 41 flows into the internal space of the water collection cassette 41 on the upper side of the drawing. The treated water present in the internal space of the water collection cassette 41 on the lower side in the drawing is sucked into the internal space of the water collection cassette 41 on the upper side through the connecting pipes 70 by the suction force generated inside the connecting pipes 70.

[0044]

That is, in each of the three filtration systems 31 illustrated in Fig. 6, the treated water that has passed through each of the plurality of filtration membranes 22 is collected in the water collection cassette 41. Then, in each of the water collection cassettes 41 of the three

filtration systems 31, the treated water in the internal space of the water collection cassette 41 located on the lower side is sucked into the internal space of the water collection cassette 41 located on the upper side. As a result, the treated water collected in the internal space of each of the three water collection cassettes 41 is finally collected in the internal space of the uppermost water collection cassette 41 and then transferred to the treated water tank (3 in Fig. 1).

[0045]

Fig. 7 is a perspective view illustrating the holder 40. Fig. 8 is a perspective view illustrating the holder 40 together with four divided pillar 100. The first side cover 65 of the holder 40 includes a pillar penetration portion 65a protruding from the outer surface at each of four corners of the outer surface. Each of the pillar penetration portions 65a includes a through hole extending in the vertical direction. This through hole is for allowing the divided pillar 100 to penetrate therethrough. Among the four pillar penetration portions 65a, two pillar penetration portions are aligned in the vertical direction and located on the same axis. Similarly, the other two are aligned in the vertical direction and positioned on the same axis. Although the number of the pillar penetration portions 65a disposed in the first side cover 65 is four,

since two of them are located on the same axis, the number of the divided pillars 100 attached to the first side cover 65 is two. Although the first side cover 65 has been described, the second side cover 66 also includes four pillar penetration portions 66a having the same configuration at each of the four corners of the outer surface. Similarly, two divided pillars 100 are attached to the second side cover 66.

[0046]

Fig. 9 is a perspective view illustrating both ends in an axial direction of the divided pillar 100. As illustrated in the drawing, recesses and protrusions 100a is provided on an outer peripheral surface of each of both ends of the divided pillar 100.

[0047]

Fig. 10 is a perspective view illustrating the holder 40 of the filtration system (31) arranged at the lowermost stage. A hanger 102 for hanging the filtration system (31) is attached to a lower end of the divided pillar 100 passed through the pillar penetration portion (65a, 66a) of the filtration system (31) arranged at the lowermost stage.

[0048]

Fig. 11 is an exploded perspective view illustrating the hanger 102. The hanger 102 includes a cover portion 102a formed of a through hole that covers the lower end of

the divided pillar (100) from the outer peripheral side, an insertion portion 102b to be inserted into a recessed portion (described later) of the first side cover (65), and two bolt holes 102c. As illustrated in the drawing, the hanger 102 is formed of two members that divide the divided pillar (100) into two in the axial direction of the divided pillar (100) in a state where bolts are not attached to the two bolt holes 102c. As illustrated in the drawing, recesses and protrusions are formed on the inner peripheral surface of the cover portion 102a including the through hole. As illustrated in Fig. 12, the recesses and protrusions are engagement recesses and protrusions to be engaged with recesses and protrusions 100a at the end of the divided pillar 100.

[0049]

Fig. 13 is a perspective view illustrating corner bottom portions of the first side cover 65 and the blind cassette 60 in the filtration system 131 arranged at the lowermost stage. In the drawing, a one-dot chain line L1 indicates the axis of the divided pillar 100. A one-dot chain line L2 is a perpendicular line to the outer surface of the first side cover 65. Of the entire area of the outer surface of the first side cover 65 as a wall including the pillar penetration portion 65a, the bottom portion of the first side cover 65 on the one-dot chain

line (perpendicular line) L2 at the intersection position of the one-dot chain line (axis) L1 and the one-dot chain line (perpendicular line) L2 is provided with a recessed portion 65b. The recessed portion 65b is recessed from the outer surface of the first side cover 65 toward the inner surface side. The insertion portion 102a3 of the hanger 102 attached to the lower end of the divided pillar 100 is inserted into the recessed portion 65b. In this state, when the divided pillar 100 is pulled upward, the filtration system 131 in which the insertion portion 102a3 is hooked to the recessed portion 65b is lifted upward.

[0050]

Note that the recessed portion 65b may be provided only in the first side cover 65, or may be provided continuously from the first side cover 65 to the blind cassette 60. In addition, although the corner bottom portions of the first side cover 65 and the blind cassette 60 have been described, similar recessed portions are also arranged at three corner bottom portions to be described next. That is, there are three of a corner bottom portion of the first side cover 65 and the water collection cassette (41), a corner bottom portion of the second side cover 66 and the blind cassette 60, and a corner bottom portion of the second side cover 66 and the water collection cassette (41).

[0051]

Fig. 14 is a perspective view illustrating the holders 40 of the two filtration systems (131) stacked in two rows. The divided pillar 100 passed through the pillar penetration portion (65a, 66a) of the holder 40 arranged in the lower stage and the divided pillar 100 passed through the pillar penetration portion (65a, 66a) of the holder 40 arranged in the upper stage are connected by the coupler 101 in the axial direction. Thus, the divided pillar 100 passed through the pillar penetration portion (65a, 66a) at the lower stage and the divided pillar 100 passed through the pillar penetration portion (65a, 66a) at the upper stage on the axis thereof are connected to each other to form one pillar. The divided pillar 100 is further connected to the divided pillar 100 attached to the filtration system (131) at the uppermost stage above the divided pillar by the coupler 101, and the divided pillar 100 is fixed to a support member (not illustrated). Thus, each filtration system (131) in the filtration treatment apparatus (20) including the plurality of filtration systems (131) stacked in multiple stages is fixed at a predetermined position.

[0052]

Fig. 15 is an exploded perspective view illustrating the coupler 101. The coupler 101 includes a cover portion

101a formed of a through hole that covers one end (upper end) and the other end (lower end) of the two divided pillars 100 to be connected from the outer peripheral side, and three bolt holes 101b. As illustrated in the drawing, the coupler 101 is formed of two members that divide the divided pillar (100) into two in the axial direction of the divided pillar (100) in a state where bolts are not attached to the two bolt holes 101b. As illustrated in the drawing, recesses and protrusions are formed on the inner peripheral surface of the cover portion 101a including the through hole. As illustrated in Fig. 16, the recesses and protrusions are engagement recesses and protrusions to be engaged with recesses and protrusions 100a at the upper end of the lower divided pillar 100 and recesses and protrusions 100a at the lower end of the upper divided pillar 100.

[0053]

As illustrated in Fig. 14, each of the pillar penetration portions 65a provided in the first side cover 65 is disposed at a position avoiding the upper end and the lower end of the first side cover 65. Thus, as illustrated in the drawing, a space for interposing the coupler 101 is secured between the pillar penetration portion 65a of the lower first side cover 65 and the pillar penetration portion 65a of the upper first side cover 65. That is, by

arranging the pillar penetration portion 65a at the avoiding position as described above, it is possible to connect the divided pillar 100 at the lower stage and the divided pillar 100 at the upper stage by the coupler 101.

[0054]

The present invention is not limited to the above-described embodiments and examples, and configurations different from the embodiments and examples can be employed within a range where the configurations of the present invention can be applied. The present invention has unique effects for each aspect described below.

[0055]

[First Aspect]

A first aspect is a holder (for example, the holder 40) in which a first holding unit (for example, the water collection cassette 41) that holds each of ends on one side in a longitudinal direction of a plurality of filtration membrane units (for example, the filtration membrane units 121) and a second holding unit (for example, the blind cassette 60) that holds each of ends on another side in the longitudinal direction of the plurality of filtration membrane units hold the plurality of filtration membrane units in a mode in which the plurality of filtration membrane units is aligned in a thickness direction of each of the filtration membranes (for example, the filtration

membranes 22) and constitute a pair of facing walls in a frame-like structure including a peripheral wall, the holder including a pillar penetration portion (for example, the pillar penetration portions 65a and 66a) that allows a pillar to penetrate in a vertical direction in each of different walls in the frame-like structure.

[0056]

In such a configuration, the pillar can be removed from the filtration system stacked in multiple stages by pulling out the pillar passed through the pillar penetration portion. Thus, it is possible to avoid a situation in which the pillar hinders the removal work when removing each filtration system for maintenance and inspection, and thus it is possible to reduce the effort for maintenance and inspection of the filtration system.

[0057]

[Second Aspect]

A second aspect is the holder having the configuration of the first aspect, in which the pillar penetration portion is disposed at a position avoiding an upper end and a lower end of the wall.

[0058]

With such a configuration, it is possible to connect the divided pillar at the lower stage and the divided pillar at the upper stage by the coupler.

[0059]

[Third Aspect]

According to a third aspect, in the holder having the configuration of the second aspect, a recessed portion (for example, the recessed portion 65b) recessed from an outer surface toward an inner surface side is provided in a wall bottom portion on a perpendicular line (for example, one-dot chain line L2) at an intersecting position between an axis (for example, one-dot chain line L1) in a penetrating direction of the pillar penetration portion and the perpendicular line (for example, one-dot chain line L2) with respect to the outer surface of the wall in an entire area of the outer surface of the wall including the pillar penetration portion.

[0060]

With such a configuration, the recessed portion can be used as a hooking portion for hooking the hanger for hanging the filtration system.

[0061]

[Fourth Aspect]

A fourth aspect is a filtration system (for example, the filtration system 131) including a plurality of filtration membrane units and a holder holding the filtration membrane units, in which the holder is the holder according to any one of the first to third aspects.

[0062]

With such a configuration, it is possible to reduce the effort for maintenance and inspection of the filtration system.

[0063]

[Fifth Aspect]

According to a fifth aspect, in the filtration system having the configuration of the fourth aspect, the holder of the second aspect or the third aspect is provided as the holder, and at least a number of divided pillars (for example, divided pillars 100) divided at the same height as the wall and a number of couplers (for example, coupler 101) that couple the two divided pillars in an axial direction are provided, the numbers being the same as the number of axes of a plurality of the pillar penetration portions arranged in the holder.

[0064]

With such a configuration, when the plurality of filtration systems is stacked in multiple stages, instead of attaching one long pillar having a length corresponding to the number of stages, short divided pillars are passed through and coupled in each stage. Thus, it is possible to eliminate the need for equipment for installing long pillars and improve efficiency of stacking operation.

In addition, when the filtration systems stacked in

multiple stages are removed one by one, instead of pulling out one long pillar, the short divided pillars are uncoupled and pulled out at each stage. Thus, it is possible to eliminate the effort for pulling out the heavy long pillar and to improve the efficiency of stage-releasing work.

[0065]

[Sixth Aspect]

According to a sixth aspect, in the filtration system having the configuration of the fifth aspect, the divided pillars include recesses and protrusions (for example, recesses and protrusions 100a) on outer peripheral surfaces of both ends, the couplers each include a cover portion (for example, cover portion 101a) that covers one end of one of the two divided pillars to be coupled and another end of another of the two divided pillars to be coupled from an outer peripheral side, and is formed of two members that are divided into two in the axial direction of the divided pillars, and the cover portion includes engagement recesses and protrusions to be engaged with the recesses and protrusions of the one end and the recesses and protrusions of the another end.

[0066]

With such a configuration, the two divided pillars can be coupled in the axial direction by a simple operation of

integrating the two members of the coupler with the bolt or the like.

[0067]

[Seventh Aspect]

According to a seventh aspect, in the filtration system having the configuration of the sixth aspect, the holder is the holder of the third aspect, at least the same number of hangers (for example, the hangers 102) for hanging a filtration system as the number of axes of the plurality of pillar penetration portions arranged in the holder is provided, in which the hangers are formed of two members that each include a cover portion (for example, the cover portion 102a) that covers another ends of the divided pillars from an outer peripheral side, an insertion portion (for example, the insertion portion 102b) to be inserted into the recessed portion, and engagement recesses and protrusions to be engaged with the recesses and protrusions of the another ends, the two members being divided into two in the axial direction of the divided pillar.

[0068]

With such a configuration, the hanger can be set in the filtration system by a simple operation of integrating the two members of the hanger with a bolt or the like.

[0069]

[Eighth Aspect]

An eighth aspect is a filtration treatment apparatus (for example, the filtration treatment apparatus 20) including a plurality of filtration systems stacked in multiple stages, in which the filtration system is any of the filtration systems of the fourth aspect to the seventh aspect.

[0070]

With such a configuration, it is possible to reduce the effort for maintenance and inspection work of the individual filtration systems stacked in multiple stages.

[0071]

20 Filtration treatment apparatus

21 Filtration membrane unit

22 Filtration membrane

23 Suction side socket (socket)

23a Socket body

23b First protrusion

23b-1 Hollow

23b-2 First outlet

23c Second protrusion

23c-1 Hollow

23c-2 Second outlet

23d Recess

23e Flow path

31 Filtration system

CLAIMS

1. A filtration treatment apparatus comprising a plurality of filtration systems stacked and arranged in a vertical direction, the filtration systems being coupled by using pillars extending in the vertical direction, wherein

the filtration system includes a plurality of filtration membrane units arranged in parallel in a thickness direction of filtration membranes, a first holding unit that holds one end in a longitudinal direction of the filtration membrane units, a second holding unit that holds another end in the longitudinal direction of the filtration membrane units, and a pair of side covers that extend in a direction orthogonal to an extending direction of the first holding unit and the second holding unit and couple the first holding unit and the second holding unit,

each of the pair of side covers is provided with a pillar penetration portion that allows a pillar to vertically penetrate,

the pillar penetration portion is disposed at a position spaced apart in the vertical direction from each of an upper end and a lower end of the side cover, and

the pillar is divided pillars divided according to a vertical length of the filtration system, and the divided pillars are coupled via a coupler disposed between a first pillar penetration portion provided in a first filtration

system and a second pillar penetration portion provided in a second filtration system.

2. The filtration treatment apparatus according to claim 1, wherein

a recessed portion recessed toward an inner surface side is formed in a bottom surface portion of the side cover at an intersection position of an axis of the pillar penetration portion in a penetrating direction and a perpendicular line to an outer surface of the side cover.

3. The filtration treatment apparatus according to claim 1 or 2, wherein

the divided pillars include recesses and protrusions on outer peripheral surfaces of both ends,

the couplers each include a cover portion that covers one end of one of the two divided pillars to be coupled and another end of another of the two divided pillars to be coupled from an outer peripheral side, and is formed of two members that are divided into two in the axial direction of the divided pillar, and

the cover portion includes engagement recesses and protrusions to be engaged with the recesses and protrusions of the one end and the recesses and protrusions of the another end.

4. The filtration treatment apparatus according to claim 3, comprising:

at least a same number of hangers for hanging the filtration system as a number of axes of the plurality of pillar penetration portions, wherein

the hangers are formed of two members that each include a cover portion that covers another ends of the divided pillars from an outer peripheral side, an insertion portion to be inserted into the recessed portion, and engagement recesses and protrusions to be engaged with the recesses and protrusions of the another ends, the two members being divided into two in the axial direction of the divided pillar.