

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 holder has a frame-like structure in which the two water collection cases face each other and the two cover members face each other. A plurality of membrane elements is arranged as a filtration membrane unit inside the frame of the holder. One of the two water collection cases of the holder holds each of ends on one side in a longitudinal direction of the plurality of membrane elements arranged in the frame of the holder (functions as a first holding unit). The other of the water collection cases holds each of ends on the other side in the longitudinal direction of the plurality of membrane elements arranged in the frame of the holder (functions as a second holding unit). Each of the plurality of membrane elements held in the frame of the holder in this manner is arranged in a mode of being aligned side by side along a 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 is used in a state where a plurality of membrane modules are stacked in multiple stages. In such a membrane separation apparatus, a plurality of membrane elements in the device is hidden in respective frames of a plurality of membrane modules stacked in multiple stages. Therefore, there is a problem that it is not possible to visually inspect the membrane element, and it takes time and effort for maintenance and inspection.

[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 capable of reducing time and effort for maintenance and inspection of a filtration membrane unit such as a membrane element. In addition, it is an object of the present invention to provide a filtration system and a filtration treatment apparatus capable of reducing the effort for maintenance and inspection of the filtration membrane unit by such a holder.

Solution to Problem

[0007]

In order to achieve the above object, one aspect of the present invention is a holder for holding a plurality of filtration membrane units in a mode of being aligned in a

thickness direction of each of the filtration membranes by a first holding unit that holds each of ends on one side in a longitudinal direction of the 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, wherein in a region surrounded by an outer edge of a cross section of the first holding unit along a direction orthogonal to a facing direction between the first holding unit and the plurality of filtration membrane units held by the first holding unit, a through opening penetrating the first holding unit along the facing direction is arranged in a region facing the plurality of filtration membrane units along the facing direction.

Advantageous Effects of Invention

[0008]

According to the present invention, there is an excellent effect that effort for maintenance and inspection of a filtration membrane unit 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 an exploded perspective view illustrating the filtration system.

Fig. 7 is a perspective view illustrating a water collection cassette of a holder according to the embodiment.

Fig. 8 is a view illustrating the water collection cassette from a side of a second long side plate.

Fig. 9 is a view of the blind cassette as viewed from an outside of a frame of the holder along a facing direction.

Fig. 10 is a perspective view illustrating three filtration systems vertically stacked on each other in a filtration treatment apparatus according to the embodiment.

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. Therefore, according to the filtration membrane unit (21) of the embodiment, it is possible to suppress occurrence of damage of the filtration membrane (22) due to rattling of the end on one side in the longitudinal direction of the filtration membrane unit.

[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]

Hereinafter, the first outlet (23b-2 in Fig. 3) provided in the first protrusion 23b and the second outlet (23c-2 in Fig. 3) provided in the second protrusion 23c are collectively referred to as "two discharge ports of the suction side socket 23". When the diameter of the discharge port is set to a predetermined value and the amount of filtrate per unit time by the filtration membrane (22 or 122) is set to a predetermined value, it is necessary to employ the following condition as a condition of the flow rate per unit time of the treated water passing through the discharge port. That is, it is a condition that the inflow amount of the treated water into the discharge port of the filtration membrane unit 121 according to the first comparative example is set to about 2 times the inflow amount of the treated water into each of the "two discharge ports of the suction side socket 23" according to the embodiment. Under such conditions, as compared with the configuration described in Patent Literature 1 in which only one discharge port (filtrate outlet) is provided, the flow path resistance of the treated water in the filtration membrane unit 21 is made smaller than that in the first comparative example, so that power of a suction power machine such as a suction pump (9 in Fig. 1) can be further reduced to achieve energy saving.

[0034]

Unlike the aspect illustrated in Fig. 3, each of the first outlet (23b-2 in Fig. 3) and the second outlet (23c-2 in Fig. 3) may be disposed at a predetermined position on peripheral surfaces of the protrusions (23b and 23c) (hereinafter, this arrangement is referred to as circumferential surface arrangement). However, as illustrated in Fig. 3, it is more desirable to arrange each of the first outlet 23b-2 and the second outlet 23c-2 on the distal end surface of the protrusion (23b or 23c) (hereinafter, this arrangement is referred to as distal end surface arrangement). This is for the reason described below. That is, in the circumferential surface arrangement, the flow of the treated water in the hollow (23b-1 or 23c-1) of the protrusion (23b-2 or 23c-2) needs to be redirected at an angle of about 90 [°] immediately before reaching the discharge port (first outlet 23b-2 or second outlet 23c-2). This increases the flow path resistance of the filtration membrane unit 21. On the other hand, in the distal end surface arrangement, the flow direction of the treated water in the hollow (23b-1 or 23c-1) of the protrusion (23b-2 or 23c-2) and the flow direction of the treated water when passing through the discharge port (first outlet 23b-2 or second outlet 23c-2) are set to the same direction. Thus, unlike the

circumferential surface arrangement, the flow of the treated water is not largely redirected in the hollow (23b-1 and 23c-1), so that the flow path resistance can be reduced as compared with the circumferential surface arrangement.

[0035]

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 has a frame shape, and the holder 40 holds the plurality of filtration membrane units 21 in the frame. Further, the holder 40 includes a water collection cassette 41, a blind cassette 60, a first side cover 65, and a second side cover 66.

[0036]

Fig. 6 is an exploded perspective view illustrating the filtration system 31 according to the embodiment. The holder (40 in Fig. 5) is formed by combining a flat rectangular parallelepiped water collection cassette 41, a flat plate-shaped first side cover 65, a flat rectangular parallelepiped blind cassette 60, and a flat plate-shaped second side cover 66 in a frame shape. Unlike the state illustrated in the drawing, in a state where the plurality of filtration membrane units 21 does not exist, the water

collection cassette 41 and the blind cassette 60 face each other. In addition, in the above state, the first side cover 65 and the second side cover 66 face each other in a direction orthogonal to a facing direction of the water collection cassette 41 and the blind cassette 60.

[0037]

Each of the water collection cassette 41 and the blind cassette 60 is disposed so that the longitudinal direction thereof is along a facing direction of the first side cover 65 and the second side cover 66. On the other hand, each of the first side cover 65 and the second side cover 66 is disposed so that the longitudinal direction thereof is along a facing direction of the water collection cassette 41 and the blind cassette 60.

[0038]

The water collection cassette 41 as the first holding unit holds each of the ends on one side in the longitudinal direction of the plurality of filtration membrane units 21. Further, the blind cassette 60 as the second holding unit holds each of the ends on the other side in the longitudinal direction of the plurality of filtration membrane units 21. By such holding, the plurality of filtration membrane units 21 are arranged side by side in the thickness direction of each filtration membrane 22.

[0039]

Fig. 7 is a perspective view illustrating the water collection cassette 41 of the holder (40 in Fig. 5). The water collection cassette 41 is formed by combining a top plate 42, a bottom plate 45, a first long side plate 43, a second long side plate 44, and a first short side plate 46 and a second short side plate 47 shorter than the long side plates (43 and 44) in a flat rectangular parallelepiped shape. The top plate 42 and the bottom plate 45 face each other. In the water treatment facility, as illustrated in the drawing, the water collection cassette 41 is arranged in such a mode that the top plate 42 and the bottom plate 45 are arranged in the vertical direction along the gravity direction.

[0040]

Each of the first long side plate 43 and the second long side plate 44 is arranged in such a mode that the longitudinal direction thereof is along the lateral direction of each of the first short side plate 46 and the second short side plate 47. On the other hand, each of the first short side plate 46 and the second short side plate 47 is arranged in such a mode that the longitudinal direction thereof is along a facing direction of the top plate 42 and the bottom plate 45.

[0041]

As illustrated in Fig. 6, the facing direction of the

water collection cassette 41 as the first holding unit and the plurality of filtration membrane units 21 held by the water collection cassette is along the facing direction of the water collection cassette 41 and the blind cassette 60. In a state where the water collection cassette 41 and the blind cassette 60 face each other as illustrated in the drawing, the longitudinal direction of the water collection cassette 41 is orthogonal to the aforementioned facing direction. The outer edge of the cross section obtained by breaking the water collection cassette 41 along the longitudinal direction is drawn by a line connecting the front surface of the top plate 42, the front surface of the first short side plate 46, the front surface of the bottom plate 45, and the front surface of the second short side plate 47 in Fig. 7. As illustrated in Figs. 5 and 6, the region surrounded by the outer edge faces all the filtration membrane units 21 held by the water collection cassette 41. Therefore, assuming that all the components constituting the water collection cassette 41 are made of a transparent member, when the filtration membrane unit 21 in the frame is viewed from the outside of the frame of the frame-shaped holder (40) through the transparent water collection cassette 41, all the filtration membrane units 21 can be visually recognized through the transparent water collection cassette 41.

[0042]

In the water collection cassette 41, a plurality of through openings penetrating the water collection cassette 41 along the facing direction is arranged in a region facing the plurality of filtration membrane units 21 along the facing direction in a region surrounded by the outer edge.

[0043]

Fig. 8 is a view illustrating the water collection cassette 41 from the second long side plate 44 side. In the drawing, for the sake of convenience, the opening of the through opening arranged in the water collection cassette 41 is marked with an x made of a one-dot chain line. The water collection cassette 41 includes 12 through openings (101 to 112) from the first through opening to the 12th through opening as described above. The operator can visually confirm many filtration membrane units 21 disposed in the frame of the frame-shaped holder (40) through the 12 through openings. Thus, according to the holder (40) of the embodiment, it is possible to reduce the effort for maintenance and inspection of the filtration membrane unit 21.

[0044]

As illustrated in Fig. 6, the facing direction of the blind cassette 60 as the second holding unit and the

plurality of filtration membrane units 21 held by the blind cassette is along the facing direction of the water collection cassette 41 and the blind cassette 60. In a state where the water collection cassette 41 and the blind cassette 60 face each other as illustrated in the drawing, the longitudinal direction of the blind cassette 60 is orthogonal to the above-described facing direction. A region surrounded by the outer edge of the cross section obtained by breaking the blind cassette 60 along the longitudinal direction faces all the filtration membrane units 21 held by the blind cassette 60 as illustrated in Figs. 5 and 6. Therefore, in a case where it is assumed that all the components constituting the blind cassette 60 are made of transparent members, when the filtration membrane unit 21 in the frame is looked in from the outside of the frame of the frame-shaped holder (40) through the transparent blind cassette 60, all the filtration membrane units 21 can be visually recognized through the transparent blind cassette 60.

[0045]

In the blind cassette 60, a plurality of through openings penetrating the blind cassette 60 along the facing direction are arranged in a region facing the plurality of filtration membrane units 21 along the facing direction in a region surrounded by the outer edge.

[0046]

Fig. 9 is a view of the blind cassette 60 as viewed from the outside of the frame of the holder (4) along the facing direction. In the drawing, for convenience, the opening of the through opening is marked with an x mark made of a one-dot chain line. The blind cassette 60 includes six through openings (201 to 206) from first to sixth as a plurality of through openings. The operator can visually confirm the filtration membrane unit 21 disposed in the frame of the frame-shaped holder (40) through the six through openings (201 to 206). The number of through openings is half of that of the water collection cassette (41), but the total opening area is wider than that of the water collection cassette (41), and almost all the filtration membrane units (21) disposed in the frame of the holder (40) can be visually confirmed through the six through openings (201 to 206). Thus, according to the holder (40) of the embodiment, it is possible to more favorably reduce the effort for maintenance and inspection of the filtration membrane unit (21).

[0047]

As illustrated in Fig. 6, each of the plurality of filtration membrane units 21 includes the suction side socket 23 at one end in the longitudinal direction. The suction side socket 23 has a shape wider than the

filtration membrane 22. Therefore, in the two filtration membrane units 21 adjacent to each other, a gap G1 between the ends on one side in the longitudinal direction is smaller than a gap G2 between the central portions in the longitudinal direction (portions where the filtration membranes 22 face each other).

[0048]

If air bubbles released from the bubble generation device (90) and received in the frame of the holder (40) escape to the outside of the frame through the plurality of through openings (101 to 112) provided in the water collection cassette 41, the separation efficiency of the foreign substances from the filtration membrane 22 by applying vibration to the filtration membrane 22 by the air bubbles is reduced. However, in order for the air bubbles to reach the through opening (101 to 112) of the water collection cassette 41, it is necessary to enter the gap G1 from the inside of the gap G2 described above. Since the gap G1 is smaller than the gap G2, stress in the direction of rising straight in the gap G2 acts more strongly on the bubble than stress in the direction of entering the gap G1 from the gap G2. This prevents air bubbles from flowing out through the plurality of through openings (101 to 112) of the water collection cassette 41. Therefore, according to the filtration system 31 according to the embodiment, it

is possible to prevent a decrease in the clogging suppression efficiency of the filtration membrane 22 due to the external flow of air bubbles through the through opening (101 to 112) of the water collection cassette 41.

[0049]

Each of the plurality of filtration membrane units 21 includes a shielding side socket 24 at the other end in the longitudinal direction. Since the shielding side socket 24 has a wider shape than the filtration membrane 22, in the two filtration membrane units 21 adjacent to each other, a gap G3 between the ends on the other side in the longitudinal direction is smaller than the gap G2 between the central portions in the longitudinal direction.

[0050]

In order for the air bubbles fed into the filtration system 31 to reach the through opening (201 to 206) of the blind cassette 60, they need to enter into the gap G3 from within the aforementioned gap G2. Since the gap G3 is smaller than the gap G2, stress in a direction in which the air bubbles rise straight in the gap G3 acts more strongly on the air bubbles than stress in a direction in which the air bubbles enter the gap G3 from the gap G2. This prevents air bubbles from flowing out through the plurality of through openings (201 to 206) of the blind cassette 60. Therefore, according to the filtration system 31 of the

embodiment, it is possible to prevent a decrease in the clogging suppression efficiency of the filtration membrane 22 due to external flow of air bubbles through the through opening (201 to 206) of the blind cassette 60.

[0051]

In Fig. 7, a first fixing portion 48 protruding from the front surface is provided on the front surface of the first short side plate 46. Further, a second fixing portion 49 protruding from the front surface is provided on the front surface of the second short side plate 47.

[0052]

Hereinafter, the frame structure of the frame-shaped holder (40 in Fig. 5) will be simply referred to as a "frame". The first long side plate 43 is located inside the "frame" with respect to the second long side plate 44. The first long side plate 43 includes a plurality of hole pairs including an insertion hole into which one of the first protrusion (23b in Fig. 3) and the second protrusion (23 c in Fig. 3) is inserted and an insertion hole into which the other of the first protrusion and the second protrusion that is not inserted into the insertion hole is inserted. In each of the plurality of hole pairs, a distance between the two insertion holes is the same.

[0053]

As illustrated in Fig. 6, the two insertion holes of

the hole pair are arranged in the lateral direction (vertical direction in Fig. 6) of the first long side plate 43. One of the first protrusion 23b and the second protrusion 23c is inserted into one of the two insertion holes of the hole pair, and the other protrusion is inserted into the other insertion hole.

[0054]

As illustrated in Fig. 2, the shape of each of the two protrusions 24b of the shielding side socket 24 is a rectangular parallelepiped shape or a rectangular parallelepiped shape. The two protrusions 24b position the other end in the longitudinal direction of the filtration membrane unit (21 in Fig. 6) to the blind cassette (60 in Fig. 6), and hold the other end to the blind cassette.

[0055]

In the suction side socket 23, each of the two protrusions (23b and 23c) integrally formed with the socket body 23a has a tubular shape.

Hereinafter, in each member, a length in a direction along a thickness direction of the flat plate-shaped filtration membrane 22 is referred to as a width. In order to efficiently draw out the filtration performance of the filtration membrane 22, it is desirable that the inner diameters of the two protrusions (23b and 23c) of the suction side socket 23 is the same as the width of the

filtration membrane 22. Then, as illustrated in Fig. 2, the tubular peripheral wall of each of the two protrusions (23b, 23c) protrudes from the socket body 23a in the width direction. That is, outer diameters of the two protrusions (23b and 23c) are larger than a width of the socket body 23a.

[0056]

Such a configuration makes it difficult to reduce the size of the filtration system (31 in Fig. 5). Specifically, in order to miniaturize the filtration system, it is desirable to minimize the arrangement pitch in the arrangement direction of the plurality of filtration membrane units (21 in Fig. 6). The narrowing of the arrangement pitch described above is restricted by the outer diameter of each of the two protrusions (23b and 23c) of suction side socket 23.

[0057]

The reason why the narrowing of the arrangement pitch described above is restricted by the outer diameters of the protrusions (23b and 23c) is as follows. That is, in each of the plurality of hole pairs provided in the first long side plate (43 in Fig. 7), the insertion holes located on one side in the lateral direction of the first long side plate (43) out of the two insertion holes are arranged along the longitudinal direction of the first long side

plate (43). In addition, in each of the plurality of hole pairs, out of the two insertion holes, the insertion hole located on the other side in the lateral direction of the first long side plate (43) is also arranged along the longitudinal direction of the first long side plate (43). Hereinafter, two insertion holes adjacent to each other along the longitudinal direction are referred to as "two adjacent insertion holes". Due to downsizing of the filtration system (31 in Fig. 5), as the arrangement pitch (arrangement pitch along the longitudinal direction of the first long side plate 43) of the plurality of filtration membrane units (21 in Fig. 6) decreases, the distance between the "two adjacent insertion holes" decreases. When this distance becomes excessively short, an inter-hole length of an inter-hole portion (portion between the "two adjacent insertion holes") of the first long side plate (43) becomes excessively short, and necessary strength cannot be obtained in the inter-hole portion. In the above-described inter-hole portion of the first long side plate (43), the inter-hole length (narrow limit value) at which the minimum strength can be obtained is constant as long as the material and thickness of the first long side plate (43) are the same. On the other hand, even when the arrangement pitches of the plurality of filtration membrane units 21 are the same, if the outer diameters of the

protrusions (23b and 23c) are different, the above-mentioned inter-hole lengths are different. As the outer diameter of the protrusion (23b or 23c) increases, the inter-hole length decreases (strength of the inter-hole portion decreases). Therefore, the narrowing of the arrangement pitch of the insertion holes is restricted by the outer diameter of the protrusion (23b and 23c).

[0058]

Thus, in the suction side socket (23) of the filtration membrane unit 21 according to the embodiment, each of the two protrusions (23b and 23c) is arranged in a mode illustrated in Fig. 3. Specifically, it is a mode in which a distance α from the center in the extending direction of the socket body 23a (position indicated by a one-dot chain line dash line L1) to the first protrusion 23b and a distance β from the center to the second protrusion 23c are different from each other ($\alpha < \beta$). In such a configuration, while the inter-hole length of the inter-hole portion of the first long side plate (43) is narrowed to the narrow limit value, the arrangement pitch of the plurality of filtration membrane units (21) can be reduced as compared with the case where the distance α and the distance β are the same as each other.

[0059]

The reason why the above-described effect can be

exhibited is as described below. That is, there are two types of the plurality of hole pairs provided in the first long side plate 43 illustrated in Fig. 7. Among the plurality of hole pairs, a first type hole pair 43c is classified as the first type, and a second type hole pair 43f is classified as the second type. The first type hole pair 43c and the second type hole pair 43f are alternately arranged along the longitudinal direction (vertical direction in Fig. 7) of the first long side plate 43. The distance between the two insertion holes (43a and 43b) in the first type hole pair 43c and the distance between the two insertion holes (43d and 43e) in the second type hole pair 43f are the same. Of the two insertion holes (43a and 43b) of the first type hole pair 43c, the insertion hole 43a located on one side (upper side in Fig. 7) in the lateral direction of the first long side plate 43 is disposed at a predetermined first position along the lateral direction of the first long side plate 43 in the plane of the first long side plate 43. This first position is indicated by a one-dot chain line L2 in Fig. 7. Of the two insertion holes (43d and 43e) of the second type hole pair 43f, the insertion hole 43d located on one side (upper side in Fig. 7) in the lateral direction of the first long side plate 43 is disposed at a predetermined second position along the lateral direction of the first long side

plate 43 in the plane of the first long side plate 43.
This second position is indicated by a one-dot chain line L3 in Fig. 7. In the lateral direction of the first long side plate 43, the first position and the second position are different from each other.

[0060]

The two protrusions (23b and 23c) of the filtration membrane unit (21) taking a predetermined first posture are inserted into the first type hole pair 43c. On the other hand, the two protrusions (23b and 23c) of the filtration membrane unit (21) taking a predetermined second posture are inserted into the second type hole pair 43f. The filtration membrane unit (21) taking the first posture and the filtration membrane unit (21) taking the second posture are at point-symmetrical positions (positions rotated by 180°) with respect to an axis (one-dot chain line L4 in Fig. 2) passing through the center in the extending direction of the suction side socket (23) and the center in the extending direction of the shielding side socket (24).

[0061]

Hereinafter, in each member, a positional deviation along the lateral direction of the first long side plate 43 is simply referred to as a positional deviation. The insertion hole 43a arranged at the above-described first position (one-dot chain line l2) of the two insertion holes

(43a and 43b) of the first type hole pair 43c and the insertion hole 43e arranged at the above-described second position (dashed-dotted line L2) of the two insertion holes (43d and 43e) of the second type hole pair 43f are positionally deviated from each other. One of the two adjacent filtration membrane units (21) inserts the two protrusions (23b and 23c) of the suction side socket (23) into the two insertion holes (43a and 43b) of the first type hole pair 43c. In the other filtration membrane unit (21), the two protrusions (23b and 23c) of the suction side socket (23) are inserted into the two insertion holes (43d and 43e) of the second type hole pair.

[0062]

In such a configuration, in the longitudinal direction of the first long side plate 43, it is possible to secure the inter-hole portion of the first long side plate 43 while the end on the other side of the adjacent insertion hole located on one side of the "two adjacent insertion holes" is located on the other side of the end on one side of the adjacent insertion hole located on the other side. More specifically, in Fig. 7, since the longitudinal direction of the first long side plate 43 is substantially along the left-right direction in Fig. 7 (strictly speaking, the longitudinal direction is slightly inclined from the left-right direction in Fig. 7), the longitudinal

direction of the first long side plate 43 will be described below as the left-right direction in Fig. 7. For example, among the plurality of hole pairs provided in the first long side plate 43, the insertion hole 43a of the first type hole pair 43c located on the leftmost side in the left-right direction in the drawing and the insertion hole 43d of the second type hole pair 43f adjacent thereto on the right side in the left-right direction will be focused as "two adjacent insertion holes". The insertion hole 43a of the first type hole pair 43c is located on the left side in the left-right direction in the drawing with respect to the insertion hole 43d of the second type hole pair 43f. That is, attention is paid to an example in which the insertion hole 43a of the first type hole pair 43c is an adjacent insertion hole located on the other side in the longitudinal direction of the first long side plate 43 out of "two adjacent insertion holes", and the insertion hole 43d of the second type hole pair 43f is an adjacent insertion hole located on one side in the longitudinal direction. In this example, the left end (other side) of the insertion hole 43d of the second type hole pair 43f is positioned on the left side of the right end (one side) of the insertion hole 43a of the first type hole pair 43c. In the first long side plate 43, an inter-hole portion between the insertion hole 43a and the insertion hole 43d is

secured while maintaining such a positional relationship. As the amount of the positional deviation between the insertion hole 43a and the insertion hole 43d increases, the inter-hole length of the above-described inter-hole portion increases. Therefore, even if the diameter of the two protrusions (23b and 23c) of the suction side socket (23) is increased or the arrangement pitch of the plurality of filtration membrane units (21) is reduced, the inter-hole length can be made equal to or more than the narrow limit value by further increasing the positional deviation amount described above.

[0063]

Therefore, with the filtration system 31, the arrangement pitch of the plurality of filtration membrane units 21 can be narrowed without causing the positional deviation of the plurality of filtration membrane units 21 (positional deviation along the lateral direction of the first long side plate 43), and the filtration system 31 can be downsized. In addition, with the filtration system 31, the diameter of the two protrusions (23b and 23c) of the suction side socket (23) can be increased to improve the filtration performance of the filtration membrane 22.

[0064]

The blind cassette 60 illustrated in Fig. 6 includes a plurality of shielding side insertion holes (not

illustrated) on a surface facing the plurality of filtration membrane units 21. These shielding side insertion holes are insertion holes for inserting the protrusion 24b of the shielding side socket 24 of the filtration membrane unit 21. When each of the two protrusions 24b of the shielding side socket 24 is inserted into the shielding side insertion hole provided in the facing surface, the end on the other side in the longitudinal direction of the filtration membrane unit 21 is positioned with respect to the blind cassette 60. In addition, the end on the other side in the longitudinal direction of the filtration membrane unit 21 is held by the blind cassette 60.

[0065]

Note that, although the example in which the plurality of shielding side insertion holes is arranged on the surface of the blind cassette 60 facing the plurality of filtration membrane units 21 and the two protrusions 24b are provided in the shielding side socket 24 of the filtration membrane unit 21 has been described, the shielding side insertion holes and the protrusions 24b may be omitted. In this case, for example, by using the following rubber member, it is possible to hold the end on the other side (shielding side) in the longitudinal direction in each of the plurality of filtration membrane

units 21. That is, it is a rubber member including a base plate extending along the longitudinal direction of the blind cassette 60 and a plurality of partition plates protruding from the surface of the base plate and arranged at a predetermined arrangement pitch along the longitudinal direction of the blind cassette 60. The shielding side socket 24 of the filtration membrane unit 21 may be sandwiched between two partition plates adjacent to each other in the rubber member.

[0066]

In addition, an example in which the shape of the filtration membrane 22 is a flat plate shape has been described, but the shape of the filtration membrane 22 is not limited to the flat plate shape, and may be, for example, a corrugated plate shape.

[0067]

Stress is applied to the filtration membrane unit 21 by a flow of the raw water (W_1) existing around the filtration membrane unit 21, bubbles released from the bubble generation device 90, and the like. Due to this stress, a force (skew force) is applied to the filtration membrane unit 21 so that the lateral direction of the filtration membrane 22 is inclined from the lateral direction (vertical direction in Fig. 6) of each of the water collection cassette 41 and the blind cassette 60. By this

skew force, a large force is applied to a region of the entire filtration membrane 22 close to the first protrusion 23b of the suction side socket 23, a region of the suction side socket close to the second protrusion 23c, and a region of the shielding side socket 24 close to the two protrusions 24b. Hereinafter, the above-described four regions are collectively referred to as a region near the protrusion.

[0068]

As illustrated in Fig. 3, the first protrusion 23b of the suction side socket 23 is disposed at a position deviated to one side (upper side in Fig. 3) from the second protrusion 23c in the lateral direction (vertical direction in Fig. 3) of the filtration membrane (22) (hereinafter, the amount of this deviation is referred to as a "first deviation amount"). Further, first protrusion 23b is disposed at a position deviated toward a center side of a socket body 23a from an end on one side (an upper side in Fig. 3) of the socket body 23a in the lateral direction (hereinafter, the amount of this deviation is referred to as a "second deviation amount").

[0069]

Hereinafter, of the two protrusions 24b provided in the shielding side socket 24, the one located on one side (upper side in the drawing) in the lateral direction

(vertical direction in the drawing) of the filtration membrane (22) is referred to as "protrusion 24b on one side". Of the two protrusions 24b, the one located on the other side (lower side in the drawing) in the lateral direction is referred to as "the protrusion 24b on the other side". The "protrusion 24b on one side" exists at a position deviated to the other side (lower side in the drawing) from an end on one side (upper end in the drawing) in the extending direction of the socket body (24a) (hereinafter, the deviation amount is referred to as a "third deviation amount"). Further, the "protrusion 24b on the other side" exists at a position deviated to one side (upper side in the drawing) from the end on the other side (lower end in the drawing) in the extending direction of the socket body (24a) (hereinafter, the deviation amount is referred to as a "fourth deviation amount").

[0070]

A comparative example different from the example illustrated in Fig. 3 will be examined as a comparison target with the example illustrated in Fig. 3. In the comparative example, the first protrusion 23b of the suction side socket 23 is located at one end (upper end in the drawing) of the filtration membrane (22) in the lateral direction. The second protrusion 23c of the suction side socket 23 is located at the other end (lower end in the

drawing) of the filtration membrane (22) in the lateral direction.

[0071]

In the shielding side socket 24 of the comparative example, the "protrusion 24b on one side" is located at an end on one side (upper end in the drawing) in the lateral direction of the filtration membrane (22). The "protrusion 24b on the other side" is located at the other end (lower end in the drawing) of the filtration membrane (22) in the lateral direction.

[0072]

That is, in the comparative example, the "first deviation amount", the "second deviation amount", the "third deviation amount", and the "fourth deviation amount" are all zero. In the comparative example having such a configuration, the distance between the first protrusion 24b and the second protrusion 24c of the suction side socket 23 is longer than the same distance in the filtration membrane unit 21 according to the embodiment. In addition, in the comparative example, the distance between the "protrusion 24b on one side" and the "protrusion 24b on the other side" of the shielding side socket 24 is longer than the same distance in the filtration membrane unit 21 according to the embodiment. Therefore, in the comparative example, the force applied to

the region near the protrusion of the filtration membrane 22 is larger than that of the filtration membrane unit 21 according to the embodiment by the principle of leverage, so that the filtration membrane 22 is easily damaged. In other words, the filtration membrane unit 21 according to the embodiment can suppress damage of the filtration membrane 22 caused by the skew force by not arranging each protrusion at the end of the socket in the lateral direction of the filtration membrane 22.

[0073]

In the filtration membrane unit 21 according to the embodiment, in order to efficiently suppress can suppress damage of the filtration membrane 22, it is desirable to make the "first deviation amount", the "second deviation amount", the "third deviation amount", and the "fourth deviation amount" as large as possible. However, in the suction side socket 23, when the "first deviation amount" and the "second deviation amount" are excessively increased, it is difficult to equalize the amount of collected water from the first protrusion 23b and the amount of collected water from the second protrusion 23c. In order to achieve the above-described uniformity, each of the "first deviation amount" and the "second deviation amount" is desirably set to 1/10 or less of the length of the suction side socket 23 in the extending direction of

the socket body 23a. More desirably, a range of 1/4 to 1/3 of the length of the suction side socket 23 in the extending direction of the socket body 23a is employed. The same applies to the "third deviation amount" and the "fourth deviation amount" in the shielding side socket 24.

[0074]

In the lateral direction of filtration membrane (22), first protrusion 23b is disposed at a position deviated to one side (upper side in Fig. 3) from the center of the socket body 23a, and second protrusion 23c is disposed at a position deviated to the other side (lower side in Fig. 3) from the center. In such a configuration, deflection of the filtration membrane unit (21) on the protrusion non-disposed side due to both the first protrusion 23b and the second protrusion 23c being disposed at positions deviated to either one side or the other side of the center is prevented. Therefore, according to the filtration membrane unit (21) of the embodiment, it is possible to prevent occurrence of damage of the filtration membrane (22) due to the above-described deflection.

[0075]

Although the filtration system (31) employing a so-called single side pulling system in which only one side of both sides in the longitudinal direction of the filtration membrane 22 is a suction side has been described, a so-

called double side pulling system in which both sides are suction sides may be employed. In this case, the suction side sockets 23 having a similar configuration may be provided as the sockets on both sides.

[0076]

Fig. 10 is a perspective view illustrating three filtration systems 31 stacked on top of each other in the filtration treatment apparatus according to the embodiment. As illustrated in the drawing, the filtration systems 31 are stacked in multiple stages in the vertical direction.

[0077]

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.

[0078]

[First Aspect]

A first aspect is a holder (for example, the holder 40) for holding a plurality of filtration membrane units (for example, the filtration membrane units 21) in a mode of being aligned in a thickness direction of each of the filtration membranes (for example, the filtration membrane 22) by a first holding unit (for example, the water

collection cassette 41) that holds each of ends on one side in a longitudinal direction of the plurality of filtration membrane units 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, in which in a region surrounded by an outer edge of a cross section of the first holding unit along a direction orthogonal to a facing direction between the first holding unit and the plurality of filtration membrane units held by the first holding unit, a plurality of through openings (for example, the through openings 101 to 112) penetrating the first holding unit along the facing direction is arranged in a region facing the plurality of filtration membrane units along the facing direction.

[0079]

With such a configuration, it is possible to visually confirm many filtration membrane units disposed in the frame of the holder through the plurality of through openings disposed in the first holding unit, and it is possible to reduce the effort for maintenance and inspection of the filtration membrane units.

[0080]

[Second Aspect]

A second aspect is the holder having the configuration

of the first aspect, in which in a region surrounded by an outer edge of a cross section of the second holding unit along a direction orthogonal to a facing direction between the second holding unit and the plurality of filtration membrane units held by the second holding unit, a plurality of through openings (for example, through openings 201 to 206) penetrating the second holding unit along the facing direction is arranged in a region facing the plurality of filtration membrane units along the facing direction.

[0081]

With such a configuration, it is possible to visually confirm many filtration membrane units arranged in the frame of the holder through the plurality of through openings arranged in the second holding unit, and it is possible to further reduce the effort for maintenance and inspection of the filtration membrane units.

[0082]

[Third Aspect]

A third aspect is a filtration system (for example, the filtration system 31) including a plurality of filtration membrane units and a holder holding the filtration membrane units, in which the holder is the holder of the first aspect or the second aspect.

[0083]

With such a configuration, it is possible to visually

inspect the plurality of filtration membrane units arranged inside the filtration system through the plurality of through openings arranged in the first holding unit, and it is possible to reduce time and effort for maintenance and inspection of the filtration membrane unit.

[0084]

[Fourth Aspect]

A fourth aspect is the filtration system having the configuration of the third aspect, in which in two of the filtration membrane units adjacent to each other, a gap between ends on one side in a longitudinal direction of each other is smaller than a gap between central portions in the longitudinal direction of each other.

[0085]

With such a configuration, it is possible to prevent a decrease in clogging suppression efficiency of the filtration membrane due to external flow of air bubbles through the through openings of the first holding unit.

[0086]

[Fifth Aspect]

A fifth aspect is a filtration system including the configuration of the third aspect or the fourth aspect, in which the holder is the holder of the second aspect, and in two of the filtration membrane units adjacent to each other, a gap between ends on another side in the

longitudinal direction of each other is smaller than the gap between the central portions in the longitudinal direction of each other.

[0087]

With such a configuration, it is possible to prevent a decrease in clogging suppression efficiency of the filtration membrane 22 due to external flow of functions through the through openings of the second holding unit.

[0088]

[Sixth Aspect]

A sixth aspect is a filtration treatment apparatus (for example, the filtration treatment apparatus 20) including a filtration system, in which the filtration system is a filtration system having the configuration of the fourth aspect or the fifth aspect.

[0089]

With such a configuration, in the filtration treatment apparatus, it is possible to visually confirm many filtration membrane units disposed in the filtration system, and it is possible to reduce the effort for maintenance and inspection of the filtration membrane units.

[0090]

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 holder for holding a plurality of filtration membrane units in a mode of being aligned in a thickness direction of each of filtration membranes by a first holding unit that holds each of ends on one side in a longitudinal direction of the 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, wherein

in a region surrounded by an outer edge of a cross section of the first holding unit along a direction orthogonal to a facing direction between the first holding unit and the plurality of filtration membrane units held by the first holding unit, a through opening penetrating the first holding unit along the facing direction is arranged in a region facing the plurality of filtration membrane units along the facing direction.

2. The holder according to claim 1, wherein

in a region surrounded by an outer edge of a cross section of the second holding unit along a direction orthogonal to a facing direction between the second holding unit and the plurality of filtration membrane units held by the second holding unit, a through opening penetrating the second holding unit along the facing direction is arranged in a region facing the plurality of filtration membrane

units along the facing direction.

3. A filtration system comprising a plurality of filtration membrane units and a holder holding the filtration membrane units, wherein

the holder is the holder according to claim 1 or 2.

4. The filtration system according to claim 3, wherein in two of the filtration membrane units adjacent to each other, a gap between ends on one side in a longitudinal direction of each other is smaller than a gap between central portions in the longitudinal direction of each other.

5. The filtration system according to claim 3 or 4, wherein

the holder is the holder according to claim 2, and

in two of the filtration membrane units adjacent to each other, a gap between ends on another side in the longitudinal direction of each other is smaller than the gap between the central portions in the longitudinal direction of each other.

6. A filtration treatment apparatus comprising a filtration system, wherein

the filtration system is the filtration system according to claim 4 or 5.